Ph. D.'s in Business and Industry (1979)

Pages
105

Size
5 x 9

ISBN
0309332877

Maxfield, Betty D.; Spisak, Andrew W.; Survey of Doctorate Recipients; Commission on Human Resources; National Research Council

PH.D.'S IN BUSINESS AND INDUSTRY

BETTY D. MAXFIELD
Project Director

ANDREW W. SPISAK
Research Associate

Survey of Doctorate Recipients
COMMISSION ON HUMAN RESOURCES

NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C. 1979

Acknowledgments

This report presents a summary of the employment characteristics of Ph.D. scientists and engineers employed in business and industry in 1973 and 1977. The report is based on the results of the 1973 and 1977 Surveys of Doctorate Recipients (SDR) which were conducted under the auspices of the Commission on Human Resources (CHR) of the National Research Council. Support for the project was provided by the National Science Foundation.

Betty D. Maxfield, Project Director of the SDR, and Andrew W. Spisak, Research Associate, were responsible for the development of the report outline, compilation of the summary statistics, and the drafting of the final report. Courtney Knauth, technical editor to the project staff, provided assistance in making final emendations. Roberta Douglas, Project Secretary, was responsible for checking the statistics presented in the report and for setting up the format for the final report.

John Coltman served as the principal reviewer for the Commission, and along with J. James Brown and John Scopino of the National Science Foundation, provided helpful suggestions for clarification of the text of the report.

William C. Kelly, Executive Director of the Commission on Human Resources, provided administrative assistance and policy guidance to the SDR staff. Lindsey Harmon and Dorothy Gilford, CHR staff members, reviewed the first draft of the report and provided a number of helpful suggestions for additional analyses.

The doctorate recipients who responded to the 1973 and 1977 Surveys of Doctorate Recipients deserve much gratitude for the cooperation and assistance that made this report possible.

Betty D. Maxfield
Director
Survey of Doctorate Recipients

Contents

Text Tables

Appendices Tables

Highlights

Business and industry currently ranks as the second largest employer of doctoral scientists and engineers (S/E), employing 25 percent of the S/E Ph.D.'s in 1977 compared with 57 percent employed by educational institutions. While the number of S/E Ph.D.'s in the U.S. labor force increased by approximately 28 percent between 1973 and 1977 (from 218,000 to 280,200), the number of S/E Ph.D.'s working in business and industry increased 34 percent (from 52,900 to 70,600) during the same period of time.

- For those doctoral scientists and engineers who were part of the U.S. labor force in both 1973 and 1977, the percentage employed in business and industry increased from 23.7 percent to 25.6 percent, while the percentages employed in educational institutions and government declined.

- By field of doctorate, newly graduated computer science Ph.D.'s showed the greatest increase in business and industry employment between 1973 and 1977. While less than 25 percent of the FY1972 Ph.D.'s entered business and industry in 1973, nearly 60 percent of the FY1976 computer science Ph.D.'s were employed in the business sector in 1977.

- Women scientists are still a small part of the scientific labor force employed in business and industry, but their numbers are growing. The percentage of women S/E Ph.D.'s employed in business and industry increased between 1973 and 1977 from 2.5 percent to 4.0 percent. The percentage of women in the employed S/E doctoral population in 1977 was 9.5 percent.

- In 1977 nearly 60 percent of the industry-employed S/E Ph.D.'s had degrees in either chemistry or engineering compared with approximately 30 percent of the total employed S/E Ph.D. population.

- In comparison with the total employed S/E Ph.D. population, slightly higher percentages of those employed in business and industry were foreign citizens (8.0 percent versus 6.0 percent) or members of racial minority groups (9.0 percent versus 6.6 percent).

- Over 70 percent of the Ph.D.'s working in business and industry in 1973 and 1977 were employed in manufacturing businesses, with 25 percent working in chemical and allied products alone. However, for those Ph.D.'s working in the psychology field, two out of every three were self-employed in 1977.

- More than 40 percent of industry-employed doctoral scientists and engineers were engaged in research and development in 1973 and 1977. In comparison with men, women were more frequently engaged in basic research and less frequently in development.

- Although management and administration was the second most frequent work activity for the employed S/E doctoral population, only 13.5 percent of the women compared with 37.8 percent of the men in 1973, and 11.8 percent of the women compared with 34.6 percent of the men in 1977, held positions as managers or administrators. Women were more frequently self-employed than men, 37.6 percent compared with 7.3 percent for men in 1973 and 38.9 percent compared with 8.5 percent for men in 1977.

- Nearly 60 percent of the industry-employed S/E Ph.D.'s whose work was federally supported in 1977 devoted a significant proportion of their professional time to national defense or energy and fuel. The areas to which scientists and engineers who received no funding from the U.S. government devoted large portions of their professional time were energy and fuel or health.

- Nearly half of all federally funded S/E Ph.D.'s received at least part of their support from the Department of Defense (DOD), of which the highest percentages were working for companies involved primarily in the manufacturing of transportation equipment or electrical and communications equipment.

- One-third of those Ph.D.'s receiving funding from the Department of Health, Education, and Welfare (DHEW) were self-employed; two-thirds of whom were in the field of psychology.

- Salaries of Ph.D.'s employed in business and industry failed to keep pace with inflation between 1973 and 1977. The median annual salary of all S/E Ph.D.'s employed full-time in business and industry increased nearly 29 percent between 1973 and 1977; the consumer price index for the same period increased approximately 38 percent.

- The median annual salary estimates for the full-time employed S/E Ph.D.'s in business and industry were $23,200 in 1973 and $29,900 in 1977 as contrasted with median academic salaries of $19,100 in 1973 and $23,600 1977. The self-employed S/E Ph.D.'s had the highest median salary in both 1973 ($30,200) and 1977 ($32,400). Ph.D.'s working in petroleum and refining businesses had the next highest median annual salary in 1977 ($32,000). Ph.D. employees of non-classifiable companies had the lowest median salary in 1977 ($25,900).

- By primary work activities, the highest median annual salaries in business and industry in 1977 were estimated for managers and administrators ($34,600) and those providing professional service ($35,200).

- By field, Ph.D.'s working in psychology had the highest estimated median annual salaries in both 1973 ($30,000) and 1977 ($33,600).

- In 1977, the S/E Ph.D.'s in business and industry who had the highest proportion of employment in the same fields as their doctoral fields were computer scientists (92.3 percent) and psychologists (88.4 percent). Ph.D. recipients who were least likely to be employed in the same fields as their degrees were mathematicians (36.6 percent remaining in field), physicists and astronomers (40.7 percent), biological scientists (41.4 percent), and social scientists (48.9 percent). Mathematics and physics doctorates gravitated principally to engineering and computer sciences.

- Of the S/E Ph.D.'s employed in business and industry in both 1973 and 1977 over 80 percent reported that they worked in the manufacturing sector both years. Retention rates ranged from 94.1 percent for petroleum and refining to 86.9 percent for electrical and communications equipment.

Overview

Educational institutions, particularly four-year colleges and universities continue to employ the majority (57 percent in 1977) of doctoral scientists and engineers.[1] However, as higher education enrollments decline and the gap widens between available faculty positions and the number of science and engineering (S/E) Ph.D.'s, many who may have preferred a career in academe are now taking jobs in other employment sectors.[2] Because of the tightening academic job market, considerable attention has been focused on the ability of other types of employers to absorb doctoral scientists and engineers.

Business and industry (includes manufacturing, nonmanufacturing, self-employed), the second largest employer of highly trained scientists and engineers,[3] has shown the

---

[1]The science/engineering Ph.D. fields include mathematics, computer sciences, physics/astronomy, chemistry, earth, environmental, and marine sciences, engineering, life sciences (agricultural, medical, and biological), psychology, and social sciences. A detailed list of fields appears as part of the 1977 survey questionnaire reproduced in Appendix A.

[2]Fernandez, Luis, U.S. Faculty After the Boom: Demographic Projections to 2000, Berkeley, Carnegie Council on Policy Studies in Higher Education, 1978. Radner, Roy and Kuh, Charlotte, Preserving a Lost Generation: Policies to Assure a Steady Flow of Young Scholars Until the Year 2000. Berkeley, Carnegie Council on Policy Studies in Higher Education, 1978.

[3]National Research Council, Commission on Human Resources, Science, Engineering, and Humanities Doctorates in the United States, 1977 Profile (Washington, D.C.: National Academy of Sciences, 1978), p. 16.

greatest gain in the number of Ph.D.'s employed over the past few years. While the total labor force of S/E Ph.D.'s increased by approximately 28 percent between 1973 and 1977 (from 218,000 to 280,200), the number working in business and industry increased nearly 34 percent (from 52,900 to 70,600).

This report looks at the characteristics of science and engineering Ph.D.'s employed in business and industry. Data are presented from the 1973 and 1977 Surveys of Doctorate Recipients on demographic characteristics, academic background, the type of job held within business and industry, and the primary work activity performed. Contrasts between characteristics of the total employed population of S/E Ph.D.'s and the business and industry group have also been noted. Although the time interval is limited, some interesting tendencies between 1973 and 1977 seem apparent, and readers may want to used the earlier data to make further comparisons of their own. Analyses for the periods 1973-1975 and 1975-1977 have been excluded because the changes are small and often statistically insignificant.

The body of the report consists of three chapters. Chapter 1 defines the population of Ph.D. scientists and engineers in the United States and subgroups such as the labor force and those employed in business and industry. The 1973 and 1977 demographic data include such variables as sex, racial/ethnic background, age, doctoral field, and year in which the Ph.D. was awarded (cohort). Distribution of the total employed S/E doctoral population and the business and industry group are compared, and observed changes over time are analyzed.

Employment characteristics include primary work activity, field of employment, and business and industry group. The relationships among these variables are discussed in Chapter 1, along with an examination of the type of employer of newly graduated Ph.D.'s by the Ph.D. field of the employee.

Federal support status and agency of support are also analyzed in Chapter 1. A recent report[4] from the

---

[4]Division of Science Resource Studies, Federal Funds for Research, Development and Other Scientific Activities, (Washington, D.C.: National Science Foundation, 1978), pp. 13-15.

National Science Foundation noted that federal expenditures for research and development (R&D) activities in business and industry increased in fiscal year 1976, largely as a result of support by the Department of Defense, the Department of Energy, and the National Aeronautics and Space Administration. This emphasis on R&D reversed the trend that existed between 1968 and 1974, when total federal R&D funding declined 3.7 percent in constant dollars.[5] The industry sector was affected not only by the decrease in federal R&D funds, but by a cut in its share of this reduced money, from 59 percent in 1968 to 48 percent in 1975.[6] Between 1975 and 1976, however, total expenditures by business and industry for R&D (company plus federal funds) increased by 5 percent.[7] Because the increase occurred during the year preceding the 1977 survey, the effect on jobs in business and industry cannot be fully assessed. But it is reasonable to infer that R&D money tends to create research jobs for scientists and engineers, and that some increase can be expected in the number of S/E Ph.D.'s in business and industry when the flow of R&D funding accelerates.

In Chapter 2, salary distributions for the S/E Ph.D.'s in business and industry by primary work activity, business and industry group, and field of employment are examined. Salary increases between 1973 and 1977 are compared with cost-of-living increases in the same period.

Chapter 3, the final section of the report, looks at mobility both in the S/E Ph.D. labor force and in the business and industry subpopulation. The movement from doctoral field to employment field is traced for the business and industry group. For the S/E Ph.D. labor force, data are presented on shifts among the major employment sectors between the two survey years. Finally, shifts among the various business and industry groups are analyzed for those employed in the business sector in both 1973 and 1977.

---

[5]Division of Science Resources Studies, Federal Funds, p. 2.

[6]Division of Science Resources Studies, Federal Funds, p. 8.

[7]Division of Science Resources Studies, "Industrial R&D Spending Reached $26.6 Billion in 1976," Highlights, (Washington, D.C.: National Science Foundation, NSF78-306, May 1978), p. 1.

Survey Sample

The data for this study were collected from the 1973 and 1977 Surveys of Doctorate Recipients (See Appendix A for the questionnaires). The surveys were conducted by the Commission on Human Resources of the National Research Council (CHR/NRC) under the sponsorship of the National Science Foundation, the National Endowment for the Humanities, and the National Institutes of Health.

The 1973 sample included science and engineering doctorates who earned degrees during the period 1930-1972, while the 1977 sample consisted of the 1934-1976 cohorts, or 42 years for each survey. The samples were stratified by field of doctorate or, for a small number of respondents whose degrees were not in science or engineering, the field of science/engineering employment; the year in which the doctoral degree was awarded; sex; location of Ph.D. institution (U.S. or foreign); size of Ph.D. institution (for the 1973 sample only); and racial/ethnic group (for the 1977 sample only). Appendix B gives the sample sizes and response rates for the two surveys by each stratifying variable. A detailed description of the weighting procedure is provided in Appendix C.

Throughout the report, whenever observed differences between categories or between the two survey years are not significant at the .95 level of confidence (i.e., whenever the estimated difference divided by its sampling errors is less than 2), the reader is so advised. The procedure followed in estimating sampling errors is described in Appendix D.

1

Demographic and Employment Characteristics

The population of doctoral scientists and engineers (S/E) in the United States was approximately 295,800 in 1977.[8] The size of the 1977 S/E labor force[9] was estimated at 280,200 Ph.D.'s, of whom 276,900 were employed and 3,300 unemployed and seeking employment.[10] Figure 1 shows the relationship that exists among the population, labor force, and employed segment of the S/E population. The distribution of the employed doctoral S/E population by type of employer in 1977 is also given in Figure 1.

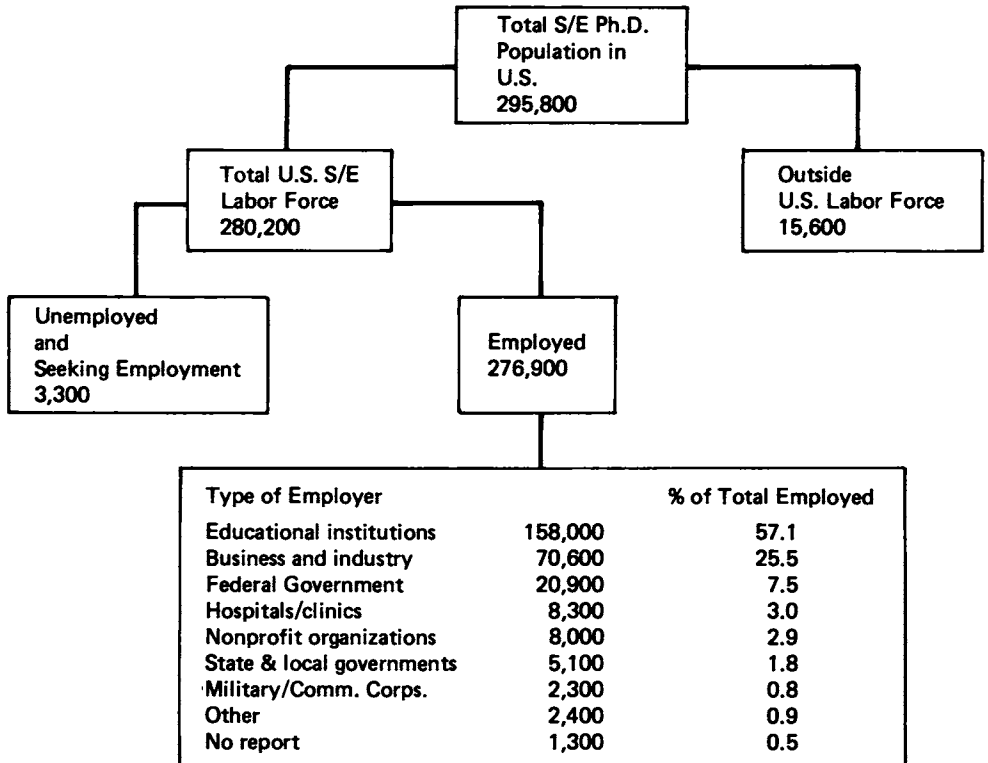
Between 1973 and 1977, the number of Ph.D. scientists and engineers in the labor force increased by approximately 28 percent, from 218,000 to 280,200. The number of S/E doctorates employed in business and industry, however, increased nearly 34 percent, from 52,900 to 70,600 (Figure 2).

---

[8]National Research Council, Commission on Human Resources, Science, Engineering, and Humanities Doctorates in the United States, 1977 Profile (Washington, D.C.: National Academy of Sciences, 1978), p. ix.

[9]Labor force estimates consist of those Ph.D.'s who indicated in the 1977 Survey of Doctorate Recipients that they were: (1) full-time employed; (2) part-time employed; (3) on a postdoctoral appointment; or (4) unemployed and seeking employment.

[10]National Research Council, Commission on Human Resources, 1977 Profile, p. ix.



Type of Employer		% of Total Employed
Educational institutions	158,000	57.1
Business and industry	70,600	25.5
Federal Government	20,900	7.5
Hospitals/clinics	8,300	3.0
Nonprofit organizations	8,000	2.9
State & local governments	5,100	1.8
Military/Comm. Corps.	2,300	0.8
Other	2,400	0.9
No report	1,300	0.5

FIGURE 1 Distribution of Doctoral Scientists and Engineers: 1977.

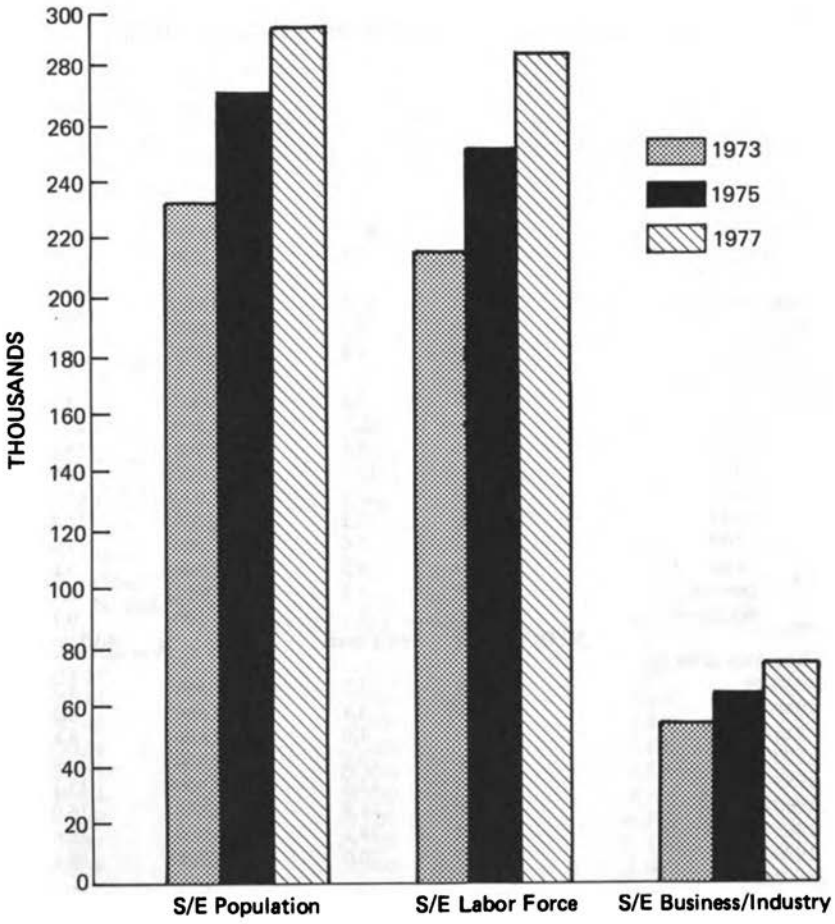


FIGURE 2 Number of Doctoral Scientists and Engineers in the U.S. Population, Labor Force, and Employed in Business and Industry, 1973-1977.

Demographic Characteristics

In Tables 1A and 1B, statistical profiles of scientists and engineers who were employed in business and industry in 1973 and 1977 are compared with profiles of all employed doctoral scientists and engineers in the United States in those years.

TABLE 1A Demographic Characteristics of Doctoral Scientists and Engineers, 1973

	Total Employed		Total Employed in Business and Industry	
Total S/E Ph.D. Population	215,500		52,900	
	N	%	N	%
Sex				
Male	199,300	92.5	51,600	97.5
Female	16,200	7.5	1,300	2.5
Racial Group				
White/Caucasian	196,100	91.0	48,400	91.4
Minority Group	11,300	5.2	3,000	5.8
No Report	8,100	3.8	1,500	2.8
Age in Survey Year				
Under 30	9,700	4.5	2,000	3.8
30-34	49,400	22.9	12,200	23.1
35-39	41,300	19.2	10,400	19.6
40-44	34,400	15.9	8,400	15.9
45-49	29,000	13.5	7,000	13.3
50-54	23,400	10.9	6,200	11.8
55-59	15,000	7.0	3,800	7.2
60-64	8,500	4.0	1,900	3.6
Over 64	4,600	2.2	900	1.7
No Report	200	0.1	100	0.1
	MEDIAN AGE	40.6 years		40.7 years
Calendar Year of Ph.D.				
1930-39	7,000	3.2	1,900	3.7
1940-44	7,400	3.4	2,500	4.8
1945-49	8,700	4.0	2,400	4.6
1950-54	23,300	10.8	7,000	13.0
1955-59	26,700	12.4	7,000	13.2
1960-64	36,500	16.9	8,400	16.0
1965-69	62,800	29.1	15,200	28.6
1970-72	43,100	20.0	8,500	16.1
Citizenship				
U.S.	204,400	94.9	50,100	94.6
Foreign	10,800	5.0	2,800	5.3
No Report	300	0.1	*	0.1
Field of Doctorate				
Mathematics	12,000	5.6	1,000	1.9
Computer Sciences	600	0.3	200	0.4
Physics/Astronomy	20,700	9.6	5,300	10.1
Chemistry	36,000	16.7	18,200	34.3
Earth Sciences	7,100	3.3	1,400	2.7
Engineering	33,300	15.5	15,500	29.2
Agricultural Sciences	9,900	4.6	1,300	2.5
Medical Sciences	5,500	2.6	1,200	2.2
Biological Sciences	39,400	18.3	4,300	8.1
Psychology	22,400	10.4	2,800	5.4
Social Sciences	28,600	13.3	1,700	3.2

*Figures total less than 100.

TABLE 1B Demographic Characteristics of Doctoral Scientists and Engineers, 1977

	Total Employed		Total Employed in Business and Industry	
Total S/E Ph.D. Population	276,900		70,600	
	N	%	N	%
Sex				
Male	250,600	90.5	67,800	96.0
Female	26,300	9.5	2,800	4.0
Racial Group				
White/Caucasian	246,700	89.1	61,800	87.5
Minority Group	18,400	6.6	6,300	9.0
No Report	11,800	4.3	2,500	3.5
Age in Survey Year				
Under 30	8,400	3.0	1,800	2.5
30-34	53,000	19.1	13,600	19.3
35-39	65,600	23.7	18,100	25.6
40-44	43,900	15.9	11,300	16.0
45-49	36,400	13.1	8,800	12.5
50-54	29,900	10.8	7,200	10.2
55-59	21,500	7.8	5,400	7.7
60-64	12,300	4.5	3,000	4.3
Over 64	5,600	2.0	1,300	1.8
No Report	300	0.1	100	0.1
	MEDIAN AGE	40.6 years		40.2 years
Calendar Year of Ph.D.				
1934-39	3,400	1.2	1,000	1.4
1940-44	6,000	2.2	2,100	3.0
1945-49	8,000	2.9	2,300	3.2
1950-54	22,800	8.3	6,600	9.4
1955-59	26,400	9.5	7,000	9.8
1960-64	36,500	13.2	8,700	12.3
1965-69	64,000	23.1	16,800	23.8
1970-74	85,300	30.8	21,100	29.9
1975-76	24,500	8.9	5,000	7.1
Citizenship				
U.S.	260,000	93.9	64,900	91.9
Foreign	16,500	6.0	5,700	8.0
No Report	400	0.1	*	0.1
Field of Doctorate				
Mathematics	15,000	5.4	1,800	2.6
Computer Sciences	1,500	0.5	600	0.8
Physics/Astronomy	25,100	9.1	6,800	9.7
Chemistry	41,200	14.9	21,200	30.1
Earth Sciences	9,100	3.3	2,000	2.8
Engineering	42,800	15.5	20,700	29.3
Agricultural Sciences	12,800	4.6	2,300	3.3
Medical Sciences	7,600	2.7	1,500	2.1
Biological Sciences	48,700	17.6	5,900	8.3
Psychology	32,200	11.6	5,100	7.2
Social Sciences	40,900	14.8	2,700	3.9

*Less than 50.

Within each group (i.e., the total employed S/E Ph.D. population and the business and industry subpopulation) most changes in demographic characteristics between 1973 and 1977 were not significant. However, the proportion of women in the total employed population rose from 7.5 percent in 1973 to 9.5 percent in 1977. Although the actual number of women in business and industry remained small, it doubled during this period, and the percentage increased from 2.5 to 4.0 percent. Otherwise, the distribution of Ph.D.'s by such variables as age, cohort, and field of doctorate remained fairly stable for both the total population and the business and industry sector.

The more interesting comparisons lie between the characteristics of the total employed population of S/E Ph.D.'s and those working in business and industry. Few differences exist between the two groups for certain variables such as age and year of Ph.D. It is interesting to note, however, that 59.4 percent of the Ph.D.'s working in business and industry in 1977 had degrees in either chemistry or engineering, compared with 30.4 percent in the total S/E employed population. Conversely, larger percentages of Ph.D.'s in the biological sciences, psychology, and the social sciences, and to a lesser extent mathematics, were working in employment sectors other than business and industry.

In comparison with the total employed S/E population, a slightly higher proportion of those employed in business and industry were foreign citizens (8.0 percent versus 6.0 percent).[11] This may be partly attributed to the fact that chemistry and engineering--fields in which the majority of those employed in business and industry had earned their Ph.D.'s--contain relatively high percentages of foreign citizens.[12] Similarly, there is a higher proportion of racial minorities (including Blacks, Asians, and American Indians) in the business and industry sector (9.0 percent) than in the total employed population (6.6 percent). Like foreign citizens, racial minorities constitute relatively high percentages of Ph.D. recipients in chemistry and

---

[11]See Appendix D for a discussion of the effects of non-response bias on estimates of demographic data.

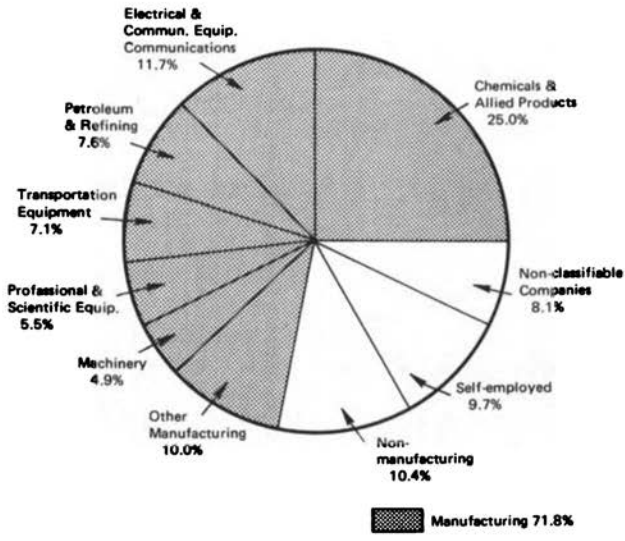
[12]National Research Council, Commission on Human Resources, 1977 Profile, p. 12.

engineering.[13]

In both survey years higher proportions of women Ph.D.'s were found in the total employed population than in business and industry--7.5 percent compared to 2.5 percent in 1973 and 9.5 percent compared to 4.0 percent in 1977. This is partly a function of the small proportions of women among doctoral graduates in engineering (0.6 percent in 1977) and chemistry (6.6 percent).[14] It also reflects the fact that there are large percentages of women among Ph.D.'s in the biological sciences, psychology, and the social sciences; fields that have higher percentages of Ph.D.'s working outside business and industry.

Business and Industry Group by Field of Employment

The distribution of all S/E doctorates who were working in business and industry in 1977 by the broad business and industry groups in which they were employed is shown in Figure 3. Over 70 percent of all the Ph.D.'s were employed



NOTE: Percentages are based on an estimated population of 70,600.

FIGURE 3 Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Business and Industry Group, 1977.

[13]National Research Council, Commission on Human Resources, 1977 Profile, p. 12.

[14]National Research Council, Commission on Human Resources, 1977 Profile, p. 12.

TABLE 2A Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Industry Group and Field of Employment, 1973

1973 Business/Industry Group	1973 Field of Employment													
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc	NonSc	No Reprt
Total	52900	800	1000	3500	14200	2100	17000	1700	2100	2900	2500	1100	2900	1100
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Manufacturing	75.8	68.4	82.2	81.9	93.3	64.3	80.3	66.2	69.3	78.6	15.4	23.6	54.4	50.6
Chemicals & Allied Products	26.6	8.2	5.8	5.1	54.0	7.1	11.3	26.8	60.4	50.9	2.2	2.8	18.7	18.9
Elec. & Comm. Equip./Comm.	13.1	22.0	27.4	29.8	5.1	4.3	24.7	0.3	1.7	2.7	3.8	3.5	4.1	7.3
Petroleum & Refining	8.3	7.0	9.8	2.5	8.7	37.5	10.0	2.8	0.6	1.9	1.2	3.5	6.8	3.1
Transportation Equipment	7.5	10.8	5.5	20.1	2.3	3.7	14.6	0.8	0.2	0.3	2.8	4.0	1.2	6.4
Professional & Sci. Equip.	5.0	2.4	8.1	11.3	7.1	1.8	3.4	1.2	4.8	4.3	1.0	1.9	6.8	5.6
Machinery	4.6	12.3	22.8	10.0	1.8	2.5	6.8	0.4	0.2	2.6	2.3	0.9	4.4	2.6
Other Manufacturing	10.7	5.6	2.7	3.1	14.4	7.5	9.6	33.8	1.3	16.0	2.2	7.0	12.5	6.7
Nonmanufacturing	9.0	19.8	9.8	7.9	1.7	15.8	9.5	20.3	8.2	9.3	10.9	33.3	16.0	10.9
Self-employed	8.0	6.8	1.5	3.1	1.0	10.6	3.2	9.0	17.5	3.8	63.2	18.2	17.4	20.1
Non-classifiable companies	7.2	5.0	6.5	7.1	4.0	9.3	7.0	4.5	5.0	8.3	10.4	24.9	12.2	18.3

TABLE 2B Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Industry Group and Field of Employment, 1977

1977 Business/Industry Group	1977 Field of Employment													
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc	NonSc	No Reprt
Total	70600	1000	2900	3800	16500	3000	21700	2600	3000	3300	4700	1600	4900	1600
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Manufacturing	71.8	73.3	70.8	85.4	93.1	63.7	77.8	54.8	66.8	78.2	12.7	24.0	55.6	49.7
Chemicals & Allied Products	25.0	10.2	5.5	8.6	54.1	8.4	11.8	18.9	56.8	50.5	2.5	4.3	20.9	18.1
Elec. & Comm. Equip./Comm.	11.7	23.4	24.5	27.5	4.4	5.0	21.5	–	–	2.7	3.4	7.2	4.8	5.8
Petroleum & Refining	7.6	5.0	4.2	2.2	9.2	37.7	9.1	3.3	0.6	1.9	0.5	4.2	5.0	2.9
Transportation Equipment	7.1	12.3	8.4	18.8	2.3	1.3	14.3	0.7	1.1	0.2	2.1	3.3	2.2	6.1
Professional & Sci. Equip.	5.5	5.5	6.9	12.9	8.3	1.6	4.7	0.4	5.7	4.6	0.8	–	5.1	2.9
Machinery	4.9	7.2	19.1	12.6	2.0	1.7	6.9	0.9	1.0	3.3	1.4	0.1	4.3	3.3
Other Manufacturing	10.0	9.6	2.3	2.9	12.8	8.1	9.6	30.6	1.7	15.0	2.0	5.0	13.3	10.6
Nonmanufacturing	10.4	16.9	14.6	6.4	2.5	14.7	11.9	21.1	5.8	9.0	7.7	40.5	18.7	8.0
Self-employed	9.7	5.2	4.6	2.1	1.2	7.2	4.0	8.4	20.6	4.7	66.7	17.2	12.6	17.1
Non-classifiable companies	8.1	4.6	10.0	6.1	3.2	14.4	6.4	15.6	6.8	8.1	12.8	18.3	13.1	25.2

in manufacturing, with 25 percent in chemical and allied products alone.

Table 2A shows the distribution of the 52,900 doctoral scientists and engineers employed in business and industry in 1973 by field of employment and business/industry group. Table 2B give analogous data for the 70,600 Ph.D.'s who were employed in business and industry in 1977.

In both survey years, the highest percentages of Ph.D.'s in most employment fields were working in manufacturing businesses. In both 1973 and 1977 the manufacturing businesses included, for example, over 90 percent of those employed as chemists and over 80 percent of those employed as physicists. A majority of the Ph.D.'s in the biological sciences, engineering, mathematics, computer sciences, earth sciences, and medical sciences were also working in manufacturing businesses. On the other hand, a greater number of Ph.D.'s employed in the social sciences were working in non-manufacturing, including real estate, banking, finance, and consulting institutions, than in any other business and industry group (33.3 percent in 1973 and 40.5 percent in 1977). An interesting finding is that in 1977 two out of every three Ph.D.'s working in psychology were self-employed.

Although the number of S/E doctorates in manufacturing businesses increased from 40,100 in 1973 to 50,700 in 1977, the corresponding proportion of doctorates in manufacturing businesses declined between the two survey years (75.8 percent and 71.8 percent, respectively). The employment field of computer sciences showed the greatest shift of S/E Ph.D.'s moving from manufacturing to non-manufacturing (82.2 percent were in manufacturing businesses in 1973 compared with 70.8 percent in 1977); however, the numbers increased from 800 in 1973 to 2,100 in 1977. Agricultural sciences also had a high percentage of Ph.D.'s who changed from manufacturing businesses in 1973 to non-manufacturing businesses in 1977 (from 66.2 percent in manufacturing businesses in 1973 to 54.8 percent in 1977).

Estimates of the number of S/E Ph.D.'s by detailed business and industry group in 1977 are reported in Appendix F, Table F.2. Industrial organizations have been classified according to the Enterprise Standard Industrial Classification, which was developed by the Office of Management and Budget, Executive Office of the President, as revised by the

Securities and Exchange Commission (SEC). A listing of these SEC codes is included following Table F.2. Table F.3 in Appendix F contains estimates of the number of S/E Ph.D.'s employed in business and industry in 1977 by fine field of employment.

Primary Work Activity and Business/Industry Group

Tables 3A and 3B present breakdowns of the business and industry categories in which S/E Ph.D.'s were employed and the principal functions that they performed.

In both 1973 and 1977, research and development (R&D) was the predominant work activity of Ph.D. scientists and engineers employed in business and industry--more than 40.0 percent, excluding R&D management and administration. Between 1973 and 1977, the number engaged in R&D increased from 22,900 to 29,900. In both survey years over 50 percent of the Ph.D.'s who were working in the electrical and communications equipment, transportation equipment, and machinery industries were employed primarily in R&D.

In 1973 and 1977, approximately one-third of the S/E Ph.D.'s in business and industry worked in management and administration, the second most predominant work activity. The percentages of Ph.D.'s in the various manufacturing categories who worked as managers in 1977 ranged from 32.2 percent in machinery to 46.5 percent in the "other manufacturing" category. In contrast, only about 8.5 percent of the self-employed were engaged in management in 1977.

The overall percentage of Ph.D.'s in management and administration dropped from 37.2 percent in 1973 to 33.7 percent in 1977 (although the actual numbers increased from 19,700 to 23,800). This may be explained partly by the influx of new Ph.D.'s (i.e., 1973-1976 cohorts), who constituted 21 percent of the population employed in business and industry. An analysis of the 1977 data shows that 38.5 percent of those who received doctorates between 1934 and 1972 were working in management and administration, compared with 16.3 percent of the recent doctorate recipients. The majority of the 1973-1976 Ph.D.'s--56.8 percent compared with 38.5 percent of the 1934-1972 cohorts--were working in research and development.

For the most part, the distribution of Ph.D.'s by primary work activity and business and industry group

TABLE 3A Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Industry Group, 1973

	1973 Business/Industry Group											
		Manufacturing										
1973 Primary Work Activity	Total	Total	Chem/ Allied Prod	Elec/ Comm Equip/ Comm	Petrl & Ref	Trans Equip	Prof- Sci Equip	Machinery	Other	Non- manufac.	Self- Empl	Non- Class Comp
Total	52900	40100	14100	6900	4400	4000	2700	2400	5600	4800	4200	3800
	%	%	%	%	%	%	%	%	%	%	%	%
Research and Development	43.2	50.0	47.2	57.9	48.1	56.0	54.9	59.1	38.0	28.3	7.3	31.0
Basic Research	*6.6*	*7.9*	*10.8*	*6.4*	*6.3*	*4.8*	*12.7*	*8.5*	*3.1*	*2.3*	*1.5*	*4.9*
Applied Research	*24.9*	*28.5*	*27.0*	*31.0*	*33.0*	*34.2*	*27.7*	*22.2*	*24.6*	*18.2*	*2.5*	*20.5*
Development	*11.7*	*13.6*	*9.4*	*20.6*	*8.8*	*16.9*	*14.5*	*28.4*	*10.3*	*7.9*	*3.3*	*5.6*
Management and Administration	37.2	40.0	42.2	34.9	38.4	36.9	38.7	29.6	49.6	40.2	12.1	32.3
of Research and Development	*26.8*	*30.1*	*32.6*	*29.1*	*25.3*	*29.2*	*30.9*	*18.1*	*34.6*	*24.8*	*2.9*	*21.2*
of Other than Res. & Devel.	*6.5*	*6.0*	*6.6*	*2.5*	*8.9*	*3.5*	*3.7*	*5.7*	*9.9*	*11.4*	*5.9*	*5.8*
of R&D and Other Activities	*3.9*	*3.9*	*3.0*	*3.4*	*4.2*	*4.2*	*4.1*	*5.8*	*5.2*	*3.9*	*3.3*	*5.3*
Consulting	5.1	1.3	1.1	1.6	1.4	0.9	1.0	2.4	0.9	12.8	22.7	16.8
Professional Services	3.8	0.5	0.6	0.4	0.6	0.3		0.3	0.4	2.6	36.4	3.9
Other	9.1	7.3	8.1	4.9	10.1	4.4	4.3	8.2	9.2	14.9	16.1	12.4
No Report	1.6	1.0	0.8	0.3	1.3	1.5	1.2	0.3	1.8	1.3	5.4	3.7

TABLE 3B Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Industry Group, 1977

	1977 Business/Industry Group											
		Manfacturing										
1977 Primary Work Activity	Total	Total	Chem/ Allied Prod	Elec/ Comm Equip/ Comm	Petrl & Ref	Trans Equip	Prof- Sci Equip	Machinery	Other	Non- manufac.	Self- Empl	Non- Class- Comp
Total	70600	50700	17700	8200	5400	5000	3900	3500	7000	7400	6800	5700
	%	%	%	%	%	%	%	%	%	%	%	%
Research and Development	42.4	50.2	48.5	56.1	50.8	56.7	49.6	56.0	39.6	33.3	7.8	26.8
Basic Research	*6.5*	*8.2*	*11.7*	*6.6*	*7.0*	*4.9*	*9.3*	*8.3*	*3.7*	*2.5*	*1.1*	*3.9*
Applied Research	*23.4*	*27.2*	*26.4*	*26.3*	*34.7*	*31.5*	*26.4*	*21.6*	*24.8*	*20.6*	*4.5*	*15.1*
Development	*12.5*	*14.8*	*10.5*	*23.2*	*9.1*	*20.3*	*13.9*	*26.2*	*11.0*	*10.1*	*2.2*	*7.8*
Management and Administration	33.7	38.1	40.4	33.1	33.8	34.3	38.6	32.2	46.5	33.0	8.5	26.5
of Research and Development	*22.5*	*27.0*	*29.6*	*25.5*	*19.5*	*24.7*	*28.8*	*22.1*	*31.4*	*14.3*	*3.0*	*15.5*
of Other than Res. & Devel.	*8.6*	*8.1*	*8.1*	*5.4*	*10.9*	*5.4*	*5.9*	*8.2*	*12.2*	*16.4*	*4.5*	*8.4*
of R&D and Other Activities	*2.6*	*2.9*	*2.7*	*2.2*	*3.4*	*4.2*	*3.9*	*1.9*	*2.9*	*2.3*	*1.0*	*2.6*
Consulting	5.7	1.3	1.1	1.5	2.6	1.2	0.7	2.5	0.7	11.5	21.7	17.5
Professional Services	5.8	0.5	0.8		0.6	0.2	0.4	0.1	0.7	4.4	45.3	7.0
Other	10.7	9.0	8.4	8.2	11.5	6.8	10.5	8.6	10.2	16.0	12.2	17.7
No Report	1.6	0.9	0.7	1.0	0.8	0.7	0.2	0.5	2.4	1.8	4.5	4.5

showed little change from 1973 to 1977. In the petroleum industry, the percentage employed in management decreased from 38.4 percent in 1973 to 33.8 percent in 1977. Non-classifiable companies had a smaller percentage of managers in 1977 and a larger percentage of Ph.D.'s engaged in "other" primary work activities, including production, sales, quality control, and writing/editing.

As expected, a majority of self-employed scientists and engineers were engaged in consulting or other professional services, 59.1 percent in 1973 and 67.0 percent in 1977. While the percentage of S/E Ph.D.'s engaged in consulting activities was essentially unchanged between 1975 and 1977, the proportion providing professional services increased from 36.4 percent to 45.3 percent.

Primary Work Activity and Sex

Tables 4A and 4B show the distribution of men and women engaged in various work activities in business and industry in 1973 and 1977.

The distribution by sex shows that research and development, the predominant work activity for the total S/E employed population (Tables 3A and 3B), was also the main activity for women as well as men. In both survey years, however, a smaller percentage of women worked in R&D (35.3 percent for women vs. 43.4 percent for men in 1973 and 31.2 percent vs. 42.9 percent in 1977). While a slightly higher proportion of women than men held jobs in basic research in both 1973 and 1977, women were less extensively engaged in development activities (3.5 percent for women vs. 11.9 percent for men in 1973 and 3.6 percent for women compared with 12.9 percent for men in 1977).

The distribution also shows that management and administration was the second most frequent work activity for men, but not for women. In both survey years, substantially smaller percentages of women held management and administrative positions, 13.5 percent compared with 37.8 percent for men in 1973 and 11.8 percent compared with 34.6 percent for men in 1977. Although a greater number of both men and women were employed as managers in 1977, the proportion of men working in management decreased from 37.8 percent in 1973 to 34.6 percent in 1977. The relative decline for women during this period is not statistically significant.

Differences also exist in the proportions of men and women providing professional services. In 1973, 23.4 percent of the women Ph.D.'s provided professional services, compared with only 3.3 percent of the men. Although the proportion of men in this activity remained essentially unchanged between 1973 and 1977, for women it rose to 30.5 percent (approximating the percentage of women in R&D). Analysis shows that in 1977, 80.0 percent of the women engaged in professional services were self-employed psychologists. The analysis also shows that a far higher percentage

TABLE 4A Doctoral Scientists and Engineers Working in Business and Industry by Primary Work Activity and Sex, 1973

1973 Primary Work Activity	Total	Sex	
		Male	Female
Total	52900	51600	1300
	%	%	%
Research and Development	43.2	43.4	35.3
Basic Research	*6.6*	*6.5*	*12.4*
Applied Research	*24.9*	*25.0*	*19.3*
Development	*11.7*	*11.9*	*3.5*
Management and Administration	37.2	37.8	13.5
of Research and Development	*26.8*	*27.3*	*8.4*
of Other than Res. & Devel.	*6.5*	*6.6*	*2.3*
of R&D and Other Activities	*3.9*	*4.0*	*2.8*
Consulting	5.1	5.1	7.3
Professional Services	**3.8**	**3.3**	**23.4**
Other	**9.1**	**8.8**	**17.5**
No Report	**1.6**	**1.5**	**3.0**

TABLE 4B Doctoral Scientists and Engineers Working in Business and Industry by Primary Work Activity and Sex, 1977

1977 Primary Work Activity	Total	Sex	
		Male	Female
Total	70600	67800	2800
	%	%	%
Research and Development	42.4	42.9	31.2
Basic Research	*6.5*	*6.4*	*9.6*
Applied Research	*23.4*	*23.6*	*18.0*
Development	*12.5*	*12.9*	*3.6*
Management and Administration	33.7	34.6	11.8
of Research and Development	*22.5*	*23.1*	*8.0*
of Other than Res. & Devel.	*8.6*	*8.9*	*3.0*
of R&D and Other Activities	*2.6*	*2.7*	*0.7*
Consulting	**5.7**	**5.7**	**6.1**
Professional Services	**5.8**	**4.7**	**30.5**
Other	**10.7**	**10.5**	**17.6**
No Report	**1.6**	**1.6**	**2.7**

of the women Ph.D.'s were self-employed, 37.6 percent vs. 7.3 percent of the men in 1973 and 38.9 percent vs. 8.5 percent of the men in 1977.

Primary Work Activity by Field of Employment

Tables 5A and 5B give the percentages of S/E Ph.D.'s performing the various primary work functions within each field of employment.

A majority of the Ph.D.'s working in mathematics, computer sciences, physics, and chemistry were employed primarily in research and development activities in 1973 and 1977. Although basic research was the principal activity of only about 6 percent of the total S/E Ph.D.'s in both survey years, relatively high percentages of the Ph.D.'s working in physics (20.0 percent), biology (15.1 percent), and chemistry (12.7 percent) were engaged in this activity. In both survey years, higher proportions of the Ph.D.'s in all fields were working in applied research--the principal activity of nearly one-fourth of the total S/E Ph.D. population--than in basic research. The employment fields of mathematics and physics had the highest percentages of Ph.D.'s in applied research (45.9 percent and 42.8 percent, respectively, in 1977). Although development was the primary activity of only 11.7 percent of the total group in 1973 and 12.5 percent in 1977, in both years it was the principal work function of a high percentage of Ph.D.'s working in the computer sciences. In 1973, 39.5 percent of Ph.D.'s employed in computer sciences were engaged in developing equipment, products, systems, or data (mainly for software systems). In 1977, 44.1 percent of those working in computer sciences were employed in development. In both survey years, one out of every five Ph.D.'s in the engineering field of employment was working in development.

In 1973, high proportions of Ph.D.'s working in the life sciences were employed in management and administration; 49.8 percent for medical sciences, 47.9 percent for agricultural sciences, and 45.2 percent for biological sciences. Somewhat smaller percentages of the Ph.D.'s in these three fields were working in management and administration in 1977. A decline in the percentage of Ph.D.'s working in management activities in the medical sciences was accompanied by an increase in the proportion of those providing professional services, from 12.8 percent in 1973 and 18.9

TABLE 5A Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Field of Employment, 1973

1973 Primary Work Activity	1973 Field of Employment													
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc	NonSc	No Reprt
Total	52900	800	1000	3500	14200	2100	17000	1700	2100	2900	2500	1100	2900	1100
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Research and Development	43.2	56.3	60.7	68.2	51.9	34.8	46.8	28.6	26.3	41.0	11.4	28.6	12.0	19.0
Basic Research	6.6	5.9	5.7	16.7	11.9	5.4	1.3	2.6	7.1	15.2	3.1	2.0	0.2	4.6
Applied Research	24.9	43.8	15.5	43.3	32.4	24.8	23.7	19.1	14.9	22.4	6.9	23.5	5.7	10.7
Development	11.7	6.6	39.5	8.2	7.6	4.6	21.8	6.9	4.3	3.4	1.3	3.0	6.1	3.7
Management and Administration	37.2	23.4	27.5	25.4	39.4	39.0	37.7	47.9	49.8	45.2	16.1	32.2	41.2	39.2
of Research and Development	26.8	17.3	16.2	21.6	31.8	19.9	27.6	36.7	39.5	36.7	7.1	17.7	14.2	19.7
of Other than Res. & Devel.	6.5	3.6	7.9	1.7	4.4	9.5	5.8	6.5	5.9	4.2	7.5	10.2	21.7	15.0
of R&D and Other Activities	3.9	2.5	3.4	2.0	3.1	9.5	4.3	4.6	4.3	4.4	1.5	4.3	5.3	4.5
Consulting	5.1	9.6	3.8	2.6	1.3	13.0	5.4	6.4	1.7	4.5	15.2	20.8	7.7	2.8
Professional Services	3.8	2.9	0.6	0.3	0.4	0.3	0.3	1.2	12.8	0.9	50.0	0.6	7.5	3.1
Other	9.1	7.7	7.4	2.3	6.0	12.0	8.7	13.7	6.9	6.7	5.0	17.7	30.1	21.5
No Report	1.6	0.1		1.3	1.1	1.0	1.1	2.2	2.6	1.7	2.3	0.2	1.5	14.5

TABLE 5B Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Field of Employment, 1977

1977 Primary Work Activity	1977 Field of Employment													
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc	NonSc	No Reprt
Total	70600	1000	2900	3800	16500	3000	21700	2600	3000	3300	4700	1600	4900	1600
	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Research and Development	42.4	66.4	57.8	70.9	55.2	41.1	45.7	25.9	25.7	39.2	9.5	43.7	8.7	20.7
Basic Research	6.5	7.5	3.6	20.0	12.7	8.3	1.9	1.0	6.4	15.1	2.1	4.8	0.7	1.1
Applied Research	23.4	45.9	10.1	42.8	33.3	29.1	22.3	18.6	14.9	18.7	6.9	38.1	5.3	9.5
Development	12.5	13.1	44.1	8.1	9.2	3.7	21.5	6.3	4.4	5.4	0.5	0.8	2.8	10.0
Management and Administration	33.7	12.4	24.0	21.0	35.8	32.9	36.3	42.9	41.8	43.3	12.3	19.1	45.5	33.5
of Research and Development	22.5	5.9	14.3	17.5	28.8	15.2	24.3	28.9	34.3	34.9	6.3	14.3	9.0	20.5
of Other than Res. & Devel.	8.6	3.5	7.2	2.4	4.6	14.7	8.5	12.2	5.7	6.5	4.4	3.3	32.1	11.8
of R&D and Other Activities	2.6	3.0	2.5	1.2	2.3	3.1	3.5	1.7	1.7	2.0	1.6	1.5	4.4	1.3
Consulting	5.7	9.3	5.0	2.4	1.2	9.5	6.3	10.6	4.1	6.5	14.9	13.7	4.6	5.8
Professional Services	5.8	0.7	1.1	0.3	0.9	0.9	0.2	2.4	18.9	1.6	57.5	2.1	6.5	4.4
Other	10.7	10.3	9.6	4.9	6.2	14.4	10.8	15.6	6.5	8.7	4.2	16.7	32.7	17.8
No Report	1.6	0.9	2.6	0.3	0.8	1.3	0.9	2.7	2.9	0.6	1.6	4.8	2.0	17.8

percent in 1977. In both survey years, high proportions of Ph.D.'s employed in the nonscience fields, which include business administration, worked in management (41.2 percent in 1973 and 45.5 percent in 1977).

In the social sciences, a shift from management and administration to R&D occurred between 1973 and 1977. In 1973, 32.2 percent of the Ph.D.'s employed in the social sciences were engaged in management, compared with 28.6 percent in R&D. By 1977, the proportion in management had declined to 19.1 percent, while the proportion in R&D had increased to 43.7 percent. A similar movement from management to R&D took place in mathematics, where the proportion of Ph.D.'s in management and administration decreased from 23.4 percent to 12.4 percent between 1973 and 1977 and the proportion in R&D increased from 56.3 percent to 66.4 percent.

In 1973, 50 percent of the Ph.D.'s employed in psychology provided professional services. By 1977, 57.5 percent of the Ph.D.'s in the employment field of psychology were engaged in this activity. Analysis shows that in 1977, 66.4 percent of all Ph.D.'s providing professional services were working in the field of psychology.

Area of National Interest and Federal Support Status

Of the 70,600 science and engineering Ph.D.'s working in business and industry in 1977, an estimated 15,600 had some portion of their work supported by federal funds. Of these, nearly 60 percent reported a significant amount of their professional time was devoted to national defense or energy/fuel matters. Much smaller percentages of the federally supported S/E Ph.D.'s in business and industry were working in each of the other national interest areas (Table 6).

In contrast, scientists and engineers who received no funding from U.S. government sources were most frequently involved in energy/fuel or health topics (18.0 percent and 15.6 percent respectively). Over one-third of the total S/E population in business and industry devoted significant amounts of professional time to either health or energy/fuel.

Comparable 1973 data are not available because the

1973 survey questionnaire did not include an item on area of national interest.

TABLE 6 Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Area of National Interest and Federal Government Support Status, 1977

Area of National Interest	Federal Government Support Status			
	Total	Receiving Support	Not Receiving Support	Don't Know/ No Report
Total	70600	15600	53400	1600
	%	%	%	%
Energy and Fuel	19.0	23.9	18.0	6.2
Food and Other Agricultural Products	6.6	1.7	8.1	2.3
Natural Resources Other than Food and Fuel	2.0	1.2	2.3	0.5
Environmental Protection	9.1	8.3	9.5	2.5
Defense	8.3	34.0	1.0	1.6
Space	1.6	6.1	0.4	1.1
Health	14.0	8.8	15.6	9.6
Education	2.2	1.6	2.3	1.0
Transportation, Communication	4.3	3.3	4.6	1.7
Other Areas	5.7	4.3	6.2	4.4
No Report	27.2	6.8	31.8	69.1

Business and Industry Group by Agency of Federal Support

Table 7 gives the distribution of the 15,600 scientists and engineers who were receiving U.S. government support in 1977 by business and industry group and the agency providing the support.

Nearly one-half of all federal funded S/E Ph.D.'s received at least part of their support from the Department of Defense (DOD). Of these individuals, one-third were employed in the manufacturing of transportation equipment (primarily aircraft, missiles, and ships), while 22.5 percent worked in the electrical and communications equipment industry.

The Energy Research and Development Administration (ERDA)[15] was the second largest supporter of industry-employed Ph.D.'s. ERDA-funded scientists and engineers were employed primarily in businesses that manufactured electronic

[15]ERDA was reorganized and absorbed by the Department of Energy, which was created after the 1977 Survey of Doctorate Recipients was conducted.

TABLE 7 Distribution of Doctoral Scientists and Engineers Employed in Business and Industry by Industry Group and Agency of Federal Support, 1977

1977 Business/Industry Group	Total	Agency of Federal Support									
		DOD	DHEW	DOT	ERDA	EPA	NASA	NSF	NRC	Other Agency or Dept.	Supporting Agency Unknown/ No Report
Total	**15600***	**7300**	**1600**	**500**	**4500**	**1000**	**1900**	**500**	**400**	**1700**	**300**
	%	%	%	%	%	%	%	%	%	%	%
Manufacturing	64.0	72.2	27.9	34.1	78.7	39.9	72.9	44.0	52.2	21.5	73.7
Chemicals & Allied Products	*9.7*	*2.6*	*14.3*	*2.2*	*22.2*	*12.8*	*1.6*	*4.8*	*35.1*	*1.7*	*24.2*
Elec. & Comm. Equip./Comm.	*19.6*	*22.5*	*2.1*	*8.3*	*28.8*	*4.7*	*16.5*	*15.0*	*12.5*	*6.1*	*21.5*
Petroleum & Refining	*2.2*	*0.3*	*0.7*		*6.7*	*3.0*		*3.5*			*2.7*
Transportation Equipment	*21.8*	*33.3*		*19.6*	*14.8*	*9.9*	*41.6*	*12.1*		*4.3*	*15.7*
Professional & Sci. Equip.	*2.8*	*4.2*	*0.4*		*1.3*	*4.1*	*5.8*		*1.8*	*2.5*	
Machinery	*4.6*	*6.4*	*9.0*	*2.8*	*1.0*	*5.0*	*3.9*	*0.2*		*2.8*	*5.1*
Other Manufacturing	*3.3*	*3.0*	*1.5*	*1.1*	*3.9*	*0.5*	*3.4*	*8.5*	*2.8*	*4.1*	*4.5*
Nonmanufacturing	16.1	15.5	17.0	36.1	13.2	29.2	13.7	24.7	24.0	33.8	5.1
Self-employed	**8.6**	**2.7**	**33.1**	**7.2**	**1.9**	**6.9**	**2.0**	**8.0**	**6.2**	**23.6**	**15.0**
Non-classifiable companies	**11.4**	**9.6**	**22.0**	**22.6**	**6.2**	**24.0**	**11.4**	**23.2**	**17.6**	**21.0**	**6.1**

***Respondents to the 1977 Survey of Doctorate Recipients could report more than one agency of support, therefore, the total for all agencies exceeds 15,600.**

DOD – Department of Defense
DHEW – Department of Health, Education, and Welfare
DOT – Department of Transportation
ERDA – Energy Research and Development Administration (now Department of Energy)
EPA – Environmental Protection Agency
NASA – National Aeronautics and Space Administration
NSF – National Science Foundation
NRC – Nuclear Regulatory Commission

TABLE 8A Distribution of Doctoral Scientists and Engineers by Type of Employer and Field of Doctorate, FY 1972 Ph.D. Recipients

1973 Employer	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc
Total Employed	16600	1000	200	1400	1700	500	2900	700	500	2800	2000	2900
	%	%	%	%	%	%	%	%	%	%	%	%
Business and Industry	17.3	6.1	23.7	20.3	26.9	14.2	48.0	19.7	9.1	4.0	5.3	5.5
Educational Institution	62.4	83.1	51.5	49.9	56.2	60.4	32.5	66.6	69.2	76.5	58.6	82.6
Government	12.2	6.6	19.5	25.2	11.5	23.6	14.3	13.4	8.9	9.9	10.8	7.1
Other	8.0	4.2	5.3	4.6	5.4	1.9	5.1		12.9	9.5	25.2	4.7
No Report	0.1							0.3		0.1		0.1

TABLE 8B Distribution of Doctoral Scientists and Engineers by Type of Employer and Field of Doctorate, FY 1976 Ph.D. Recipients

1977 Employer	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc
Total Employed	16000	700	300	1000	1400	600	2200	700	600	2800	2600	3100
	%	%	%	%	%	%	%	%	%	%	%	%
Business and Industry	18.5	10.3	57.0	21.5	34.6	14.4	46.9	17.9	11.6	6.7	9.8	9.2
Educational Institution	61.7	78.4	33.3	60.3	54.0	62.1	38.2	58.3	62.1	76.4	52.3	75.8
Government	9.3	7.3		10.1	6.0	20.4	12.5	18.9	13.2	8.1	7.7	7.1
Other	10.2	4.0	9.6	7.4	4.9	3.1	2.5	4.9	13.2	8.6	29.5	7.8
No Report	0.2	0.1		0.6	0.6					0.2	0.6	0.1

and communications equipment, chemicals and allied products, and transportation equipment. The largest proportion of the Ph.D.'s whose work was supported by the National Aeronautics and Space Administration (NASA) were employed in the manufacturing of transportation equipment, 41.6 percent.

Relatively high percentages (ranging from 24 to 36 percent) of the Ph.D.'s whose work was funded by the Department of Transportation (DOT), the Environmental Protection Agency (EPA), the National Science Foundation (NSF), and the Nuclear Regulatory Commission (NRC) were employed in non-manufacturing businesses.

Almost one-third of the Ph.D.'s whose employment was supported by the Department of Health, Education and Welfare (DHEW) were self-employed. An analysis of this group indicated that nearly two-thirds were psychologists engaged in consulting or professional services.

Type of Employer and Field of Doctorate for Recent Ph.D.'s

Table 8A gives the 1973 Survey data for all individuals who received their Ph.D.'s in science and engineering in fiscal year 1972 (July 1, 1971 - June 30, 1972). Table 8B gives analogous statistics from the 1977 Survey for fiscal year 1976 (July 1, 1975 - June 30, 1976).

By field of Ph.D., recent Ph.D.'s in computer sciences showed the greatest increase in industrial employment between 1973 and 1977 (from 23.7 percent to 57.0 percent), with a corresponding decline in the percentage employed in educational institutions (from 51.5 percent to 33.3 percent). During the period an increasing proportion of new psychologists accepted employment in business and industry, 5.3 percent in 1973 and 9.8 percent in 1977. There was a slight increase in the percentage of new S/E Ph.D.'s taking jobs in business and industry between 1973 and 1977 (17.3 percent compared with 18.5 percent), but this was not statistically significant.

Similar proportions of recent Ph.D.'s took jobs in educational institutions in 1977 (61.7 percent) as in 1973 (62.4 percent). However, shifts into and out of academic employment occurred in a number of fields. Like computer scientists, a smaller portion of the social scientists accepted jobs in educational institutions in 1977 (75.8

percent) compared with 1973 (82.6 percent). In only a few fields was there a relative increase in academic employment for new Ph.D.'s, and among these only physics Ph.D.'s showed a statistically significant gain (from 49.9 percent to 60.3 percent). This increase appears to be related to a decrease in the proportion of Ph.D. physicists entering government service (from 25.2 percent to 10.1 percent).

For all fields combined, the percentage of recent doctorate recipients who accepted government employment (federal, state, or local) declined from 12.2 percent in 1973 to 9.3 percent in 1977. Among the individual fields, the largest decrease between 1973 and 1977 (15.1 percentage points) occurred for government employed physicists. A relative decline also occurred in the employment of chemists in government from 11.5 percent to 6.0 percent. In a number of other fields, estimated differences in the percentages of government employment are not statistically significant.

2

Ph.D. Salaries in Business and Industry

In this chapter, median annual salaries of science and engineering Ph.D.'s employed full-time in business and industry are examined in relationship to their primary work activity, business and industry group, and field of employment. Changes in salaries between 1973 and 1977 are compared with cost-of-living increases that occurred during the same period.

Salary Estimates by Primary Work Activity and Business/Industry Group

Tables 9A and 9B show the estimated median annual salaries for the total full-time S/E Ph.D.'s employed in business and industry by the type of work they performed.

The median annual salary estimates for the business/industry employed S/E Ph.D.'s were $23,200 in 1973 and $29,900 in 1977. Among the business and industry groups, self-employed doctoral scientists and engineers had the highest median salaries in both 1973 ($30,200) and 1977 ($32,400). This finding appears to be related to the large proportion of self-employed individuals providing professional services, an activity for which median salaries were as high as $30,600 in 1973 and $36,500 in 1977. Along with the self-employed group, Ph.D.'s working in the petroleum and refining industry had an estimated median salary of approximately $32,000 in 1977. Ph.D. employees of nonclassifiable companies had the lowest median salary for that year, $25,900. Estimated 1973 median salaries varied little among the other business and industry groups, ranging from $22,000 in other manufacturing to $24,000 in the electrical and communications equipment and the

TABLE 9A Median Annual Salaries of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Industry Group, 1973

1973 Primary Work Activity	1973 Business/Industry Group											
		Manufacturing										
	Total	Total Manufactu.	Chem/ Allied Prod	Elec/ Comm Equip/ Comm	Petrl & Ref	Trans Equip	Prof/ Sci Equip	Machinery	Other	Non-manufac.	Self-Empl	Non-Class Comp
	(In Thousands of Dollars)											
Total	$23.2	$23.1	$22.7	$24.0	$23.5	$23.3	$23.5	$24.0	$22.0	$22.8	$30.2	$22.7
Research and Development	21.3	21.4	20.9	22.3	21.5	21.8	21.9	22.5	19.5	20.8		20.4
Basic Research	*21.6*	*21.7*	*21.2*	*24.4*	*22.1*	*20.7*	*21.5*	*24.7*	*19.2*			*20.2*
Applied Research	*21.3*	*21.2*	*20.9*	*22.1*	*21.4*	*21.5*	*22.0*	*21.8*	*19.8*	*22.3*		*20.5*
Development	*21.3*	*21.4*	*20.6*	*22.1*	*21.6*	*22.3*	*22.1*	*22.2*	*18.8*	*19.7*		*20.4*
Management and Administration	27.0	27.1	26.3	28.8	29.5	26.5	27.8	29.3	25.7	26.8	26.7	26.0
of Research and Development	*26.3*	*26.4*	*25.8*	*28.9*	*27.2*	*26.4*	*27.6*	*28.2*	*25.1*	*25.5*		*26.8*
of Other than Res. & Devel.	*29.8*	*29.5*	*28.5*	*30.2*	*34.1*				*29.4*	*35.1*	*30.6*	*26.0*
of R&D and Other Activities	*28.6*	*29.7*	*28.9*	*25.8*	*36.1*	*26.4*			*30.5*	*28.2*		*25.0*
Consulting	25.1	25.1								21.5	35.7	23.7
Professional Services	30.0	21.8									30.6	
Other	21.1	22.2	22.4	22.9	23.8			23.7	19.6	20.2	14.5	17.7
No Report	23.3	23.4										

NOTE: Median salaries were computed only for Ph.D.'s employed full-time. Median salaries have not been calculated for cells with fewer than 20 individuals reporting salary.

TABLE 9B Median Annual Salaries of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Industry Group, 1977

1977 Primary Work Activity	1977 Business/Industry Group											
		Manufacturing										
	Total	Total Manufactu.	Chem/ Allied Prod	Elec/ Comm Equip/ Comm	Petrl & Ref	Trans Equip	Prof/ Sci Equip	Machinery	Other	Non-manufac.	Self-Empl	Non-Class Comp
	(In Thousands of Dollars)											
Total	$29.9	$30.1	$30.2	$29.9	$31.8	$29.5	$30.3	$29.4	$28.7	$27.3	$32.4	$25.9
Research and Development	27.2	27.5	27.0	28.3	28.9	27.5	28.2	27.4	24.9	25.5	30.0	24.7
Basic Research	*27.4*	*27.7*	*27.0*	*29.4*	*28.7*	*27.8*	*27.3*	*30.5*	*24.0*			*21.9*
Applied Research	*27.4*	*27.5*	*26.8*	*28.9*	*28.5*	*27.6*	*28.9*	*27.1*	*25.5*	*26.7*		*25.5*
Development	*26.9*	*27.3*	*27.6*	*27.1*	*30.0*	*27.4*	*28.0*	*27.2*	*23.9*	*24.5*		*22.3*
Management and Administration	34.6	35.3	35.2	36.3	38.7	33.9	36.2	33.9	33.1	31.8	30.1	30.1
of Research and Development	*34.3*	*34.9*	*34.7*	*36.8*	*37.2*	*33.5*	*36.5*	*33.6*	*32.1*	*31.6*		*30.3*
of Other than Res. & Devel.	*35.4*	*36.9*	*39.0*	*33.4*	*41.5*	*35.8*	*31.0*	*35.8*	*39.2*	*31.8*	*28.4*	*29.6*
of R&D and Other Activities	*34.9*	*35.2*	*34.7*			*35.6*			*32.1*	*37.0*		
Consulting	30.0	30.2	31.1							29.5	30.5	27.5
Professional Services	35.2	25.7								24.1	36.5	30.8
Other	26.6	28.0	29.1	26.7	30.8	26.6	26.2	29.4	27.0	23.1	20.0	23.6
No Report	26.2	26.2										

NOTE: Median salaries were computed only for Ph.D.'s employed full-time. Median salaries have not been calculated for cells with fewer than 20 individuals reporting salary.

machinery industries.

Among the various primary work activities, the highest median salaries in 1977 were estimated for those who were engaged in management and administration ($34,600) and professional services ($35,200). In 1973, managerial and administrative Ph.D.'s in the petroleum and refining, machinery, and electrical and communications equipment industries had a median salary of approximately $29,000. In 1977, management salaries in petroleum and refining ($38,700), electrical and communications equipment ($36,300), and professional and scientific equipment ($36,200) were among the highest estimated medians.

In research and development, the primary work activity in which the highest percentage of Ph.D.'s were engaged in both years (over 40 percent), median salaries were about 20 percent below salaries earned by those Ph.D.'s in management and administration ($21,300 vs. $27,000 in 1973 and $27,200 vs. $34,600 in 1977). (See Tables 3A and 3B for the distribution of S/E Ph.D.'s by primary work activity and business/industry group.) Median salaries for those engaged in R&D in the manufacturing sector ranged from $19,500 (other manufacturing) to $22,500 (machinery) in 1973 and from $24,900 (other manufacturing) to 28,900 (petroleum and refining) in 1977. In both survey years, the median salaries of Ph.D.'s working in basic research, applied research, and development were comparable both for the total population and most business and industry groups.

Longitudinal comparison of salary data shows that the median annual salary of all doctoral scientists and engineers employed full-time in business and industry increased nearly 29 percent between 1973 and 1977 (from $23,200 to $29,900). However, the Bureau of Labor Statistics reported an increase in the Consumer Price Index of approximately 38 percent, from 128.6 in February 1973 to 177.1 in February 1977,[16] the two months for which the data were requested in the 1973 and 1977 Survey questionnaires. Thus, the 1977 median salary for S/E Ph.D.'s employed full-time in business and industry was less than the 1973 median when adjusted for inflation.

---

[16]U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, April 1973, Vol. 96, No. 4, p. 112 and April 1977, Vol. 100, No. 4, p. 109. The index numbers are computed on a base of 100.0 for 1967.

Changes in median annual salaries over the period varied among the business and industry groups. In 1977, the median salary for all manufacturing groups was 30 percent higher than in 1973 ($30,100 vs. $23,100), while salaries in nonmanufacturing and non-classifiable companies had risen less than 20 percent (from $22,800 to $27,300 and from $22,700 to $25,900). During this period self-employed scientists and engineers showed an increase of only 7.3 percent, although in both years the self-employed groups had the highest median salaries.

Salary increases varied less by primary work activity over the 4-year period than by business and industry group. The medians for the major activities of R&D and management and administration both increased about 28 percent between 1973 and 1977. Within management and administration, managers of R&D had the highest salary increase between 1973 and 1977, from $26,300 to $34,300 (30 percent). Among the other major work activities, Ph.D.'s engaged in consulting and professional services had the smallest increase (20.0 percent and 17.3 percent, respectively). This is consistent with the small increase noted earlier for self-employed scientists and engineers, two-thirds of whom were engaged either in consulting or in providing professional services in 1977.

Salary by Primary Work Activity and Field of Employment

Tables 10A and 10B give the 1973 and 1977 median salaries of full-time employed S/E Ph.D.'s in business and industry according to their work functions and employment fields.

For both survey years, the salaries of S/E Ph.D.'s showed considerable variation by field of employment. In 1973, the highest estimated medians were $30,000 for Ph.D.'s working in psychology, $27,300 for those in the social sciences, $26,200 for scientists in medical sciences, and $25,900 for S/E Ph.D.'s working in nonscience fields. The Ph.D. scientists in agricultural fields had the lowest median salary in 1973, $21,800 per year.

In 1977, the highest median salaries were again for Ph.D.'s working in psychology ($33,600), followed by those in medical sciences ($33,200) and the nonscience fields ($31,800). There were slight differences in the

TABLE 10A Median Annual Salaries of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Field of Employment, 1973

1973 Primary Work Activity	1973 Field of Employment													
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc	NonSc	No Reprt
	(In Thousands of Dollars)													
Total	$23.2	$23.8	$22.2	$23.8	$22.3	$22.6	$23.2	$21.8	$26.2	$22.6	$30.0	$27.3	$25.9	$24.4
Research and Development	21.3	23.2	21.3	22.4	20.9	20.6	21.5	18.9	21.6	20.7	25.3	22.7	21.1	20.6
Basic Research	*21.6*			*22.9*	*21.5*		*22.5*		*20.7*	*20.4*				
Applied Research	*21.3*	*23.6*	*22.6*	*22.1*	*20.7*	*20.6*	*21.4*	*19.0*	*22.4*	*20.9*		*24.2*		
Development	*21.3*		*20.5*	*22.7*	*20.8*		*21.7*							
Management and Administration	27.0		27.0	28.7	25.7	25.4	27.2	25.1	29.8	25.9	33.1	35.0	31.1	30.6
of Research and Development	*26.3*			*28.9*	*25.4*	*25.2*	*26.9*	*25.0*	*29.2*	*25.8*		*29.9*	*29.2*	*26.8*
of Other than Res. & Devel.	*29.8*				*27.5*	*25.7*	*28.6*			*25.7*	*33.4*		*31.2*	
of R&D and Other Activities	*28.6*				*32.6*	*26.5*	*27.2*			*26.1*				
Consulting	25.1					25.0	22.7				25.7		30.2	
Professional Services	30.0								35.0		30.3			
Other	21.1				20.3	21.8	20.9	23.0	21.1	20.8			24.0	
No Report	23.3													

NOTE: Median salaries were computed only for Ph.D.'s employed full-time. Median salaries have not been calculated for cells with fewer than 20 individuals reporting salary.

TABLE 10B Median Annual Salaries of Doctoral Scientists and Engineers Employed in Business and Industry by Primary Work Activity and Field of Employment, 1977

1977 Primary Work Activity	1977 Field of Employment													
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc	NonSc	No Reprt
	(In Thousands of Dollars)													
Total	$29.9	$27.7	$26.7	$29.8	$29.5	$28.7	$29.9	$27.1	$33.2	$27.3	$33.6	$30.1	$31.8	$33.9
Research and Development	27.2	26.8	25.3	28.5	26.7	27.8	27.6	25.1	27.3	25.1	30.0	29.3	25.2	32.8
Basic Research	*27.4*			*28.0*	*27.0*	*27.8*	*30.2*		*26.8*	*25.5*				
Applied Research	*27.4*	*27.0*	*28.0*	*29.0*	*26.5*	*28.0*	*27.5*	*25.0*	*28.3*	*25.4*	*29.8*	*29.3*	*24.8*	
Development	*26.9*		*24.8*	*27.3*	*27.3*		*27.5*			*22.9*				
Management and Administration	34.6		32.8	34.4	33.8	33.3	35.0	29.5	36.6	31.0	33.8	35.9	40.4	37.0
of Research and Development	*34.3*		*35.4*	*35.8*	*34.0*	*33.1*	*34.8*	*30.2*	*35.7*	*30.9*	*32.4*	*35.9*	*40.4*	*36.2*
of Other than Res. & Devel.	*35.4*		*30.5*		*34.1*	*33.3*	*35.0*	*27.8*	*42.7*	*32.0*			*40.4*	
of R&D and Other Activities	*34.9*				*32.3*		*36.9*						*40.1*	
Consulting	30.0					29.1	30.1	28.7		22.9	30.4		32.0	
Professional Services	35.2								54.4		35.6		26.6	
Other	26.6		23.1	25.3	28.1	25.3	26.8	27.1	25.9	24.2		29.9	26.7	30.4
No Report	26.2													

NOTE: Median salaries were computed only for Ph.D.'s employed full-time. Median salaries have not been calculated for cells with fewer than 20 individuals reporting salary.

median salaries in the other employment fields, ranging from a low of $26,700 in computer sciences to $30,100 in the social sciences, a range of less than $3,500.

Examination of salaries by primary work activity indicate that median salaries for Ph.D.'s employed in research and development in 1973 ranged from $25,300 for psychologists to $18,900 for agricultural scientists. In 1977, the R&D salaries ranged from a median of $30,000 for psychologists to $25,100 for agricultural and biological scientists (excluding the "no report" category).

In management and administration, the highest median salaries in 1973 were for Ph.D.'s in the social sciences ($35,000) and psychology ($33,100). Relatively low median salaries for managers and administrators (approximately $25,000) were estimated for Ph.D.'s in agricultural sciences, earth sciences, and chemistry. However, managers of R&D and other activities in the field of chemistry in 1973 had a relatively high median salary of $32,600. By 1977, the highest median salaries for managers and administrators were in the nonscience fields ($40,400), the medical sciences ($36,600), the social sciences ($35,900), and engineering ($35,000). The estimated management salaries for all other fields in 1977 ranged from $34,400 for those working in physics to $29,500 for those in the agricultural sciences.

The data in Tables 5A and 5B indicate that well over one-half of the Ph.D.'s employed in psychology were engaged in either consulting or professional services activities. The median salaries for these activities were $25,700 for consulting and $30,300 for professional services in 1973. Corresponding estimates for 1977 were $30,400 for consulting and $35,600 for professional services. Ph.D. engineers--who constituted one-third of all consultants in both surveys--had an estimated median salary of $22,700 in 1973 and $30,100 in 1977. Between 1973 and 1977 the median salary of Ph.D.'s who were providing professional services and working in the medical sciences rose from $35,000 to $54,400.

As noted, the Consumer Price Index rose approximately 38 percent between February 1973 and February 1977, the reference time period of the two surveys. None of the increases in median salaries in the various fields of employment kept pace with the rise in the cost of living, as is evident from Table 10C.

The median salary for Ph.D.'s working in chemistry increased more than 32 percent between 1973 and 1977. Medians for the social scientists and psychologists increased only 10.2 percent and 12.0 percent, respectively. For most fields, the increase was substantially below the rate of inflation.

TABLE 10C Median Salary Increases Between 1973 and 1977 for S/E Ph.D.'s in Business and Industry

	Estimated Median Salary (In Thousands of Dollars)		
	1973	1977	% Increase
All Fields	$23.2	$29.9	28.9%
Mathematics	23.8	27.7	16.4
Computer Sciences	22.2	26.7	20.3
Physics	23.8	29.8	25.2
Chemistry	22.3	29.5	32.3
Earth Sciences	22.6	28.7	27.0
Engineering	23.2	29.9	28.9
Agricultural Sciences	21.8	27.1	24.3
Medical Sciences	26.2	33.2	26.7
Biological Sciences	22.6	27.3	20.8
Psychology	30.0	33.6	12.0
Social Sciences	27.3	30.1	10.2
Nonscience Fields	25.9	31.8	22.8

3

Mobility of Ph.D.'S in Business and Industry

The longitudinal nature of the data from the Survey of Doctorate Recipients lends itself to an assessment of the career patterns of Ph.D.'s in the United States. Chapter 3 addresses the issues of mobility for science and engineering doctorates in business and industry, including field mobility (the transition from field of doctorate to field of employment), employer mobility (movement among employment sectors), and industry group mobility (movement among the various segments of the business and industry sector).

Field Mobility

Data on mobility from doctoral field to employment field for the scientists and engineers employed in business and industry in 1977 are presented in Table 11.

In 1977, the S/E Ph.D.'s showing the highest proportion of employment in their doctoral fields were computer scientists (92.3 percent) and psychologists (88.4 percent). Large proportions of engineers (81.9 percent), and medical scientists (80.0 percent) were also working in their fields. Ph.D. recipients who were least likely to be employed in fields corresponding to their doctoral disciplines were mathematicians (with only 36.6 percent remaining in the field), physicists and astronomers (40.7 percent), biological scientists (41.4 percent), and social scientists (48.9 percent).

Approximately 30 percent of all S/E Ph.D.'s in business and industry in 1977 were working in engineering, the largest field of employment. In addition to the high percentage of engineering Ph.D.'s working in their field, 31.2 percent of the physicists, 17.6 percent of the mathe-

TABLE 11 Field of Mobility of Doctoral Scientists and Engineers Employed in Business and Industry, 1977

		Field of Employment												
Field of Doctorate	All Fields N	Math %	Comp %	Phys %	Chem %	Earth %	Engr %	Agric %	Med %	Biol %	Psych %	SocSc %	NonSc %	No Reprt %
	70,600	1.5	4.2	5.3	23.4	4.2	30.8	3.6	4.3	4.7	6.7	2.3	6.9	2.3
Mathematics	1,800	**36.6**	24.4	0.5		0.9	17.6			6.2	0.4	1.9	11.0	0.4
Computer Sciences	600		**92.3**	0.3			3.1					0.3	4.0	
Physics/Astronomy	6,800	2.1	8.4	**40.7**	1.9	4.7	31.2	0.4	0.7	0.1	0.8	0.8	6.0	2.1
Chemistry	21,200	0.2	0.9	1.7	**71.7**	2.0	8.7	0.6	2.1	1.7	0.1	0.2	7.8	2.3
Earth Sciences	2,000		0.4	1.5	1.1	**81.6**	7.6		0.2	0.9			5.1	1.6
Engineering	20,700	0.7	5.3	2.7	1.5	1.6	**81.9**	0.1	0.3	0.1		0.2	3.4	2.0
Agricultural Sciences	2,300				3.4	4.7	0.5	**68.8**	2.4	9.0		1.0	5.8	4.5
Medical Sciences	1,500			0.5	5.1			0.7	**80.0**	4.7	0.1	0.3	5.7	3.0
Biological Sciences	5,900	0.2	0.1	0.2	10.8	2.5	2.7	10.6	19.5	**41.4**	0.1	0.2	8.7	3.0
Psychology	5,100		0.7	0.2			0.6	0.4	1.3		**88.4**	1.0	5.1	2.3
Social Sciences	2,700	1.2	1.8		0.7	0.7	3.6	4.8	0.5	1.0	5.3	**48.9**	28.2	3.1

maticians, 8.7 percent of chemists, and 7.6 percent of the earth scientists were in the field of engineering. Computer sciences also drew heavily from other disciplines: 24.4 percent of the mathematicians worked in the computer field, as did 8.4 percent of the physicists and 5.3 percent of the engineers.

Among the more mobile groups, mathematics and physics Ph.D.'s gravitated largely to engineering and computer sciences, although 11.0 percent of mathematicians entered nonscience fields. Of the Ph.D.'s in other disciplines showing a high degree of field mobility, the biological scientists switched mainly to the closely related medical sciences (19.5 percent) and agricultural sciences (10.6 percent); an additional 10.8 percent, mostly biochemists moved to chemistry. The highest proportion of social scientists working outside their doctoral field (28.2 percent) were employed in nonscience jobs.

A number of forces appear to affect field mobility. Some educational fields for instance, have traditionally permitted a substantial degree of employment mobility; and the definition of the employment fields may in itself play a role. Personal goals and preferences may also have an effect, especially when the job market is tight.[17] An investigation of these and other factors, however, is beyond the scope of this report.

Employer Mobility

Tables 12A and 12B present data on mobility among various employment sectors during the 1973-1977 period. This analysis is based on data for S/E Ph.D.'s who were in the U.S. labor force in both years and who responded to both the 1973 and 1977 surveys.

Data regarding type of employer of the total Ph.D. labor force in the two survey years are presented in Table 12A.

Between 1973 and 1977, the proportion of science and engineering Ph.D.'s employed in business and industry

[17] National Research Council, Commission on Human Resources, Field Mobility of Doctoral Scientists and Engineers, (Washington, D.C.: National Academy of Sciences, 1975).

TABLE 12A Distribution of the Doctoral Science and Engineering Labor Force by Type of Employer, 1973 and 1977*

Type of Employer	1973	1977
	%	%
Business and Industry	23.7	25.6
Educational Institution	58.3	57.4
Government	11.3	9.9
Other	5.8	5.8
Unemployed, seeking employment	0.8	0.8
No Report	0.1	0.5

*Percents are based on the number (170,800) of doctoral scientists and engineers who were in the labor force in both 1973 and 1977. The procedure followed to obtain the estimates is described in Appendix E.

increased from 23.7 to 25.6 percent. During the same period, the segment of S/E Ph.D.'s employed in educational institutions declined from 58.3 percent to 57.4 percent and the segment working in government decreased from 11.3 percent to 9.9 percent.

Table 12B shows the 1977 retention/redistribution pattern of the S/E Ph.D.'s who worked in each of the various employment sectors in 1973 or who were unemployed and seeking employment.

Business/industry and educational institutions retained the highest percentages of S/E Ph.D.'s between 1973 and 1977, with over 90 percent remaining in each sector. In contrast, only 72.7 percent of the Ph.D.'s working in government in 1973 were still government employees in 1977. Among those who left the government sector, 12.3 percent gained employment with educational institutions and 8.5 percent moved into "other" employment (principally, hospitals, clinics, and nonprofit organizations). Over 20 percent of those in "other" employment in 1973 had moved to educational institutions in 1977.

Although 16.4 percent of those Ph.D.'s who were unemployed in 1973 were also seeking work in 1977, this group represents only 0.1 percent of the total labor force. Of the Ph.D.'s unemployed and seeking employment in 1973, over two-thirds were working in either business and industry or education in 1977. Conversely, only 0.7 percent of the

TABLE 12B Employer Mobility of Doctoral Scientists and Engineers, 1973-1977*

1973 Employer	Total S/E Ph.D. Labor Force	1977 Employer: Business & Industry	Educational Institution	Government	Other	Unemployed/ Seeking Employment	No Report
	N	%	%	%	%	%	%
Total S/E Ph.D. Labor Force	170,800	25.6	57.4	9.9	5.8	0.8	0.5
Business/Industry	40,500	92.4	3.4	1.4	1.6	0.7	0.5
Educational Institution	99,600	3.8	91.9	1.6	1.5	0.7	0.4
Government	19,400	5.8	12.3	72.7	8.5	0.4	0.3
Other	9,900	10.5	21.8	5.2	60.1	1.7	0.7
Unemployed/Seeking Employment	1,300	30.2	32.5	12.1	8.3	16.4	0.4
No Report	100	34.1	5.7	17.0	30.7	12.5	0.0

*The procedure followed to generate the data in Table 12B is described in Appendix E.

scientists and engineers who held positions in either business and industry or educational institutions in 1973 were unemployed in 1977.

Industry Group Mobility

Tables 13A and 13B show how those business and industry employed doctoral scientists and engineers who responded to both surveys were distributed by industrial group.

TABLE 13A Distribution of Scientists and Engineers Employed in Business and Industry by Business/Industry Group, 1973 and 1977*

Business and Industry Group	1973	1977
	%	%
Manufacturing	80.9	81.2
Chemicals	29.7	29.6
Elec. & Comm. Equip./Comm.	13.4	12.6
Petroleum & Refining	8.8	8.7
Transportation Equipment	7.8	8.0
Professional & Scientific Equip.	5.6	6.0
Machinery	4.3	5.1
Other Manufacturing	11.3	11.2
Nonmanufacturing	7.6	8.0
Self-employed	5.7	6.0
Non-classifiable companies	5.7	4.7

*Percents are based on the number (37,400) of doctoral scientists and engineers who were employed in business and industry in both 1973 and 1977. The procedure followed to obtain the estimates is described in Appendix E.

The overall percentages of science and engineering Ph.D.'s in the various groups fluctuated only slightly from 1973 to 1977. This stability may be explained in part by the high retention rates in the manufacturing industries, where over 80 percent of the doctoral scientists and engineers were employed in both years. Table 13B shows the retention and redistribution in 1977 of the Ph.D.'s who were working in each of the industry groups in 1973. Within the different manufacturing areas, retention rates ranged from 94.1 percent to 86.9 percent for the petroleum/refining and the electrical and communications equipment industries, respectively,

Science and engineering doctorates employed in non-classifiable companies appeared to be the most mobile group;

TABLE 13B Industry Group Mobility of Doctoral Scientists and Engineers, 1973-1977

1973 Business/Industry Group	Total	1977 Business/Industry Group										
		Manufacturing										
		Total	Chem/ Allied Prod	Elec/ Comm Equip/ Comm	Petrl & Ref	Trans Equip	Prof/ Sci Equip	Machinery	Other	Non-Manufac.	Self-Empl	Non-Class Comp
	N	%	%	%	%	%	%	%	%	%	%	%
Total	37,400	81.2	29.6	12.6	8.7	8.0	6.0	5.1	11.2	8.0	6.0	4.7
Manufacturing	30,300	95.6	35.0	15.0	10.5	9.2	7.0	5.9	13.0	1.5	1.0	1.7
Chemicals & Allied Products	*11,100*	**97.5**	**93.1**	*0.2*	*0.2*	*0.7*	*0.6*	*0.7*	*1.0*	*0.6*	*1.1*	*0.5*
Elec. & Comm. Equip./Comm.	*5,000*	*94.5*	*0.8*	**86.9**	*0.0*	*2.0*	*2.3*	*1.4*	*1.1*	*2.5*	*0.8*	*2.2*
Petroleum & Refining	*3,300*	*97.0*	*1.5*	*0.4*	**94.1**	*0.0*	*0.3*	*0.0*	*0.7*	*1.4*	*1.3*	*0.5*
Transportation Equipment	*2,900*	*94.2*	*1.4*	*2.1*	*0.3*	**87.5**	*0.2*	*0.8*	*1.9*	*1.9*	*0.9*	*2.9*
Professional & Sci. Equip.	*2,100*	*95.1*	*0.5*	*1.8*	*0.6*	*0.6*	**89.6**	*2.0*	*0.0*	*0.9*	*1.6*	*2.4*
Machinery	*1,600*	*94.8*	*2.0*	*1.2*	*0.4*	*1.3*	*1.3*	**88.6**	*0.0*	*1.1*	*0.4*	*3.7*
Other Manufacturing	*4,300*	*92.4*	*2.3*	*0.7*	*0.4*	*0.2*	*0.5*	*0.9*	**87.4**	*3.2*	*1.1*	*3.1*
Nonmanufacturing	2,800	17.2	4.1	2.6	0.6	4.1	0.9	1.1	3.8	**70.1**	4.0	8.0
Self-employed	2,100	6.9	1.0	0.7	0.7	2.2	1.3	0.0	1.0	4.5	**76.2**	12.4
Non-classifiable companies	2,200	36.3	15.3	4.0	3.2	2.9	3.0	3.1	4.8	19.1	9.8	**34.7**

only about one-third of the Ph.D.'s working for such firms in 1973 were still employed by them in 1977. Over 35 percent moved to the manufacturing sector, nearly one-half of them into chemicals and allied products, and nearly 20 percent moved into non-manufacturing companies. It is, however, difficult to estimate the extent to which this represents a real shift. In part, this "movement" may be explained by the SIC coding of certain firms in 1977 that could not be classified in 1973.

In the nonmanufacturing group, nearly 30 percent of the Ph.D.'s moved to new employment sectors by 1977; 17.2 percent of them to manufacturing and 8.0 percent to non-classifiable companies. One quarter of the Ph.D.'s who were self-employed in 1973 were employees of a company in 1977, 12.4 percent of them working for non-classifiable companies and 6.9 percent in manufacturing industries.

Appendix A

1973 and 1977 Surveys of Doctorate Recipients Questionnaires and Specialties Lists

NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES NATIONAL ACADEMY OF ENGINEERING

2101 CONSTITUTION AVENUE WASHINGTON, D.C. 20418

OFFICE OF SCIENTIFIC PERSONNEL

March 1973

Dear Colleague:

The National Science Foundation has asked the National Academy of Sciences-National Academy of Engineering-National Research Council to assist it in operating the Manpower Characteristics System. The Foundation has established the System to provide data needed to assay this Nation's human resources in the sciences and engineering and guide in the development of national policies and programs.

As our part of the task, we shall maintain information about recipients of the earned doctorate in the natural and social sciences, mathematics, and engineering. Already available data will be utilized to the greatest extent possible. We believe the Survey of Doctoral Scientists and Engineers will provide critically needed data bearing on the problem of utilization and supply of doctoral scientists and engineers, the support of graduate education, and the support of research and development and postdoctoral activities.

We seek your help. You are one of a carefully drawn sample of doctoral scientists and engineers who are being asked to provide current data. The questionnaire on the following pages has been designed to make minimum demands upon your time and yet to provide data that in the aggregate will be statistically significant and useful. Some data already available to us have been preprinted on the form to conserve your time.

Information provided will be treated as privileged and used only for purposes of statistical description. Summaries will be published after analysis of the results.

Please complete and return the questionnaire promptly. A self-addressed envelope is enclosed for your convenience. Your assistance will be greatly appreciated and, indeed, is essential to the success of this project.

Sincerely yours,

Robert A. Alberty

Robert A. Alberty
Chairman, Advisory Committee

SURVEY OF DOCTORAL SCIENTISTS AND ENGINEERS

OMB No. 99-S7300I
Approval expires Dec. 31, 1975

CONDUCTED BY THE NATIONAL RESEARCH COUNCIL WITH THE SUPPORT OF THE NATIONAL SCIENCE FOUNDATION.

The letter on the adjacent page requests that you assist in this survey of doctoral scientists and engineers – including the fields of the natural and social sciences, mathematics, and engineering.

Please print or type your answers on this first page. If selected information has been printed by computer, check to be certain the entries are CORRECT and COMPLETE. The second page has special instructions. After the form has been completed, please return it in the enclosed envelope to: Manpower Studies Branch, Office of Scientific Personnel, National Research Council, 2101 Constitution Avenue, Washington, D. C. 20418.

NOTE: ALL INFORMATION IS REGARDED AS CONFIDENTIAL AND WILL BE USED FOR STATISTICAL PURPOSES ONLY. IT WILL NOT BE RELEASED IN ANY WAY THAT WILL ALLOW IT TO BE IDENTIFIED WITH YOU.

If your name and address are incorrect, please enter correct information to the right. Include zip code.

_____ (10)

_____ (29)

_____

If there is an alternate address through which you could be reached, please provide it in the space below.

C/O Number Street City State Zip Code (11)

Please Do Not Write In This Space

1 1 2-9 ctr #
C
10 11

V
12 13 14 15 16
17 18 19 20
21 22 23-31 SS #
32 33

B
34 35 36
37 38 39
40 41 42 43 44 45

M
46 47 48
49 50 51
52 53 54 55 56 57

D
58 59 60
61 62 63 64 65 66
67 68 69 70 71 72

C
2 2-9 ctr #

O
10 11 12 13
14 15 16
17 18 19 20 21 22

23-44 Th Ad

E
45 46 47 48 49 50
51 52 53 54 55 56
57 58 59 60 61 62
63 64

VITA

1. Date of Birth (12-16) Mo. Day Yr.

2. State or Foreign Country of Birth (17-18)

3. State or Foreign Country of Secondary School Graduation (19-20)

4. Sex: (21) ☐1- Male ☐2- Female

5. Citizenship: (22) ☐0- USA ☐1- Non-USA (specify country) _____

6. Social Security No. (23-31)

7. Race: (32) ☐0- White/Caucasian ☐2- American Indian ☐4- Other, specify _____
(Please check one) ☐1- Black/Negro ☐3- Asian, specify _____

8. Ethnic Group: ☐0- Puerto Rican American ☐2- Spanish American ☐4- None of these. (Please specify any other)
(Please check one) ☐1- Mexican American/Chicano ☐3- Afro-American _____ (33)

9. List in the table below all collegiate and graduate degrees that have been awarded to you; e.g., BA/BS, MA/MS, PhD. If some information has been entered by computer, please be sure it is CORRECT and COMPLETE (including the number and name of the specialty field from the list on the reverse side).

Type of Degree	Granted Mo.	Granted Yr.	Major Field (Use Specialties List) Name	Major Field (Use Specialties List) Number	Institution Name	City (or campus) and State
BS						
MS						
PhD						

10. Name of your doctoral thesis advisor: _____ (23-44)
(please print FULL name) (First Name) (Middle Initial) (Last Name)

PROFESSIONAL EMPLOYMENT

11. Please give the name of your present principal employer (organization, company, etc. or, if self-employed, "self"), and actual place of employment.

_____ (45-50) _____ (51-55)
Name of present principal employer Actual place of employment (city, state and zip code)

If employed by a university, college, or junior college, please check the rank of your present position: (56)

☐0- Professor ☐2- Assistant Professor ☐4- Lecturer
☐1- Associate Professor ☐3- Instructor ☐5- Other, specify _____

12. Please give the basic annual salary associated with your principal professional employment in 1972 and 1973. If you were on a postdoctoral appointment (e.g., fellowship, traineeship, research associateship) give your annual stipend plus allowances below.

1972 - $ _____ (57-59) 1973 - $ _____ (60-62)

(Basic Annual Salary is your annual salary before deductions for income tax, social security, retirement, etc., but does not include bonuses, overtime, summer teaching, or other payment for professional work.)

If academically employed, check whether salary is for:

	1972	1973
9-10 mos.	☐	☐
11-12 mos.	☐	☐

(63) (64)

PLEASE CONTINUE ▶

PLEASE READ DIRECTIONS ON ADJACENT PAGE.

13. What is your employment status? 1972 1973

- Employed full-time, science or engineering related position ○ ○
- Employed full-time, nonscience or nonengineering related position. (Complete 13a below) ○ ○
- Employed part-time, science or engineering related position (Complete 13b below) ○ ○
- Employed part-time, nonscience or nonengineering related position (Complete 13b below) ○ ○
- Postdoctoral appointment (fellowship, traineeship, research associateship, etc.) Complete 13c below ○ ○
- Unemployed and seeking employment ○ ○
  - Specify number of months unemployed: ___ ___
- Unemployed and not seeking employment ○ ○
- Retired and not seeking employment ○ ○
  - Specify year of retirement: ___ ___
- Other, specify _____ ○ ○

13a. If you are employed full-time in 1973 in a position unrelated to science or engineering, what was the MOST important reason for taking the position? 1973

- Prefer nonscience or nonengineering position ○
- Promoted out of science or engineering position ○
- Pay is better ○
- Locational preference ○
- Science or engineering position not available ○
- Other, specify _____ ○

13b. If employed part-time in 1973, are you seeking full-time employment? 1973

- Yes ○
- No ○

13c. If on postdoctoral appointment in 1973, what was the MOST important reason for taking the appointment? 1973

- Sought additional research experience in field ○
- Opportunity to change to another field ○
- Employment position not available ○
- Other, specify _____ ○

14. If employed or on a postdoctoral appointment in 1973, please indicate the term of employment or appointment: 1973

- Three months or less ○
- More than 3 months, not more than one year ○
- More than one year, not more than 3 years ○
- More than 3 years, not more than 5 years ○
- Permanent or tenured position ○

15. Which categories best describe the sector of the economy and type of organization of your principal employer or postdoctoral affiliation? 1972 1973

A. **Sector:**
- Public ○ ○
- Private ○ ○

B. **Type of organization:**
- Business or industry ○ ○
- Junior college, 2-year college, technical institute ○ ○
- Medical school ○ ○
- 4-year college or university, other than medical school ○ ○
- Elementary or secondary school system ○ ○
- Hospital or clinic ○ ○
- U.S. military service, active duty, or Commission Corps., e.g., USPHS, NOAA ○ ○
- U.S. government, civilian employee ○ ○
- State government ○ ○
- Local or other government, specify _____ ○ ○
- International agency ○ ○
- Non-profit organization, other than hospital, clinic, or educational institution ○ ○
- Other, specify _____ ○ ○

16. What are the primary (A) and secondary (B) work activities related to your position?

	1972 A	1972 B	1973 A	1973 B
Management or administration of:				
Research and development	○	○	○	○
Other than research and development	○	○	○	○
Both	○	○	○	○
Basic research	○	○	○	○
Applied research	○	○	○	○
Development of equipment, products, systems, data	○	○	○	○
Design	○	○	○	○
Teaching	○	○	○	○
Report or other technical writing, editing	○	○	○	○
Production	○	○	○	○
Consulting, specify _____	○	○	○	○
Professional services to individuals	○	○	○	○
Quality control, inspection, testing	○	○	○	○
Sales, marketing, purchasing, estimating	○	○	○	○
Other, specify _____	○	○	○	○

17. From the specialties list on the adjacent page, select and enter both the number and title of the scientific specialty most closely related to your principal employment or postdoctoral appointment. Write in your specialty if it is not on the list.

1972 Number _____

1973 Number _____

18. Is ANY of your work being supported or sponsored by U.S. government funds?

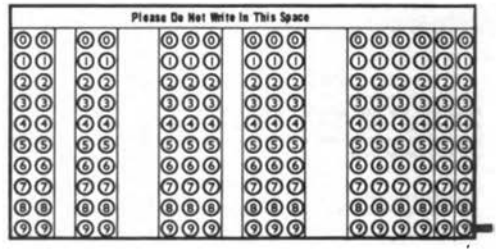
	Yes	No	Don't Know
1972	○	○	○
1973	○	○	○

If yes, which of the following federal agencies or departments are supporting the work? (Mark all that apply.)

	1972	1973		1972	1973
NASA	○	○	Dept. of Defense	○	○
NSF	○	○	Dept. of Commerce	○	○
EPA	○	○	Dept. of Agriculture	○	○
AEC	○	○	Dept. of Transportation	○	○
AID	○	○	Dept. of Justice	○	○
Dept. of Health, Educ., & Welfare			Dept. of Housing and Urban Development	○	○
NIH	○	○	Dept. of Interior	○	○
Health Services & Mental Health Admin.	○	○	Other agency or dept., specify _____	○	○
Office of Educ.	○	○			
Other HEW, specify _____	○	○	Don't know source	○	○

This is the end of the questionnaire. Thank you.

Please Do Not Write In This Space



DIRECTIONS: Your response to this portion of the questionnaire will be read by an optical mark reader. Your careful observance of these few simple rules will be most appreciated.

- Use only black lead pencil (No. 2½ or less).
- Make heavy black marks that fill the circle.
- Erase cleanly any answer you wish to change.
- Make no stray markings of any kind.

EXAMPLE:

Will marks made with ball pen, felt tip, or fountain pen be properly read?

Yes ○ No ●

PLEASE NOTE that we are requesting that you furnish the following information for both the current year, as of the time you receive this form, and last year, as of March 31, 1972. Fill in the category of each item which most appropriately describes your status in 1972 and 1973. Unless otherwise specified, mark only one category in each year.

SPECIALTIES LIST

MATHEMATICAL SCIENCES

000 - Algebra
010 - Analysis & Functional Analysis
020 - Geometry
030 - Logic
040 - Number Theory
052 - Probability
055 - Math. Statistics (see also 544, 670, 725, 729)
060 - Topology
080 - Computing Theory & Practice
082 - Operations Research (see also 477)
085 - Applied Mathematics
089 - Combinatorics & Finite Mathematics
091 - Physical Mathematics
096 - Mathematics, General
098 - Mathematics, Other*

ASTRONOMY

101 - Astronomy
102 - Astrophysics

PHYSICS

110 - Atomic & Molecular Physics
120 - Electromagnetism
130 - Mechanics
132 - Acoustics
134 - Fluids
135 - Plasma Physics
136 - Optics
138 - Thermal Physics
140 - Elementary Particles
150 - Nuclear Structure
160 - Solid State
198 - Physics, General
199 - Physics, Other*

CHEMISTRY

List A	List B
Fields used to classify academic degrees. Use for Item 9 on questionnaire. Also see note below.	Fields used to classify present professional employment. Use for Item 17 on questionnaire. Also see note below for the doctoral field in Item 9.
200 - Analytical	205 - Analytical Chemistry
210 - Inorganic	215 - Synthetic Organic & Organometallic Chemistry
220 - Organic	225 - Synthetic, Inorganic & Natural Products
230 - Nuclear	235 - Nuclear Chemistry
240 - Physical	245 - Quantum Chemistry
250 - Theoretical	255 - Structural Chemistry
260 - Agricultural & Food	265 - Thermodynamics & Material Properties
270 - Pharmaceutical	275 - Polymers
298 - Chemistry, General	285 - Chemical Dynamics
299 - Chemistry, Other*	

NOTE: Please use List B fields to classify your doctoral degree in Item 9. This is a classification which is requested in addition to the field chosen from List A. Print the List B field beside the doctoral code number from List A.

EARTH, ENVIRONMENTAL & MARINE SCIENCES

301 - Mineralogy, Petrology
305 - Geochemistry
310 - Stratigraphy, Sedimentation
320 - Paleontology
330 - Structural Geology
340 - Geophysics (Solid Earth & Atmospheric)
350 - Geomorph., Glacial Geology
360 - Hydrology
370 - Oceanography
380 - Meteorology
388 - Environmental Sciences, General
389 - Environmental Sciences, Other*
391 - Applied Geology, Geol. Engr., Econ. Geol.
397 - Marine Sciences, Other*
398 - Earth Sciences, General
399 - Earth Sciences, Other*

ENGINEERING

400 - Aeronautical & Astronautical
410 - Agricultural
415 - Biomedical
420 - Civil
430 - Chemical
435 - Ceramic
440 - Electrical
445 - Electronics
460 - Industrial, Manufacturing
455 - Nuclear
460 - Engineering Mechanics
465 - Engineering Physics
470 - Mechanical
475 - Metallurgy & Phys. Met. Engr.
477 - Operations Research, Systems (see also 082)
478 - Fuel Technology, Petrol Engr.
480 - Sanitary/Environmental
486 - Mining
497 - Materials Science Engr.
498 - Engineering, General
499 - Engineering, Other*

AGRICULTURAL SCIENCES

500 - Agronomy
501 - Agricultural Economics
502 - Animal Husbandry
504 - Fish & Wildlife
506 - Forestry
506 - Horticulture
507 - Soils & Soil Science
510 - Animal Sciences
511 - Phytopathology
517 - Food Science & Technology (see also 573)
518 - Agriculture, General
519 - Agriculture, Other*

MEDICAL SCIENCES

520 - Medicine & Surgery
522 - Public Health
523 - Veterinary Medicine
524 - Hospital Administration
527 - Parasitology
534 - Pathology
536 - Pharmacology
537 - Pharmacy
538 - Medical Sciences, General
539 - Medical Sciences, Other*

BIOLOGICAL SCIENCES

540 - Biochemistry
542 - Biophysics
543 - Biomathematics
544 - Biometrics, Biostatistics (see also 055, 670, 725, 729)
545 - Anatomy
546 - Cytology
547 - Embryology
548 - Immunology
550 - Botany
560 - Ecology
562 - Hydrobiology
564 - Microbiology & Bacteriology
566 - Physiology, Animal
567 - Physiology, Plant
569 - Zoology
570 - Genetics
571 - Entomology
572 - Molecular Biology
573 - Food Science & Technology (see also 517)
574 - Behavior/Ethology
578 - Biological Sciences, General
579 - Biological Sciences, Other*

PSYCHOLOGY

600 - Clinical
610 - Counseling & Guidance
620 - Developmental & Gerontological
630 - Educational
635 - School Psychology
641 - Experimental
642 - Comparative
643 - Physiological
660 - Industrial & Personnel
660 - Personality
670 - Psychometrics (see also 055, 544, 725, 729)
600 - Social
696 - Psychology, General
699 - Psychology, Other*

SOCIAL SCIENCES

700 - Anthropology
703 - Archeology
708 - Communications*
709 - Linguistics
710 - Sociology
720 - Economics (see also 501)
725 - Econometrics (see also 055, 544, 670, 729)
729 - Social Statistics (see also 055, 544, 670, 725)
740 - Geography
745 - Area Studies*
750 - Political Science, Public Admin.
755 - International Relations
770 - Urban & Reg. Planning
775 - History & Phil. of Science
798 - Social Sciences, General
799 - Social Sciences, Other*

ARTS & HUMANITIES

841 - Fine & Applied Arts (including Music, Speech, Drama, etc.)
842 - History
843 - Philosophy, Religion, Theology
845 - Languages & Literature
846 - Other Arts and Humanities*

EDUCATION & OTHER PROFESSIONAL FIELDS

938 - Education

882 - Business Administration
883 - Home Economics
884 - Journalism
886 - Speech and Hearing Sciences
888 - Law, Jurisprudence
887 - Social Work
891 - Library & Archival Science
896 - Professional Field, Other*

999 - OTHER FIELDS*

Identify the specific field in the space provided on the questionnaire.

NATIONAL RESEARCH COUNCIL
COMMISSION ON HUMAN RESOURCES
2101 Constitution Avenue Washington, D. C. 20418

February, 1977

Dear Colleague,

Perhaps you have seen or heard of the reports on the experience and employment status of Ph.D. scientists and engineers published by the National Academy of Sciences in 1974 and 1976 ("Doctoral Scientists and Engineers in the United States: 1973 Profile." (March, 1974); "1975 Profile." (December, 1976); "Employment Status of Ph.D. Scientists and Engineers: 1973 and 1975." (December, 1976).) These reports summarize data on field of employment, employment status, work activities, and salaries of Ph.D.'s in the work force as of 1973 and 1975. The data are based on the responses of a representative sample of doctoral scientists and engineers.

We are now conducting a new survey to update the 1975 employment and other career-related information. The sample for the 1977 survey has been augmented to include a sample of Ph.D.'s in the humanities as well as recent doctorates in science and engineering. You are a member of the survey sample and we ask for your assistance in providing information which is important not only to doctorate recipients themselves but also to educational organizations and government agencies that fund graduate studies and research.

Please be assured that the National Research Council, along with the three supporting agencies (the National Science Foundation, the National Endowment for the Humanities, and the National Institutes of Health) maintains strict confidentiality of all data. Information is released only in the form of statistical summaries, and no individually identified data is ever divulged.

During the past two years, a great deal of attention has been given to the impact of economic change on Ph.D.'s and to trends in employment, salaries, and career development for this important segment of the population. Your cooperation in the 1977 survey will help to assure that ongoing research in these areas is successful. For your convenience, a pre-addressed, postage paid envelope has been enclosed for the return of your completed questionnaire. Thank you for your assistance.

Sincerely yours,

Robert A. Alberty

Chairman

The National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering to serve government and other organizations

OMB No. 099-R0294

1977 SURVEY OF DOCTORATE RECIPIENTS

CONDUCTED BY THE NATIONAL RESEARCH COUNCIL WITH THE SUPPORT OF THE NATIONAL SCIENCE FOUNDATION, THE NATIONAL ENDOWMENT FOR THE HUMANITIES, AND THE NATIONAL INSTITUTES OF HEALTH

THE ACCOMPANYING LETTER requests your assistance in this biennial survey of Ph.D.'s in the humanities, sciences, and engineering.
PLEASE READ the instructions for each question carefully and answer by printing your reply or checking the appropriate box.
PLEASE CHECK the pre-printed information to be certain that it is correct and complete.
PLEASE RETURN the completed form in the enclosed envelope to the Commission on Human Resources, JH 638, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.
NOTE: THIS INFORMATION IS SOLICITED UNDER THE AUTHORITY OF THE NATIONAL SCIENCE FOUNDATION ACT OF 1950, AS AMENDED. ALL INFORMATION YOU PROVIDE WILL BE TREATED AS CONFIDENTIAL AND USED FOR STATISTICAL PURPOSES ONLY. INFORMATION WILL BE RELEASED ONLY IN THE FORM OF STATISTICAL SUMMARIES OR IN A FORM WHICH DOES NOT IDENTIFY INFORMATION ABOUT ANY PARTICULAR PERSON. YOUR RESPONSE IS ENTIRELY VOLUNTARY AND YOUR FAILURE TO PROVIDE SOME OR ALL OF THE REQUESTED INFORMATION WILL IN NO WAY ADVERSELY AFFECT YOU.

_____

_____

_____

If your name and address are incorrect, please enter correct information above. Include ZIP CODE.

If there is an alternate address through which you can always be reached, please provide it on the line below. (10)

C/O Number Street City State ZIP Code (11)

1. Date of Birth Mo. Day Year (12-16)	2. State or Foreign Country of Birth (17-18)	3. Citizenship 0 ☐ U.S.A. 1 ☐ Non-U.S.A., Specify Country _____ (19) (20-21)	4. Sex 1 ☐ M 2 ☐ F (22)

5. What is your racial background?
0 ☐ American Indian or Alaskan Native
1 ☐ Asian or Pacific Islander
2 ☐ Black
3 ☐ White
(23)

5a. Is your ethnic heritage Hispanic?
0 ☐ Yes
1 ☐ No
(24)

6. List in the table below all collegiate and graduate degrees, excluding honorary degrees, that have been awarded to you. Please check the pre-printed information, including the number and name of the specialty from the list on page 4, to be certain that it is correct and complete.

Type of Degree	Granted Mo. Yr.	Major Field (Use Specialties List) Name Number	Institution Name	City (or Campus) & State
Bachelor's				
Master's				
Doctorate				
Other (Specify) _____				

7. What was your employment status as of February 6-12, 1977? (Check only one category.)

Employed full-time in field of Ph.D. ☐ 1
Employed full-time in field other than field of Ph.D. ☐ 2
Employed part-time ☐ 3
Were you seeking full-time employment? 1 ☐ Yes 2 ☐ No (66)
Postdoctoral appointment (fellowship, traineeship, research associateship, etc.) ☐ 4
Unemployed and seeking employment ☐ 5
Not employed and not seeking employment ☐ 6
Retired and not employed ☐ 7
Other, specify: _____ ☐ 8
(66)

7a. If you were employed full-time during February 6-12, 1977, in a field other than your field of Ph.D., what was the MOST important reason for taking the position?

Preferred position outside Ph.D. field ☐ 1
Promoted out of position in Ph.D. field ☐ 2
Better pay ☐ 3
Locational factors ☐ 4
Position in Ph.D. field not available ☐ 5
Other, specify: _____ ☐ 6
(67)

If you checked 5, 6 or 7, ANSWER ONLY 8a, 9a, 13, 14 and 17 of the following questions.

8. **Which category below best describes the type of organization of your principal employment OR postdoctoral appointment during February 6-12, 1977?** (Check only one category.)

- ☐ 1 Business or industry
- ☐ 2 Junior college, 2-year college, technical institute
- ☐ 3 Medical school
- ☐ 4 4-Year college
- ☐ 5 University, other than medical school
- ☐ 6 Elementary or secondary school system
- ☐ 7 Private foundation
- ☐ 8 Museum or historical society
- ☐ 9 Research library or archives
- ☐ 10 Hospital or clinic
- ☐ 11 U.S. military service, active duty, or Commissioned Corps, e.g., USPHS, NOAA
- ☐ 12 U.S. government, civilian employee
- ☐ 13 State government
- ☐ 14 Local or other government, specify: _____
- ☐ 15 Non-profit organization, other than those listed above
- ☐ 16 Other, specify: _____

(68-69)

8a. **Which of the above categories best describes the type of organization related to your first position following the receipt of your doctorate?** (List only one category)

_____

Type of Organization (70-71)

9. **What percent of time did you devote to each of the following activities during the week of February 6-12, 1977?** (Total should equal 100%) **What were your primary (A) and secondary (B) work activities?** (Check only one in each column.)

	%	A	B
Management or administration of			
Research and development	_____ (10)	☐ 1	☐
Other than research and development	_____ (12)	☐ 2	☐
Both	_____ (14)	☐ 3	☐
Basic research	_____ (16)	☐ 4	☐
Applied research	_____ (18)	☐ 5	☐
Development of equipment, products, systems, data	_____ (20)	☐ 6	☐
Development of humanities resource materials	_____ (22)	☐ 7	☐
Design	_____ (24)	☐ 8	☐
Teaching	_____ (26)	☐ 9	☐
Writing, editing	_____ (28)	☐ 10	☐
Curatorial	_____ (30)	☐ 11	☐
Production	_____ (32)	☐ 12	☐
Consulting, specify: _____	_____ (34)	☐ 13	☐
Professional services to individuals	_____ (36)	☐ 14	☐
Quality control, inspection, testing	_____ (38)	☐ 15	☐
Sales, marketing, purchasing, estimating	_____ (40)	☐ 16	☐
Other, specify: _____	_____ (42)	☐ 17	☐
	Total = 100%	(44-47)	

9a. **Which of the above categories best describes the primary work activity related to your first position following the receipt of your doctorate?**

_____

Primary Work Activity Number (48-49)

10. **From the Degree and Employment Specialties List on page 4 select and enter both the number and title of the employment specialty most closely related to your principal employment or postdoctoral appointment during the week of February 6-12, 1977. Write in your specialty if it is not on the list.**

_____ _____

Number Title of Employment Specialty (50-52)

11. **Please give the name of your principal employer (organization, company, etc. or, if self employed, write "self"), and actual place of employment as of the week of February 6-12, 1977.**

_____

Name of Employer (53-58)

_____

Number Street

_____

City State ZIP Code (59-63)

12. **What was the basic annual salary* associated with your principal professional employment during the week of February 6-12, 1977? If you were on a postdoctoral appointment (e.g., fellowship, traineeship, research associateship), what was your annual stipend plus allowances?**

$ _____ per year (64-66)

*NOTE: Basic annual salary is your annual salary before deductions for income tax, social security, retirement, etc., but does not include bonuses, overtime, summer teaching, or other payment for professional work.

IF ACADEMICALLY EMPLOYED:

a. Check whether salary was for ☐ 9-10 months or ☐ 11-12 months. (67)

b. Did you hold a tenured position during February 6-12, 1977? 0 ☐ Yes 1 ☐ No (68)
If Yes, what year was tenure granted? _____ (69-70)

c. What was the rank of your position? (Check only one.)

- 1 ☐ Professor
- 2 ☐ Associate Professor
- 3 ☐ Assistant professor
- 4 ☐ Instructor
- 5 ☐ Lecturer
- 6 ☐ Other, specify: _____

(71)

d. What, if any, administrative position did you hold?

- 1 ☐ Dean
- 2 ☐ Department Chairman
- 3 ☐ President or Chancellor
- 4 ☐ Vice-President or Vice-Chancellor
- 5 ☐ Other, specify: _____
- 6 ☐ Does not apply

(72)

13. How many full-time equivalent years of professional work experience, including teaching, have you had? _____ Year(s)
(73-74)

14. Following completion of your doctorate have you ever held a fellowship, traineeship, or research associateship? 0 ☐ Yes 1 ☐ No
(75)

15. Listed below are selected topics of national interest. If you devoted a proportion of your professional time which you considered significant to any of these problem areas during the week of February 6-12, 1977, please check the box for the one on which you spent the MOST time.

1 ☐ Health
2 ☐ Defense
3 ☐ Environmental protection, pollution control
4 ☐ Education
5 ☐ Space
6 ☐ Crime prevention and control
7 ☐ Energy and fuel
8 ☐ Food and other agricultural products
9 ☐ Natural resources,other than fuel or food
10 ☐ Community development and services
11 ☐ Housing (planning, design, construction)
12 ☐ Transportation, communications
13 ☐ Cultural life
14 ☐ Other area, specify: _____
15 ☐ Does not apply
(10-11)

16. Was any of your work in the week of February 6-12, 1977 supported or sponsored by U.S. Government funds?

0 ☐ Yes 1 ☐ No 2 ☐ Don't know (12)

If Yes, which of the following federal agencies or departments were supporting the work? (Check all that apply.)

13 ☐ Agency for International Development
14 ☐ Energy Research & Development Administration
15 ☐ Environmental Protection Agency
16 ☐ National Aeronautics & Space Administration
17 ☐ National Endowment for the Arts
18 ☐ National Endowment for the Humanities
19 ☐ National Science Foundation
20 ☐ Nuclear Regulatory Commission
21 ☐ Smithsonian Institution
22 ☐ Department of Agriculture
23 ☐ Department of Commerce
24 ☐ Department of Defense

Department of Health, Education, and Welfare
25 ☐ National Institutes of Health
26 ☐ Alcohol, Drug Abuse & Mental Health Administration
27 ☐ National Institute of Education
28 ☐ Office of Education
29 ☐ Other, specify: _____
30 ☐ Department of Housing and Urban Development
31 ☐ Department of the Interior
32 ☐ Department of Justice
33 ☐ Department of Labor
34 ☐ Department of State
35 ☐ Department of Transportation
36 ☐ Other agency or department, specify: _____
37 ☐ Don't know source agency

17. If you received your doctoral degree in science or engineering or are employed as a scientist or engineer, please check all that apply below:

☐ (a) Changed positions during the period 1973 to 1976.
☐ (b) Received doctoral degree in 1965 or later and employed sometime since receiving your doctoral degree in industry, government, or as non-faculty academic staff.
☐ (c) Held a postdoctoral appointment any year during 1970-1976 inclusive.
☐ (d) None of the above apply. (38-41)

If you have checked a, b, or c, please give a brief career history starting with the position prior to your present position and continuing back in time for a maximum of four positions after receiving your doctoral degree (include postdoctoral appointments).

Name and Location (City and State) of Employer	Position Title	Dates Held	Primary Work Activity*	Employment Specialty (Use Degree & Employment Specialties List)	Reason for Leaving Position
1.					
2.					
3.					
4.					

*Enter code (1-17) from the list given in item 9.

(a) Of the positions described above, as well as your present position, please check any in which your doctoral training was/is not being used.
☐ Position 1 ☐ Position 2 ☐ Position 3 ☐ Position 4 ☐ Present Position ☐ None
(74-79)

DEGREE AND EMPLOYMENT SPECIALTIES LIST

MATHEMATICAL SCIENCES

000 - Algebra
010 - Analysis & Functional Analysis
020 - Geometry
030 - Logic
040 - Number Theory
052 - Probability
055 - Math. Statistics (see also 544, 670, 725, 729)
060 - Topology
082 - Operations Research (see also 478)
085 - Applied Mathematics
089 - Combinatorics & Finite Mathematics
091 - Physical Mathematics
098 - Mathematics, General
099 - Mathematics, Other*

COMPUTER SCIENCES

071 - Theory
072 - Software Systems
073 - Hardware Systems
074 - Intelligent Systems
079 - Computer Sciences, Other

PHYSICS & ASTRONOMY

101 - Astronomy
102 - Astrophysics
110 - Atomic & Molecular Physics
120 - Electromagnetism
130 - Mechanics
132 - Acoustics
134 - Fluids
135 - Plasma Physics
136 - Optics
138 - Thermal Physics
140 - Elementary Particles
150 - Nuclear Structure
160 - Solid State
198 - Physics, General
199 - Physics, Other*

CHEMISTRY

200 - Analytical
210 - Inorganic
215 - Synthetic Inorganic & Organometallic
220 - Organic
225 - Synthetic Organic & Natural Products
230 - Nuclear
240 - Physical
245 - Quantum
250 - Theoretical
255 - Structural
260 - Agricultural & Food
265 - Thermodynamics & Material Properties
270 - Pharmaceutical
275 - Polymers
280 - Biochemistry (see also 540)
285 - Chemical Dynamics
298 - Chemistry, General
299 - Chemistry, Other*

EARTH, ENVIRONMENTAL AND MARINE SCIENCES

301 - Mineralogy, Petrology
305 - Geochemistry
310 - Stratigraphy, Sedimentation
320 - Paleontology
330 - Structural Geology
341 - Geophysics (Solid Earth)
350 - Geomorph. & Glacial Geology
391 - Applied Geol., Geol. Engr. & Econ. Geol.
395 - Fuel Tech. & Petrol. Engr. (see also 479)
360 - Hydrology & Water Resources
370 - Oceanography
387 - Marine Sciences, Other*
381 - Atmospheric Physics & Chemistry
382 - Atmospheric Dynamics
383 - Atmospheric Sciences, Other*
388 - Environmental Sciences, General (see also 480, 528)
389 - Environmental Sciences, Other*
398 - Earth Sciences, General
399 - Earth Sciences, Other*

ENGINEERING

400 - Aeronautical & Astronautical
410 - Agricultural
415 - Biomedical
420 - Civil
430 - Chemical
435 - Ceramic
440 - Electrical
445 - Electronics
450 - Industrial & Manufacturing
455 - Nuclear
460 - Engineering Mechanics
465 - Engineering Physics
470 - Mechanical
475 - Metallurgy & Phys. Met. Engr.
476 - Systems Design & Systems Science (see also 072, 073, 074)
478 - Operations Research (see also 082)
479 - Fuel Technology & Petrol. Engr.
480 - Sanitary & Environmental
486 - Mining
497 - Materials Science Engr.
498 - Engineering, General
499 - Engineering, Other*

AGRICULTURAL SCIENCES

500 - Agronomy
501 - Agricultural Economics
502 - Animal Husbandry
504 - Fish & Wildlife
505 - Forestry
506 - Horticulture
507 - Soils & Soil Science
510 - Animal Science & Animal Nutrition
511 - Phytopathology
517 - Food Science & Technology (see also 573)
518 - Agriculture, General
519 - Agriculture, Other*

MEDICAL SCIENCES

520 - Medicine & Surgery
522 - Public Health & Epidemiology
523 - Veterinary Medicine
524 - Hospital Administration
526 - Nursing
527 - Parasitology
528 - Environmental Health
534 - Pathology
536 - Pharmacology
537 - Pharmacy
538 - Medical Sciences, General
539 - Medical Sciences, Other*

BIOLOGICAL SCIENCES

540 - Biochemistry (see also 280)
542 - Biophysics
543 - Biomathematics
544 - Biometrics, Biostatistics (see also 055, 670, 725, 729)
545 - Anatomy
546 - Cytology
547 - Embryology
548 - Immunology
550 - Botany
560 - Ecology
562 - Hydrobiology
564 - Microbiology & Bacteriology
566 - Physiology, Animal
567 - Physiology, Plant
569 - Zoology
570 - Genetics
571 - Entomology
572 - Molecular Biology
573 - Food Science & Technology (see also 517)
574 - Behavior/Ethology
576 - Nutrition & Dietetics
578 - Biological Sciences, General
579 - Biological Sciences, Other*

PSYCHOLOGY

600 - Clinical
610 - Counseling & Guidance
620 - Developmental & Gerontological
630 - Education
635 - School Psychology
641 - Experimental
642 - Comparative
643 - Physiological
650 - Industrial & Personnel
660 - Personality
670 - Psychometrics (see also 055, 544, 725, 729)
680 - Social
698 - Psychology, General
699 - Psychology, Other*

SOCIAL SCIENCES

700 - Anthropology
703 - Archeology
708 - Communications*
709 - Linguistics
710 - Sociology
720 - Economics (see also 501)
725 - Econometrics (see also 055, 544, 670, 729)
729 - Social Statistics (see also 055, 544, 670, 725)
740 - Geography
745 - Area Studies*
751 - Political Science
752 - Public Administration
755 - International Relations
770 - Urban & Regional Planning
775 - History & Philosophy of Science
798 - Social Sciences, General
799 - Social Sciences, Other*

HUMANITIES

802 - History & Criticism of Art
804 - History, American
805 - History, European
806 - History, Other*
808 - American Studies
830 - Music
831 - Speech as a Dramatic Art (see also 885)
833 - Religion (see also 881)
834 - Philosophy
836 - Comparative Literature
878 - Humanities, General
879 - Humanities, Other*
891 - Library & Archival Sciences

LANGUAGES & LITERATURE

811 - American
812 - English
821 - German
822 - Russian
823 - French
824 - Spanish & Portuguese
826 - Italian
827 - Classical*
829 - Other Languages*

EDUCATION & OTHER PROFESSIONAL FIELDS

938 - Education
801 - Art, Applied
881 - Theology (see also 833)
882 - Business Administration
883 - Home Economics
884 - Journalism
885 - Speech & Hearing Sciences (see also 831)
886 - Law, Jurisprudence
887 - Social Work
897 - Professional Field, Other*

899 - OTHER FIELDS*

*Identify the specific field in the space on the questionnaire

Appendix B
Sample and Response Rates

TABLE B.1 Response Rates for the 1977 Survey of Doctorate Recipients in Science, Engineering, and the Humanities

	Sampling Frame* (N)	Sample (N)	Survey Sample+ (N)	Contacted# (N)	Survey Responses** (N)	Response Rates++ A (%)	Response Rates++ B (%)
Total	402,383	83,546	79,375	73,698	50,648	63.8	68.7
Field of Doctorate/Employment##							
Mathematics/Computer Sciences	19,384	5,141	4,776	4,472	2,873	60.2	64.2
Physics/Astronomy	28,861	6,013	5,795	5,395	3,609	62.3	66.9
Chemistry	48,260	9,148	8,786	8,213	5,736	65.3	69.8
Earth Sciences	10,004	2,197	2,095	1,954	1,457	69.5	74.6
Engineering	47,590	7,667	7,506	6,779	4,429	59.0	65.3
Life Sciences (Agricultural, Medical and Biological)	82,060	20,104	19,359	18,062	12,707	65.6	70.4
Psychology	40,601	8,390	7,772	7,375	4,994	64.3	67.7
Social Sciences	50,622	9,282	8,653	7,927	5,187	59.9	65.4
History	19,257	2,784	2,620	2,459	1,809	69.0	73.6
Art History	1,722	643	616	575	430	69.8	74.8
Music	3,910	929	890	835	621	69.8	74.4
Speech	4,913	1,038	991	926	653	65.9	70.5
Philosophy	6,214	1,186	1,131	1,030	681	60.2	66.1
Other Humanities	2,202	1,059	1,003	932	705	70.3	75.6
English/American Literature	20,891	2,859	2,730	2,548	1,830	67.0	71.8
Classics	2,282	706	661	612	448	67.8	73.2
Modern Languages	12,641	3,810	3,625	3,294	2,278	62.8	69.2
Unknown	969	590	366	310	201	54.9	64.8
Year of Doctorate							
CY1930-49	42,954	10,025	8,384	7,630	5,444	64.9	71.3
CY1950-FY1961	85,740	16,864	15,800	14,904	10,455	66.2	70.1
FY1962-69	114,461	25,496	24,317	22,649	15,407	63.4	68.0
FY1970-74	113,743	21,726	21,470	19,788	13,210	61.5	66.8
FY1975-76	44,713	9,109	9,106	8,508	6,040	66.3	71.0
Unknown	772	326	298	219	92	30.9	42.0
Ph.D. Institution							
U.S.	390,266	78,464	74,574	68,708	48,108	64.5	69.0
Foreign	12,117	5,082	4,801	3,990	2,540	52.9	63.7
Sex							
Male	351,110	64,041	60,840	56,754	38,791	63.8	68.3
Female	51,273	19,505	18,535	16,944	11,857	64.0	70.0
Race/Ethnic Group							
Minority Group***	9,176	5,177	5,145	4,700	2,743	53.3	58.4
White/Unknown	393,207	78,369	74,230	68,998	47,905	64.5	69.4

* The sampling frame includes those deceased, those residing in foreign countries, and those with doctorates in education or professional fields who were working in science or engineering.

\+ The survey sample is the sample size minus persons known to be deceased or out-of-scope prior to the 1977 survey. The out-of-scope classification is assigned to an individual who indicated in a previous survey that he or she:
a) holds a doctorate in education or a professional field and works in a nonscience/nonengineering position, or
b) holds a Ph.D. degree from a foreign institution, is a foreign citizen, and resides in a foreign country.

\# The number assumed contacted equals the survey sample minus those individuals for whom no valid addresses could be obtained.

** Responses include individuals found to be deceased in the 1977 survey and persons residing in foreign countries in 1977.

++ Response rate "A" is the number of 1977 survey responses divided by the number in the survey sample. Response rate "B" is the number of 1977 survey responses divided by the number assumed to have been contacted.

Individuals who earned doctorates in science, engineering, or the humanities were stratified by field of degree. Those with doctorates in education or professional fields who were identified as working in science or engineering were stratified by field of employment.

***Includes only those individuals whose ethnic group was known at the time the sample was selected.

TABLE B.2 Response Rates for the 1975 Survey of Doctorate Recipients in Science and Engineering

	Sampling Frame* (N)	Sample (N)	Survey Sample+ (N)	Contacted# (N)	Survey Responses** (N)	Response Rates++ A (%)	Response Rates++ B (%)
Total	295,970	62,471	59,608	55,412	41,905	70.3	75.6
Field of Doctorate/Employment##							
Mathematics/Computer Sciences	17,577	4,706	4,423	4,157	3,018	68.2	72.6
Physics/Astronomy	26,771	5,527	5,343	4,984	3,694	69.1	74.1
Chemistry	45,770	8,501	8,178	7,532	5,836	71.4	77.5
Earth Sciences	9,094	2,040	1,947	1,837	1,453	74.6	79.1
Engineering	42,543	6,840	6,709	6,162	4,635	69.1	75.2
Life Sciences (Agricultural, Medical and Biological)	73,817	18,243	17,599	16,436	12,822	72.9	78.0
Psychology	35,290	7,659	7,186	6,676	4,965	69.1	74.4
Social Sciences	44,118	8,351	7,802	7,257	5,203	66.7	71.7
Unknown	990	604	421	371	279	66.3	75.2
Year of Doctorate							
CY1932-49	35,935	8,396	7,346	6,817	5,254	71.5	77.1
CY1950-FY1961	71,739	14,260	13,535	12,781	9,745	72.0	76.2
FY1962-69	95,797	22,045	21,153	19,643	14,720	69.6	74.9
FY1970-72	55,208	10,461	10,296	9,588	7,267	70.6	75.8
FY1973-74	36,519	6,983	6,977	6,343	4,796	68.7	75.6
Unknown	772	326	301	240	123	40.9	51.3
Ph.D. Institution							
U.S.	283,630	57,273	54,662	51,260	38,901	71.2	75.9
Foreign	12,340	5,198	4,946	4,152	3,004	60.7	72.4
Sex							
Male	268,041	49,869	47,615	44,372	33,589	70.5	75.7
Female	27,929	12,602	11,993	11,040	8,316	69.3	75.3
Race/Ethnic Group							
Minority Group***	3,596	1,780	1,778	1,595	1,056	59.4	66.2
White/Unknown	292,374	60,691	57,830	53,817	40,849	70.6	75.9

* The sampling frame includes those deceased, those residing in foreign countries, and those with doctorates in education or professional fields who were working in science or engineering.

\+ The survey sample is the sample size minus persons known to be deceased or out-of-scope prior to the 1975 survey. The out-of-scope classification is assigned to an individual who indicated in a pervious survey that he or she:
a) holds a doctorate in education or a professional field and works in a nonscience/nonengineering position, or
b) holds a Ph.D. degree from a foreign institution, is a foreign citizen, and resides in a foreign country.

\# The number assumed contacted equals the survey sample minus those individuals for whom no valid addresses could be obtained.

** Responses include individuals found to be deceased in the 1975 survey and persons residing in foreign countries in 1975.

++ Response rate "A" is the number of 1975 survey responses divided by the number in the survey sample. Response rate "B" is the number of 1975 survey responses divided by the number assumed to have been contacted.

Individuals who earned doctorates in science and engineering were stratified by field of degree. Those with doctorates in education or professional fields who were identified as working in science or engineering were stratified by field of employment.

***Includes only those individuals whose race or ethnic group was known at the time the sample was selected.

Appendix C
Weighting Procedure

Estimates in this report are based on weighted responses. The 4,171 individuals in the total 1977 sample of 83,546 who were known to be deceased or out-of-scope prior to the survey were excluded from the survey and weighted by their sample weight, as were the 1,109 individuals who were known to be deceased prior to the 1973 survey. The responses received from the survey sample (50,648 in 1977 and 41,024 in 1973) were assigned a response weight that is the product of the weight for nonresponse and the sample weight. Table C.1 shows the classification of the 1973 sample and the formulas used for calculating the weights. Table C.2 provides comparable data for 1977.

Each stratum with fewer than two responses was merged with a similarly defined stratum in order to calculate sampling errors. Respondents in each stratum were assigned a weight equal to the integral part plus one. Allocation of weights within a stratum was made at random so as to represent the stratum population. This technique avoids the necessity of rounding fractional estimates of totals.

For example, consider a stratum which contains 60 individuals of whom 15 were selected for the sample. One of the 15 is known to be deceased prior to the survey. This individual receives a sample weight, 60/15, or 4.0, and thus represents 4 individuals in the population. The number of survey sample cases in the stratum is 14. Of these 14 individuals, 10 responded. The average weight for the respondents in this stratum would be $[60/15]\cdot[14/10] = 5.6$. To obtain integer weights, 4 of the respondents, chosen at random, would each receive a weight of 5, thus representing 20 individuals in the population. The 6 remaining respondents would each receive a weight of 6, thus representing 36. Combined, the 10 respondents would represent 56 individuals in the stratum, who together with the 4 individuals who are estimated to be deceased represent the entire 60 individuals in the stratum.

TABLE C.1 Classification of Sample and Weighting for 1973 Survey of Doctorate Recipients

GROUP		Number in Sample	Type of Estimation Weight*
TOTAL SAMPLE		56,096	
EXCLUDED FROM SURVEY			
Known Deceased Prior to 1973 Survey**		1,109	Sample
SURVEY SAMPLE		54,987	
Unable to Mail, No Valid Address		3,174	
CONTACTED SAMPLE		51,813	
RESPONSES			
Good Responses	40,594		Response
Known Deceased as a Result of the 1973 Survey	430		Response
Total		41,024	

* The sample weights (Ws) and response weights (Wr) for each stratum were computed as follows:

$$Ws_h = \frac{N_h}{n_h}$$, where N_h and n_h are the respective population and sample sizes of the stratum (h).

$$Wr_h = \frac{N_h}{n_h} \cdot \frac{\hat{n}_h}{r_h}$$, where $\hat{n}_h$ is the number of survey sample cases in the stratum and r_h is the number of survey responses in that stratum.

** Based on data obtained through address searches.

TABLE C.2 Classification of Sample and Weighting for 1977 Survey of Doctorate Recipients

Group		Number in Sample	Type of Estimation Weight*
TOTAL SAMPLE		83,546	
EXCLUDED FROM SURVEY			
Known Deceased Prior to 1977 Survey**	2,505		Sample
Out-of-Scope			
Foreigns: Out-of-Scope, Based on 1973 Survey Responses+	135		Sample
Fields: Out-of-Scope, Based on 1973 Survey Responses#	1,186		Sample
Fields: Out-of-Scope, Based on 1975 Survey Responses#	345		Sample
Total		4,171	
SURVEY SAMPLE		79,375	
Unable to Mail, No Valid Address		5,611	
CONTACTED SAMPLE		73,698	
RESPONSES			
Good Responses	50,352		Response
Known Deceased as a Result of the 1977 Survey	296		Response
Total		50,648	

* The sample weights (Ws) and response weights (Wr) for each stratum were computed as follows:

$Ws_h = \frac{N_h}{n_h}$, where N_h and n_h are the respective population and sample sizes of the stratum (h).

$Wr_h = \frac{N_h}{n_h} \cdot \frac{\hat{n}_h}{r_h}$, where $\hat{n}_h$ is the number of survey sample cases in the stratum and r_h is the number of survey responses in that stratum.

** Based on data obtained through 1973 or 1975 survey responses or through address searches.

\+ Based on responses that indicated individuals held Ph.D.'s from foreign institutions, were foreign citizens, and resided in foreign countries

\# Based on responses that indicated individuals held doctorates in education or professional fields and were employed in nonscience/nonengineering positions.

Appendix D
Sampling Error

Sampling Error Estimates for Ratios, Proportions, and Differences

Most of the statistics presented in this report are ratios of two weighted sums of observations, i.e., ratios of random variables. Thus we are concerned with a ratio, $r = y/x$, where

$$y = \sum_h \left[N_h/n_h\right] \sum_i y_{hi}$$

$$x = \sum_h \left[N_h/n_h\right] \sum_i x_{hi}$$

and where y_{hi} and x_{hi} are observations made on the i^{th} response of stratum h, N_h is the number of individuals in the active population of stratum h, and n_h is the number of responses from stratum h.

The variance of the ratio y/x is estimated by the expression

$$s_r^2 = \left(\frac{y}{x}\right)^2 \left(\frac{s_y^2}{y^2} + \frac{s_x^2}{x^2} - \frac{2s_{xy}}{xy}\right)$$

where

$$s_{xy} = \sum_h \frac{N_h^2}{n_h} \frac{N_h - n_h}{N_h - 1} \frac{1}{n_h - 1} \left(\sum_i \left[x_{hi} - \bar{x}_h\right]\left[y_{hi} - \bar{y}_h\right]\right),$$

$\bar{x}_h$ and $\bar{y}_h$ being the means of the x and y values observed in stratum h, respectively. Similarly, s_x^2 and s_y^2 are defined

using $\left[x_{hi} - \bar{x}_h\right]^2$ and $\left[y_{hi} - \bar{y}_h\right]^2$ in the inner summation.

Some of the statistics in the report are differences between two estimated ratios in percentage form, e.g., the difference between the percentage of engineers employed by business and industry who were working in R&D in 1977 and the corresponding percentage for 1973. If we write the difference as

$$r_1 - r_2 = \frac{y_1}{x_1} - \frac{y_2}{x_2}$$

the variance is estimated by

$$s^2_{r_1 - r_2} = s^2_{r_1} + s^2_{r_2} - 2s_{r_1 r_2}$$

The terms $s^2_{r_1}$ and $s^2_{r_2}$ are estimated variances of ratios, calculated as given above, and $s_{r_1 r_2}$ is estimated by

$$s_{r_1 r_2} = r_1 r_2 \left(\frac{s_{y_1 y_2}}{y_1 y_2} + \frac{s_{x_1 x_2}}{x_1 x_2} - \frac{s_{x_1 y_2}}{x_1 y_2} - \frac{s_{x_2 y_1}}{x_2 y_1} \right)$$

where for example,

$$s_{y_1 y_2} = \sum_h \hat{n}_h \frac{N_{1h} N_{2h}}{n_{1h} n_{2h}} \frac{1}{\hat{n}_h - 1} \left(\sum_i \left[y_{1hi} - \bar{y}_{1h} \right] \left[y_{2hi} - \bar{y}_{2h} \right] \right)$$

and the other covariances are written in similar fashion. In these expressions, $\hat{n}_h$ is the number of responses in stratum h that are common to the estimates y_1 and y_2.

These formulas were used to estimate sampling errors for survey statistics published in NRC-CHR report,

Science, Engineering, and Humanities Doctorates in the United States, 1977 Profile (Washington, D.C.: National Academy of Sciences, 1978.). Sampling error estimates were computed as if the responses obtained from a stratum were a random sample from that stratum. Strata were combined whenever the number of responses in a stratum was less than two.

Comparisons were made between sampling errors computed on the basis of a simple random sample (srs) and those which take into account stratification. Table D.1 presents sampling errors associated with selected statistics from the 1977 Profile report. Bases of various sample sizes and a range of statistic values have been chosen to provide representative comparisons. Sampling errors in the column s_p were computed by the expression $\left[\frac{p[1-p]}{n}\right]^{\frac{1}{2}}$, while those under s_r were calculated by the formula described above, which takes into account the sample design. The statistics are in percentage form and are the estimated proportion (p) of a variable category with a given characteristic, $p = \frac{1}{n}\sum_{i}^{n} y_i$ (for the purpose of s_p), or the ratio of two random variables, $r = \frac{y}{x}$ (for the purposes of s_r).

For the most part, differences between the two error estimates are quite small. Calculations based on an srs are for most statistics the same as or slightly higher than those which take account of the stratification. For

statistics which are ratios of two stratifying variables (e.g., the ratio of women biological science Ph.D.'s to total biological science Ph.D.'s), the estimate of sampling error is somewhat higher using the formula for s_p. In certain cases (mainly those involving estimates of type of employer or primary work activity for small subgroups), the use of the formula for an srs appears to underestimate slightly the sampling error.

Table D.2 provides a similar comparison of sampling errors of estimated differences. Sampling errors of differences between two proportions (p_1-p_2) were computed using the formula

$$s_{p_1 - p_2} = \left\{\left[p_1 (1-p_1)/n_1\right] + \left[p_2(1-p_2)/n_2\right] - \left[\frac{2n_c (p_c - p_1p_2)}{n_1n_2}\right]\right\}^{1/2}$$

In this formula, p_1, and p_2 are the proportions possessing the characteristic in the 1977 and 1975 surveys respectively; n_1 and n_2 are the number of observations from which these proportions were estimated; and p_c denotes the proportion possessing the attribute in both surveys, estimated from the number of observations (n_c) common to both surveys.[18]

[18] Leslie Kish, Survey Sampling, (John Wiley & Sons, Inc., New York, 1965), p. 461.

TABLE D.1 Comparison of Sampling Errors for Selected Statistics

Variable Base and Subcategory	Sample Size of Variable Base	Statistic (%)	s_p (%) (srs)	s_r (%) (Stratified)
Science/Engineering				
Field of Ph.D.--Total	37,488			
Engineering Ph.D.		15.0	0.2	0.1
Field of Employment--Total Employed	34,599			
Employed in Mathematics		4.7	0.1	0.1
Physics/Astronomy Ph.D.--Total Employed	3,097			
Employed in Physics/Astronomy		61.8	0.9	0.9
Biological Science Ph.D.--Total	8,895			
Female		16.9	0.4	0.1
Earth Science Ph.D.--Total	1,382			
Employed Part-Time		2.0	0.4	0.4
Computer Science Ph.D.--Total Full- or Part-Time Employed	636			
Employed in Business or Industry		53.9	2.0	2.1
Chemistry Ph.D. (FY 1971-1976 Graduates)--Total Full- or Part-Time Employed	992			
Employed in Teaching		22.6	1.3	1.4
1960-1969 Ph.D. Recipients (Male)--Total Academically Employed	6,364			
Hold Rank of Professor		42.8	0.6	0.6
Labor Force--Total	35,115			
Unemployed, Seeking Employment		1.2	0.1	0.1
Labor Force--Total Social Science Ph.D.	4,366			
Employed Full-Time		94.3	0.4	0.4
Labor Force--Total Male	28,199			
Unemployed, Seeking Employment		0.9	0.1	0.1
Labor Force--Medical Science Ph.D./Female	304			
Employed Full-Time		79.6	2.3	2.3

TABLE D.2 Comparison of Sampling Errors of Differences

Characteristic	1975 Estimate	1975 Sample	1977 Estimate	1977 Sample	Difference (1977-1975)	$s_{(p_1-p_2)}$ (srs)	$s_{(r_1-r_2)}$ (stratified)
	%	(n_1)	%	(n_2)	%	%	%
Ph.D.'s Employed Full-Time:[a]							
Total U.S. S/E Pop.	88.8	37,734	87.9	37,488	-0.9	0.1	0.2
Biological Sci.	82.5	8,960	80.7	8,895	-1.8	0.3	0.4
Engineering	95.1	4,424	94.6	4,176	-0.5	0.3	0.3
Physics/Astron.	88.2	3,370	88.4	3,307	0.2	0.5	0.6
Mathematics	93.1	2,443	91.9	2,353	-1.2	0.5	0.5
Earth Sciences	91.4	1,367	90.1	1,382	-1.3	0.6	0.8
Computer Sciences	99.4	152	99.0	192	-0.4	0.1	0.8
Ph.D.'s Employed in Business and Industry:[b]							
Total Empl. in U.S.	26.3	33,822	26.4	33,036	0.1	0.2	0.1
Biological Sci.	12.7	7,547	13.2	7,269	0.5	0.3	0.2
Chemistry	54.1	4,851	53.6	4,706	-0.5	0.5	0.4
Psychology	14.0	3,574	16.1	3,689	2.1	0.6	0.5
Mathematics	11.0	2,279	12.4	2,164	1.4	0.6	0.4
Medical Sciences	23.4	1,332	20.8	1,318	2.6	0.7	0.4
Computer Sciences	32.6	150	38.7	191	6.1	3.8	3.2

[a]Percentage of the total U.S. science and engineering population in each category that was employed full-time.
[b]Percentage of the total full-time and part-time employed population in each category that was working in business and industry.

Sampling errors of the differences between two ratios ($s_{r_1-r_2}$) were computed using the formula discussed above. The data in Table D.2, are drawn from the 1977 Profile report and were selected to represent various sample sizes and percentage values.

In most cases, the formula that assumes a simple random sample yields a sampling error estimate close to the estimate computed by strata. Sampling errors of the estimated percentages of various Ph.D. fields who were employed computed s_{p1-p2} are somewhat lower than those obtained by $s_{r_1-r_2}$ for four of the seven estimates and much lower in the case of computer sciences. The estimates for this field are extreme values (> 99.0%), based on a relatively small number of observations (< 200).

Sampling error estimates obtained by the formula for an srs are greater than those computed by $s_{r_1-r_2}$ for the estimated percentages of the population employed full-time or part-time in business and industry. These proportions and ratio estimates take on less extreme values than the estimates of the full-time employed.

The reader should take these potential discrepancies into account when interpreting the sampling errors of statistics presented in this report. These sampling error estimates were obtained using the formulas for simple

random samples discussed above. Table D.3 summarizes sampling errors associated with various proportion values and sample sized.

Values in Table D.3 were computed using the formula $s_p = \left[\frac{p[1-p]}{n}\right]^{\frac{1}{2}}$, in which p is the proportion of a particular category (variable) possessing a certain characteristic, $y\left(\text{i.e., } p = \frac{1}{n}\sum_{i}^{n} y_i\right)$, and n is the number of sample members in the variable-specified category (e.g., doctoral scientists and engineers in the U.S. labor force) who responded to the survey. The finite population correction factor, $fpc = \left[[N-n] / [N-1]\right]^{\frac{1}{2}}$, has been omitted from the calculations, since the fpc has negligible effect on most statistics in this report, unless the estimate applies to a subgroup that has a high sampling rate. In any case, the omission of the fpc in the formula for s_p yields a conservative estimate (i.e., a higher estimate) of the sampling error.

The estimated sizes of population and population subgroups are provided in the tables in the body of the report. The sample sizes on which these population estimates were based can be approximated by multiplying the population by the weighting fraction, which is the sampling fraction corrected for nonresponse. Weighting fractions for selected groups are provided in Table D.4.

TABLE D.3 Approximate Sampling Errors for Various Statistics and Sample Sizes

	Proportion				
Sample Size	0.01 or 0.99	0.05 or 0.95	0.10 or 0.90	0.25 or 0.75	0.50
32,000	0.001	0.001	0.002	0.002	0.003
16,000	0.001	0.002	0.002	0.003	0.004
8,000	0.001	0.002	0.003	0.005	0.006
4,800	0.001	0.003	0.004	0.006	0.007
2,400	0.002	0.004	0.006	0.009	0.010
1,600	0.002	0.005	0.008	0.010	0.013
1,200	0.003	0.006	0.009	0.013	0.014
800	0.004	0.008	0.010	0.015	0.018
400	0.005	0.010	0.015	0.022	0.025
200	0.007	0.015	0.021	0.031	0.035
100	0.010	0.022	0.030	0.043	0.050

TABLE D.4 Weighting Fractions for Selected Variables

	1977	1973
Ph.D.'s Employed in Business and Industry, Total	0.112	0.132
Sex		
Male	0.105	0.127
Female	0.280	0.343
Field of Employment		
Mathematics	0.122	0.147
Computer Sciences	0.111	0.144
Physics/Astronomy	0.114	0.135
Chemistry	0.113	0.122
Earth Sciences	0.122	0.150
Engineering	0.097	0.121
Agricultural Sciences	0.108	0.143
Medical Sciences	0.155	0.185
Biological Sciences	0.155	0.178
Psychology	0.113	0.136
Social Sciences	0.098	0.129
Nonsciences	0.114	0.133

Example: In Table 3B, the estimated population of doctoral scientists and engineers employed in business and industry is 70,600. Multiplying by .112, the approximate sample size is 7,907. The sampling error of a reported statistic (for instance, 22.5 percent employed in management and administration of R&D) can be estimated by the formula for s_p or by consulting Table D.3 using rough approximations of the sample size and percentage in proportion form. In this case $s_p = \left(\frac{0.225 \quad [1-0.225]}{7,907}\right)^{\frac{1}{2}} = 0.00470$ or approximately 0.5 percent. Similarly, the value in the table opposite 8,000 for 0.25 is 0.005, or 0.5 percent. The reader can construct the desired confidence interval by multiplying the standard error by the approriate coefficient: $\pm 1s_p$ will provide a 66.7 percent confidence interval, $\pm 2s_p$, approximately a 95 percent interval, etc.

Sampling Error Estimates for Medians[19]

Sampling errors of median salary estimates presented in this report were computed not by strata but for all observations n, the number of full-time employed individuals in a particular subgroup who reported a salary. Comparisons

[19]The method for determining sampling errors of medians in this report was adapted from Morris H. Hansen, William N. Hurwitz, and William G. Madow, Sample Survey Methods and Theory, vol. 1 (John Wiley & Sons, Inc., New York, 1953), pp. 448-449.

of sampling errors for ratios, proportions, and differences indicate minor differences for the most part, between those calculated by strata and those that do not fully take into account sample design. The reader should interpret the confidence intervals as close approximations.

From the estimated population distribution, a statistic, m is computed that is an estimator of M, the position measure (median, quartile, decile, etc.). When m is a median, p_m the proportion of cases in the derived distribution falling below the position measure equals o.5. The sampling error of p_m is estimated by the formula $s_{p_m} = \left(\frac{p_m[1-p_m]}{n}\right)^{\frac{1}{2}}$. Two additional proportions are then computed:

$$p_1 = p_m - ks_{p_m}$$

$$p_2 = p_m + ks_{p_m}$$

The confidence interval for the median is set by calculating m_1 and m_2, the values below which the proportions p_1 and p_2 of the estimated distribution fall. The level of confidence is determined by k and will be 66.7 percent when k = 1, approximately 95 percent when k = 2, etc.

The 95 percent confidence intervals for selected categories of Ph.D. scientists and engineers employed in business and industry are presented in Table D.5.

TABLE D.5 95 Percent Confidence Intervals of Median Salaries for Selected Categories (In Thousands of Dollars)

	1973	1977
TOTAL, FULL-TIME EMPLOYED Ph.D.'s	$23.0 - 23.4	$29.6 - 30.0
Primary Work Activity		
Research and Development	21.1 - 21.5	26.9 - 27.5
Management and Administration	26.6 - 27.4	33.9 - 35.1
Consulting	23.0 - 25.8	28.5 - 30.4
Professional Services	25.9 - 30.5	30.9 - 35.8
Other	20.7 - 21.9	25.9 - 27.5
Business and Industry Group		
Manufacturing	22.9 - 23.3	29.9 - 30.2
Nonmanufacturing	22.2 - 23.8	26.4 - 28.1
Self-Employed	26.9 - 30.6	30.7 - 35.3
Nonclassifiable Companies	21.7 - 24.2	25.3 - 27.5
Field of Employment		
Mathematics	22.6 - 25.2	26.0 - 30.0
Computer Sciences	21.3 - 23.8	25.5 - 28.3
Physics	22.9 - 24.5	28.9 - 30.4
Chemistry	22.1 - 22.6	29.0 - 29.9
Earth, Envir., and Marine Sci.	21.7 - 24.0	27.6 - 29.8
Engineering	22.9 - 23.5	29.5 - 30.1
Agricultural Sciences	20.5 - 23.0	25.6 - 28.2
Medical Sciences	24.9 - 27.9	32.0 - 34.9
Biological Sciences	21.7 - 23.4	26.2 - 28.6
Psychology	26.7 - 30.5	31.3 - 35.4
Social Sciences	25.0 - 30.0	28.4 - 30.9
Nonscience/Nonengineering	25.1 - 28.1	30.3 - 33.9

Nonresponse Bias

In addition to sampling error, survey estimates are subject to a number of nonsampling errors, including misinterpretation of survey questions, errors in coding and processing of responses, incomplete sampling frame, and bias due to nonresponse. A recently published study[20] of the effects of nonresponse bias on data from the 1975 Survey of Doctorate Recipients concluded that although evidence of nonresponse bias was detected for certain employment and demographic characteristics, data published in the 1975 Profile of Doctoral Scientists and Engineers in the United States do not appear to be seriously affected.

Although the nonresponse bias study was confined to 1975 survey data, it is reasonable to assume that because the sample is longitudinal major findings are valid for the 1973 and 1977 survey results as well. The most serious bias detected was a lower percentage of foreign residents in the response group than in the nonresponse group. This bias resulted in an overestimation , 6-7 percent, of the sizes of the doctoral science and engineering population and labor force in the United States. A related bias was also discovered in the underestimation of the percentage of foreign citizens in the U.S. science and engineering population. The study found that the proportion of full-time and part-time employed doctoral scientists and engineers who were working in business and industry was slightly underestimated.

These nonresponse biases suggest that estimates of the number of doctoral scientists and engineers employed in business and industry in 1973 and 1977 are slightly higher than the actual figures. Of course, countervailing biases are possible, such as those resulting form the lack of a comprehensive sampling frame for Ph.D. recipients who earned their degrees at foreign institutions and who may be working in the United States.

[20] National Research Council, Commission on Human Resources, The Effects of Nonresponse Bias on the Results of the 1975 Survey of Doctoral Scientists and Engineers (Washington, D.C.: National Academy of Sciences, 1979), p. 33.

Appendix E
Estimation Procedure for Tables 12 and 13

The estimation of Tables 12 and 13 proceeded in several steps. The first step was to estimate the number of Ph.D.'s that were in the labor force in both years, 1973 and 1977. Two estimates are available, one based on the weights associated with the 1973 survey and the other based on the weights associated with the 1977 survey. Since these two estimates have approximately the same variance, an improved estimate is the simple mean of the 1973 and 1977 estimates.

The next stage was to adjust the 1973 and 1977 distributions by type of employment to the estimated total labor force. This adjustment is a ratio estimate, of the form $x_j' = (x_j/\Sigma x_j)t$, where x_j is the original estimate for class j in the given year and t is the estimated total labor force. The adjusted values then become the marginal totals of Table 12, whose cells initially contain estimates using the weights associated with the 1977 survey. However, the cells do not, in general, sum to either of the marginal totals.

The cells of Table 12 are then adjusted to sum to the row totals by a ratio estimate of the same form as that given above; i.e., the adjusted figure for the cell in the i-th row and j-th column is given by $x' = (x_{ij}/\sum_j x_{ij})t_{i\cdot}$, where x_{ij} is the figure in the cell and $t_{i\cdot}$ is the marginal total for the i-th row. The adjustment is then made to column totals in a

similar way, namely $x'' = (x'_{ij} / \sum_i x'_{ij})\, t_{.j}$.

It has been shown that iteration of the adjustment to row and column totals converges, and that the result has attractive statistical properties. These include the property that the procedure provides estimates which minimize discriminant information and that the resulting estimates are best asymptotically normal estimators, conditional on the marginal totals.

The procedure for Table 13 followed the same steps, after fixing the total number employed in business and industry as given by the final adjustment of Table 12.[21, 22]

---

[21] Ireland, C.T. and Kullback, S. (1968). "Contingency tables with given marginals." Biometrika, vol. 55, pp. 179-188.

[22] Stephan, F.F. (1942). "An iterative method of adjusting sample frequency tables when expected marginal totals are known." Annals of Mathematical Statistics, vol. 13, pp. 166-178.

Appendix F
Supplementary Tables

Ph.D. Granting Institutions and Field of Doctorate

Table F.1 shows the top 25 institutions, in terms of the number of Ph.D. degrees awarded, for scientists and engineers employed in business and industry. These 25 U. S. educational institutions graduated almost half (46.8 percent) of the doctoral scientists and engineers employed in business and industry in 1977. The University of Illinois at Champaign-Urbana and the Massachusetts Institute of Technology (MIT) graduated the largest numbers of science and engineering Ph.D.'s who were employed in business and industry in 1977 (over 2,300 from each school).

Of those Ph.D.'s employed in business and industry, by far the highest percentages held degrees in chemistry (30 percent) and engineering (29 percent). The 25 universities listed in Table E.1 awarded 43.2 percent of the doctorates in chemistry and 49.3 percent of those in engineering, with the remainder granted by other U.S. institutions and foreign institutions. Nearly 10 percent of the Ph.D. degrees held by engineers who were employed in business and industry were earned at two universities, MIT and Stanford.

Fewer than 20 institutions awarded over 70 percent of doctoral degrees in computer sciences. Further, just four schools, the University of Wisconsin at Madison, the University of Michigan, the University of Illinois at Urbana, and Stanford University, awarded nearly 30 percent of the Ph.D.'s in this field.

Three schools granted over 20 percent of the doctoral degrees hald by all agricultural scientists working in business and industry: Iowa State (8.7 percent), Michigan State (6.9 percent), and the University of Illinois at Urbana (6.6 percent). High percentages of medical science doctorates were granted by the University of Minnesota (9.2 percent), Purdue University (8.7 percent), and the University of Wisconsin at Madison (8.5 percent). Several Eastern schools awarded high percentages of Ph.D.'s earned in the social sciences: New York University (6.2 percent), Columbia University (5.2 percent), and Harvard University (5.2 percent).

TABLE F.1 Number of Doctoral Scientists and Engineers Employed in Business and Industry in 1977 by Ph.D. Granting Institution and Field of Doctorate

Ph.D. Granting Institution	Field of Doctorate											
	All Fields	Math	Comp	Phys	Chem	Earth	Engr	Agric	Med	Biol	Psych	SocSc
Total, All Institutions	70600	1800	600	6800	21200	2000	20700	2300	1500	5900	5100	2700
	%	%	%	%	%	%	%	%	%	%	%	%
Univ. of Illinois (Urbana)	3.4	2.0	7.1	4.2	4.2	2.3	3.3	6.7	0.9	3.1	0.4	2.0
Mass. Institute of Technology	3.3	2.1	6.2	3.8	3.1	3.7	5.4	0.9		0.8		2.5
Purdue University	2.8	1.9	0.3	0.9	3.2		2.4	5.5	8.7	2.9	3.7	2.5
Univ. of Wisconsin (Madison)	2.7	0.6	7.7	2.2	2.6	3.1	1.9	5.2	8.5	6.4	0.8	1.8
Ohio State University	2.5	0.4		1.5	3.0	3.0	2.8	4.6	3.7	1.4	3.0	
Univ. of California (Berkeley)	2.5	4.1	2.1	2.6	1.8	1.5	3.7	1.5	1.1	2.2	0.9	3.1
Stanford University	2.3	2.1	7.1	3.2	0.9	4.7	4.4			0.5	1.2	1.9
University of Michigan	2.2	1.5	7.6	2.4	1.7	1.1	2.8	0.2	3.9	1.6	2.8	1.7
University of Minnesota	2.1	2.5		1.1	1.8	1.3	1.4	4.2	9.2	3.8	2.8	1.4
Columbia University	1.9	1.6		2.2	1.5	4.3	1.6		1.6	1.1	4.1	5.2
Iowa State University	1.9	2.3		1.2	2.1	0.8	1.7	8.7	0.3	2.3		1.6
Cornell University	1.8	2.5	2.1	2.6	1.6	0.3	1.7	4.1	0.8	2.9	0.1	0.9
New York University	1.5	2.6		1.6	0.9	0.7	1.1		0.6	1.5	4.7	6.2
Univ. of Calif. (Los Angeles)	1.5	1.9	5.7	2.5	1.0	1.9	1.6		0.7	1.4	2.3	2.1
Pennsylvania State University	1.5	0.3	3.4	1.2	1.6	6.2	1.5	2.1		1.5	0.5	
Case Western Reserve Univ.	1.5	2.7	3.4	2.6	1.4	0.7	1.7		0.4	0.3	1.6	0.2
Michigan State University	1.4	1.5	2.2	0.6	1.5	2.2	0.7	6.9	0.3	2.0	0.9	3.1
Carnegie-Mellon University	1.4	2.5	4.5	1.8	1.0		2.6				0.4	
Harvard University	1.3	4.4	0.9	3.3	1.2	1.3	0.4		1.8	0.6	1.0	5.2
University of Pennsylvania	1.3	1.3	1.7	1.3	1.1		1.8		1.3	1.3	0.2	3.7
Northwestern University	1.3	1.1	5.3	0.4	1.5	1.9	1.7		1.6	0.8	0.7	0.9
Rutgers Univ. (New Brunswick)	1.3			1.0	1.1	1.9	0.8	1.6	2.1	4.5	0.6	1.4
Princeton University	1.2	0.3		1.3	1.3	3.1	1.2			0.6	1.4	1.8
University of Florida	1.2	0.5		0.6	1.2	0.3	1.7	2.7	0.3	0.4	0.7	0.9
Univ. of Maryland (College Pk.)	1.2	1.2	2.1	1.4	0.9		0.8	4.8	1.3	1.9	1.2	1.0
Other U.S. Institutions	49.6	53.7	29.8	46.1	50.3	50.2	47.7	39.6	48.4	52.1	62.7	47.5
Foreign Institutions	3.6	2.4	0.9	6.2	6.5	3.3	1.6	0.5	2.1	1.9	1.3	1.5

FINE FIELDS OF EMPLOYMENT AND DETAILED BUSINESS AND INDUSTRY GROUPS

Tables F.2 and F.3 present estimates of the number of doctoral scientists and engineers employed in business and industry in 1977 by their specific business and industry groups and their fine field of employment. These tables provide a detailed breakdown of the broad employment categories that were aggregated in the multivariate cross-tabulations presented in the body of the report. The three-digit SEC Industry Codes (based on SIC) are given in Table F.2 followed by the SIC classification of business and industry groups. Three-digit codes in Table F.3 correspond to the Degree and Employment Specialties List that is part of the 1977 questionnaire in Appendix A.

TABLE F.2 Number of Doctoral Scientists and Engineers Employed in Business and Industry by Detailed Business and Industry Group, 1977

Detailed Bus. and Ind. Group	No. Employed	SEC Ind. Code[a]
Total	70618	
Manufacturing	50726	
Food & Allied Products	1680	201 to 209
Textiles & Apparel	272	221 to 239
Lumber, Wood Prod, Furn	280	241, 251
Paper & Allied Products	718	262 to 265
Chemicals & Allied Products	17685	281 to 289
Industrial Chemicals	10752	281
Drugs & Medicines	5445	283
Other Chemicals	1488	284 to 289
Petrol Refining & Extraction	5400	131 to 139, 291 to 299
Rubber Products	753	301 to 309
Stone, Clay, & Glass Prod.	962	321 to 327
Primary Metals	1210	331, 335
Ferrous Metals & Prod.	492	331
Nonferrous Metals & Prod.	718	335
Fabricated Metal Products	586	341 to 349
Machinery	3494	351 to 358
Office Comp & Acct Mach.	2537	357
Other Machinery	957	351 to 356, 358
Elec. & Comm. Equip./Comm.	8231	363 to 369, 481 to 489
Comm Rec Equip, Elec Comp	2641	366
Communication	2324	481 to 489
Other Electrical Equip.	3266	363, 369
Transportation Equipment	5022	371 to 379
Motor Vehicles & Equip.	1719	371
Aircraft & Missiles	3223	372
Other Trans. Equip.	8	373 to 379
Professional & Sci. Equip.	3855	381 to 387
Sci & Mech Measuring Inst	1039	381, 382
Optic, Med, Photo, Oth Ins	2816	383 to 387
Other Manufacturing Industr.	650	211, 219, 271, 275, 311 to 319, 391 to 399
Nonmanufacturing	7344	
Agric, Forestry & Fisheries	375	011 to 021
Mining (Excl Petrol & Gas)	162	100 to 120, 140
Contract Construction	634	150 to 171
Transportation & Utilities	666	400 to 478, 491 to 499
Wholesale & Retail Trade	572	501 to 599
Finance, Insurance, Real Est	1017	601 to 679
Services	3918	701 to 899
Non-Classifiable Companies	5714	991
Self-Employed	6834	(identified from survey response)

[a]The SEC industry code is an adaptation of the Enterprise Standard Industrial Classification (SIC), which was developed by the Office of Management and Budget, Executive Office of the President. The complete coding system follows on pp. 84-88, which reproduce pp. iv-viii of the *Directory of Companies Required to File Annual Reports with the Securities and Exchange Commission*, Washington, D.C.: Securities and Exchange Commission, 1977.

SIC INDUSTRY CODES

SEC Industry Code No.		Corresponding Establishment SIC Code No.
	I. AGRICULTURE, FORESTRY AND FISHERIES (86)	
011	Field crops	011, 071, 072, 076, 078
013	Fruits, tree nuts and vegetables	013-019, 081-085
021	Livestock	021-029, 074, 075, 091-097
	II. MINING (757)	
100	Metal mining	101-106, 109
108	Metal mining - nonproducers	108
120	Coal mining	111, 121
131	Crude petroleum extraction and natural gas	131, 132
138	Oil and gas field services	138
139	Crude petroleum and natural gas - nonproducers (exploration & drilling funds)	-
140	Nonmetallic minerals	141, 142, 144, 145, 147-149
	III. CONTRACT CONSTRUCTION (105)	
150	General building contractors	152-154
160	Heavy construction contractors	161-162
171	Special trade contractors	171-179
	IV. MANUFACTURING (3577)	
201	Meat products	201, 207
202	Dairy products	202
203	Canned, cured and frozen foods	203, 209
204	Grain mill products	204
205	Bakery products	205
206	Sugar, confectionery and related products	206
208	Alcoholic and malt beverages	2082-2085
209	Bottled soft drinks and flavorings	2086-2087
211	Cigarettes	211
219	Tobacco manufactures, n.e.c.	212-214
221	Weaving and finishing mills; yarn and thread mills; miscellaneous textile mill products	221-224, 226, 228, 229
225	Knitting mills, includes knitted apparel	225
227	Floor covering mills	227
231	Apparel, except knitted apparel	231-238
239	Miscellaneous fabricated textile products	239

SEC Industry Code No.		Corresponding Establishment SIC Code No.
241	Lumber and Wood products, except furniture	241-245, 249
251	Furniture and fixtures	251-254, 259
262	Pulp, paper and board	261-263, 266
264	Miscellaneous converted paper products	264
265	Paperboard containers and boxes	265
271	Newspapers, periodicals and books - publishing, or publishing and printing	271, 272 2731, 274
275	Printing and allied industries	2732, 275-279
281	Basic chemicals, plastics materials, and synthetics	281, 282
283	Drugs	283
284	Soap, cleaners, and toilet goods	284
285	Paints and allied products	285, 2893
287	Agricultural chemicals	287
289	Chemical products, n.e.c.	286, 289 (except 2893)
291	Petroleum refining	291
299	Petroleum and coal products, n.e.c.	295, 299
301	Tires and inner tubes	301
309	Rubber and plastic products, n.e.c.	302-304, 306, 307
311	Leather tanning and finishing	311
314	Footwear, except rubber	314
319	Leather and leather products, n.e.c.	313, 315-317, 319
321	Glass products	321-323
324	Cement, hydraulic	324
325	Structural clay products	325
327	Concrete, gypsum and plaster products and non-metallic mineral products, n.e.c.	326-329
331	Iron and steel - blast furnaces, steel mills, and iron and steel foundries	331, 332
335	Nonferrous metals - refining, rolling, drawing and nonferrous foundries	333-339
341	Metal cans and shipping containers	341
342	Cutlery, hand tools, and hardware	342
343	Plumbing and heating, except electical	343
345	Screw machine products, bolts, etc.	345
348	Ordnance, except vehicles and guided missiles	348
349	Fabricated metal products, n.e.c.	344, 346, 347, 349
351	Engines and turbines	351
352	Farm machinery, construction, mining and materials handling machinery	352, 353
354	Metalworking machinery	354
355	Special industry machinery	355
356	General industrial machinery	356, 359
357	Office and computing machines	357
358	Service industry machines	358

SEC Industry Code No.		Corresponding Establishment SIC Code No.
363	Household appliances	363
366	Radio, television, communication equipment, and electronic components and accessories	365-367
369	Electrical lighting and wiring equipment, transmission and distribution equipment, and electrical machinery, n.e.c.	361, 362, 364, 369
371	Motor vehicles and equipment, including rebuilt parts	371
372	Aircraft, guided missiles and parts	372, 376
373	Ships and boat building and repairing	373
374	Railroad equipment	374
379	Transportation equipment, n.e.c.	375, 379
381	Scientific instruments and mechanical measuring devices	381, 382
383	Optical and opthalmic goods, photographic equipment and supplies	383, 385, 386
384	Medical instruments and supplies	384
387	Watches, clocks, and watchcases	387
391	Jewelry, silverware, and plated ware	391, 396
393	Musical instruments and parts	393
394	Toys and sporting goods	394
399	Manufactures, n.e.c.	395, 399
	V. TRANSPORTATION, COMMUNICATION, ELECTRIC, GAS AND SANITARY SERVICES (801)	
400	Railroad transportation	401, 404
411	Local and suburban transit	411, 414
419	Local and interurban passenger transit, including taxicabs, n.e.c.	412, 413, 415, 417
421	Trucking, including terminal facilities	421
422	Public warehousing	422, 423
440	Water transportation	441-446
450	Air transportation	451, 452, 458
460	Pipe line transportation, except natural gas	461
471	Freight forwarding	471
474	Rental of railroad cars	474
478	Services incidental to transportation	472, 478
481	Telephone communication	481
482	Telegraph communication	482
483	Radio and television broadcasting	483
489	Communication services, n.e.c.	489
491	Electric companies and systems	491
492	Gas companies and systems, including natural gas pipelines	492
493	Combination companies and systems, electric and gas	493
499	Water supply and other sanitary services	494-497

SEC Industry Code No.		Corresponding Establishment SIC Code No.
	VI. WHOLESALE AND RETAIL TRADE(1012)	
501	Wholesale Trade - Motor vehicles and automotive equipment	501
506	Wholesale Trade - Electrical goods	506
507	Wholesale Trade - Hardware, plumbing, and heating equipment	507
508	Wholesale Trade - Machinery, equipment, and supplies	508
509	Wholesale Trade - Miscellaneous wholesalers	502-505, 509 511, 517-519
512	Wholesale Trade - Drugs, chemicals, and allied products	512, 516
513	Wholesale Trade - Dry goods and apparel	513
514	Wholesale Trade - Groceries and related products	514
515	Wholesale Trade - Farm products raw materials	515
521	Retail Trade - Building materials hardware and farm equipment	521-527
531	Retail Trade - Department Stores	531
533	Retail Trade - Limited price variety and general merchandise stores	533, 539
541	Retail Trade - Grocery and misc. food stores	541-546, 549
551	Retail Trade -Automotive, aircraft, and marine dealers	551, 552 555-557, 559
553	Retail Trade - Tire, battery, and automotive accessory dealers	553
554	Retail Trade - Gasoline service stations	554
561	Retail Trade - Apparel and accessory stores, except shoes	561-565, 568, 569
566	Retail Trade - Shoe stores	566
571	Retail Trade - Furniture, home furnishings, and equipment stores	571
573	Retail Trade - Household appliance stores, including radio and television	572, 573
581	Retail Trade - Eating and drinking places	581
591	Retail Trade - Drug and proprietary stores	591
594	Retail Trade - Jewelry stores	5944
596	Retail Trade - Non-store retailers	596
598	Retail Trade - Fuel and ice dealers	598
599	Retail Trade - Retail stores, n.e.c.	592-595, 599 (except 5944)

SEC Industry Code No.		Corresponding Establishment SIC Code No.
	VII. FINANCE, INSURANCE AND REAL ESTATE (2187)	
601	Banks and related functions	601-605
612	Savings and loan associations	612
614	Personal credit institutions	614
615	Business credit institutions	611, 613, 615
616	Loan correspondents and brokers	616
621	Security and commodity brokers, dealers and services	621, 622, 628
631	Life, accident, and health insurance carriers	631, 632
633	Fire, marine, casualty and surety insurance carriers	633, 635, 637, 639
636	Title insurance carriers	636
640	Insurance agents, brokers, and service	641
651	Real estate - operators and lessors	651
652	Real estate - investment trusts	-
653	Real estate - agents, brokers, and managers	653, 654, 661
655	Real estate - subdividers, developers, and operative builders	655
671	Bank holding companies	671 (pt.)
674	Savings and Loan holding companies	671 (pt.)
675	Insurance holding companies	671 (pt.)
676	Financial holding companies and trusts	671 (pt.), 673
679	Miscellaneous investing institutions	679
	VIII. SERVICES (922)	
701	Hotels, tourist courts, and motels	701-704
721	Laundries and dry cleaning plants	721
729	Personal services, n.e.c.	722-726, 729
731	Advertising Services	731
737	Computer and other data processing services	737
739	Miscellaneous business services, n.e.c.	732-736, 739 762-764, 769
750	Automobile repair shops and services	751-754
781	Motion picture production, distribution, and related services	781, 782
783	Motion picture theatres	783
791	Amusement and recreation services, n.e.c.	791-794, 799, 841, 842
801	Medical and other health services -Hospitals, clinics, rest homes, etc.	801-809
820	Education services	821-824, 829
895	Nonprofit membership organizations	861-866, 869
899	Miscellaneous services, n.e.c.	811, 832, 833 835, 836, 839 881, 891-893, 899
	IX. NON-CLASSIFIABLE COMPANIES	
991	Non-Classifiable Companies	99

TABLE F.3 Number of Doctoral Scientists and Engineers Employed in Business and Industry by Broad Field and Fine Field of Employment, 1977

Total		70618
Mathematics, Total		1055
010	Analysis & Func Anal	7
040	Number Theory	2
052	Probability	22
055	Math Statistics	283
082	Operations Research	256
085	Applied Mathematics	369
089	Combinatorics & Fin Math	4
091	Physical Mathematics	28
098	Mathematics, General	23
099	Mathematics, Other	61
Computer Sciences, Total		2948
071	Theory	48
072	Software Systems	2057
073	Hardware Systems	332
074	Intelligent Systems	145
079	Computer Sciences, Other	366
Physics/Astronomy, Total		3758
101	Astronomy	20
102	Astrophysics	72
110	Atomic & Molecular Phys	185
120	Electromagnetism	144
130	Mechanics	29
132	Acoustics	198
134	Fluids	69
135	Plasma Physics	416
136	Optics	600
138	Thermal Physics	22
150	Nuclear Structure	91
160	Solid State	1040
198	Physics, General	376
199	Physics, Other	496
Chemistry, Total		16498
200	Analytical Chemistry	2110
210	Inorganic Chemistry	662
215	Synth Inorg & Organomet	303
220	Organic Chemistry	2887
225	Synth Organ & Nat Prod	1353
230	Nuclear Chemistry	135
240	Physical Chemistry	1292
245	Quantum Chemistry	10
250	Theoretical Chemistry	7
255	Structural Chemistry	91
260	Agricultural & Food	492
265	Thermodyn & Mater'l Prop	208
270	Pharmaceutical Chemistry	831
275	Polymers	3849
280	Biochemistry	255
285	Chemical Dynamics	67
298	Chemistry, General	410
299	Chemistry, Other	1536
Earth, Envir, & Marine Sci, Total		2969
301	Mineralogy, Petrology	91
305	Geochemistry	88
310	Stratigraphy, Sediment'n	219
320	Paleontology	60
330	Structural Geology	44
341	Geophysics (Solid Earth)	360
350	Geomorph, Glacial Geol	9
360	Hydrology	175
370	Oceanography	65
381	Atmospheric Chem & Phys	161
382	Atmospheric Dynamics	26
383	Atmospheric Sci, Other	81
388	Environmental Sci, Gen	490
389	Environmental Sci, Other	166
390, 391	Applied Geology, etc.	623
395	Fuel Tech & Petrol Engr.	92
397	Marine Sciences, Other	65
398	Earth Sciences, General	35
399	Earth Sciences, Other	119
Engineering, Total		21720
400	Aero- & Astronautical	748
410	Agricultural Engineering	42
415	Biomedical Engineering	207
420	Civil Engineering	652
430	Chemical Engineering	3732
435	Ceramic Engineering	323
440	Electrical Engineering	1312
445	Electronics Engineering	2446
450	Industrial/Manufacturing	444
455	Nuclear Engineering	940
460	Engineering Mechanics	826
465	Engineering Physics	833
470	Mechanical Engineering	1931
475	Metallurgy & Phys Met	1414
476	Systems Design & Sys Sci	1495
478	Operations Research	377
479	Fuel Tech & Petrol Engr	566
480	Sanitory/Environmental	481
486	Mining Engineering	32
497	Materials Sci Engr	1339
498	Engineering, General	495
499	Engineering, Other	1085
Agricultural Sciences, Total		2560
500	Agronomy	413
501	Agricultural Economics	331
502	Animal Husbandry	33
504	Fish & Wildlife	22
505	Forestry	89
506	Horticulture	124
507	Soils & Soil Science	15

TABLE F.3 (Continued)

Agricultural Sciences, Total (continued)		
510	Animal Sciences	441
511	Phytopathology	168
517,		
503	Food Science & Tech	428
518	Agricultural Sci, Gen	195
519	Agricultural Sci, Other	301
Medical Sciences, Total		**3043**
520	Medicine & Surgery	439
522	Public Health	78
523	Veterinary Medicine	96
524	Hospital Administration	8
527	Parasitology	49
528	Environmental Health	85
534	Pathology	143
536	Pharmacology	790
537	Pharmacy	412
538	Medical Sciences, Gen	281
539	Medical Sciences, Other	662
Biological Sciences, Total		**3308**
540	Biochemistry	599
542	Biophysics	58
544	Biometrics, Biostatis	190
546	Cytology	22
547	Embryology	6
548	Immunology	243
550	Botany	8
560	Ecology	273
562	Hydrobiology	21
564	Microbiol & Bacteriol	658
566	Physiology (Animal)	86
567	Physiology (Plant)	49
569	Zoology	18
570	Genetics	94
571	Entomology	127
572	Molecular Biology	83
573	Food Science & Technol	363
576	Nutrition & Dietetics	83
578	Biological Sciences, Gen	90
579	Biological Sciences, Other	237
Psychology, Total		**4704**
600	Clinical Psychology	2909
610	Counseling & Guidance	183
620	Developmental & Gerontol	6
630	Educational Psychology	55
635	School Psychology	9
641	Experimental Psychology	117

Psychology, Total (continued)		
642	Comparative Psychology	9
643	Physiological Psychol	2
650	Industrial & Personnel	910
670	Psychometrics	49
680	Social Psychology	109
698	Psychology, General	14
699	Psychology, Other	332
Social Sciences, Total		**1594**
700	Anthropology	32
703	Archeology	10
708	Communications	70
710	Sociology	50
720	Economics	832
725	Econometrics	173
729	Social Statistics	34
740	Geography	19
745	Area Studies	21
751	Political Science	36
752	Public Administration	37
755	International Relations	34
770	Urban & Regional Plan	62
798	Social Sciences, General	61
799	Social Sciences, Other	123
Arts & Humanities, Total		**48**
804	American History	2
830	Music	17
836	Comparative Literature	2
879	Humanities, Other	20
891	Library & Archival Sci	7
Languages & Literature, Total		**29**
821	German	6
822	Russian	23
Educ & Other Prof Fields, Total		**4786**
938	Education	131
801	Applied Art	26
833	Religion	18
882	Business Administration	2253
884	Journalism	70
886	Law, Jurisprudence	313
887	Social Work	8
897	Professional Field, Other	152
899	Other Fields	1815
No Report		**1598**