INFOBRIEF
SRS Science Resources Statistics

National Science Foundation
Directorate for Social, Behavioral, and Economic Sciences

NSF 04-328
June 2004

EMPLOYMENT SECTOR, SALARIES, PUBLISHING, AND PATENTING ACTIVITIES OF S&E DOCTORATE HOLDERS

by Thomas B. Hoffer[1]

This InfoBrief draws upon the National Science Foundation's 2001 Survey of Doctorate Recipients (SDR) to describe the broad employment sectors of the U.S.-trained doctoral science and engineering (S&E) workforce and some of their employment outcomes, particularly salaries, publications, and patent applications. The 2001 data are compared with results from the 1995 SDR, which also collected information on these outcomes.

As defined in the SDR and throughout this InfoBrief, the U.S.-trained doctoral S&E workforce consists of those who have earned S&E doctorates from U.S. institutions and who are employed in the United States. This population has grown significantly (over 18 percent) since the mid-1990s, increasing from about 485,000 persons employed full or part time in 1995 to almost 575,000 in 2001.[2]

Employment Sectors

The doctoral S&E workforce in 2001 was distributed across three main employment sectors: education (46 percent), industry (45 percent), and government (10 percent).[3] This distribution is broken down into five broad categories of doctoral study fields in table 1.[4]

In 2001, the education sector employed over 50 percent of those earning their doctorates in computer and mathematical sciences (53 percent), life sciences (55 percent), and social sciences (which include psychology Ph.D.s) (52 percent). In contrast, a majority of doctoral engineers (65 percent) and physical scientists (53 percent) were employed in industry in 2001.

Comparing the records from the 1995 and 2001 SDR studies, the absolute numbers of S&E doctorate holders increased in all three sectors since 1995. The gains relative to the 1995 numbers were greater in some sectors and for certain doctoral fields. The number employed in industry grew the most over the period with an increase of 27 percent since 1995. In contrast, the increases in the numbers employed in education and government were 12–14 percent of the 1995 totals. Overall, the S&E doctoral labor force became less concentrated in education and more concentrated in industry between 1995 and 2001 (table 1).

The numbers of doctoral-level workers increased from 1995 to 2001 in each of the five broad S&E fields. The increases were greatest in computer and mathematical sciences (26 percent increase), life sciences (23 percent), and engineering (27 percent). The numbers of doctorate holders in physical sciences and social sciences in the workforce increased by 10 and 15 percent, respectively (table 1).

Examining the patterns of change across employment sectors for each broad field, the proportions of doctorate holders in computer and mathematical sciences, physical sciences, life sciences, and engineering em-

[1]Thomas B. Hoffer is Principal Research Scientist at the National Opinion Research Center, University of Chicago.

[2]The 2001 data are the most recent available.

[3]Self-employed individuals and those working for private nonprofit organizations are included in the industry sector.

[4]The SDR requests detailed information from respondents on their fields of specialization both in terms of their doctorate degree programs and their current occupations. As used here, however, "field" refers exclusively to field of doctorate, aggregated into five broad areas—computer and mathematical sciences, life and related sciences, physical and related sciences (includes the earth, atmospheric, and ocean sciences as well as chemistry, physics, and astronomy), social and related sciences (including psychology), and engineering.

TABLE 1. Number and percent distribution across employment sectors of science and engineering doctorate holders, by field of doctorate: 1995 and 2001

Field of doctorate	Number employed	Total	Education	Government	Industry
		Percent distribution			
All science and engineering fields					
1995	484,780	100.0	48.5	9.9	41.6
2001	574,890	100.0	45.8	9.5	44.7
Computer/mathematical sciences					
1995	29,250	100.0	63.3	4.3	32.4
2001	36,740	100.0	53.1	5.4	41.5
Life/related sciences					
1995	132,190	100.0	56.8	11.5	31.7
2001	162,180	100.0	55.2	10.2	34.6
Physical/related sciences					
1995	101,300	100.0	40.1	9.4	50.4
2001	111,330	100.0	36.6	10.3	53.1
Social/related sciences					
1995	143,390	100.0	52.1	11.6	36.4
2001	165,060	100.0	51.8	10.4	37.8
Engineering					
1995	78,650	100.0	33.1	6.9	60.0
2001	99,580	100.0	27.8	7.5	64.6

NOTES: Education sector includes teaching, administrative, and research positions at all levels of K-12 and higher educational institutions. Self-employed and employees of private nonprofit organizations are included in the industry sector.

SOURCE: National Science Foundation, Division of Science Resources Statistics, 1995 and 2001 Survey of Doctorate Recipients.

ployed in industry increased from 1995 to 2001. These relative gains were mainly complemented by decreases in the proportions employed in education from 1995 to 2001 (table 1).

Salary Differences by Sector and Specialization

For the S&E doctoral workforce overall, median annual salaries in 2001 were highest among the full-time employed[5] in the industry sector ($92,000), followed by those in government ($78,000), and then those in education ($63,000). Those employed in industry also had the highest median salary when sector comparisons are made among the S&E doctorate holders who had earned their degrees 10 or more years ago (referred to here as the "older cohort"), and among the newer doctorate holders who earned their degrees within the last 10 years (the "newer cohort").

Within the education sector, doctorate holders in engineering were the highest paid group, and the differences among the other broad fields were not statistically significant. Within the government sector, those who earned doctorates in the computer and mathematical sciences, physical sciences, and engineering had higher median salaries than those in the life and social sciences. In industry, doctorate holders in computer and mathematical sciences and engineering had the highest median salaries in 2001, with those in physical sciences following closely behind (table 2).

The 1995 median salaries reported in table 2 are adjusted for inflation to compare them with 2001. The median annual salaries of the full-time employed S&E workforce increased from 1995 to 2001 overall and within each of the three employment sectors. Median salaries increased in constant dollars by 10 percent in both government and industry, and by 4 percent in education. Salaries for the newer doctoral cohort increased by 13 percent in industry, compared to 8 percent in government; there was no salary increase for the newer cohort in education after adjusting for inflation. In contrast, the older cohort saw real average salary gains of 6–8 percent in all three employment sectors.

Real salary gains from 1995 to 2001 varied by field of doctorate. The median salary of computer and mathematical sciences doctorate holders increased from $69,700 in 1995 to $80,000 in 2001 in constant dollars, or 15 percent, while the increases were 6 percent for life sciences, 8 percent for physical sciences, 5 percent for social sciences, and 11 percent for engineering doctorate holders. The median salary increases for the newer doctoral cohort were 28 percent in the computer and mathematical sciences, about 15 percent in the physical sciences and engineering, and 5 percent in life science. There was no change in the inflation-adjusted median salary of social scientists in the newer doctoral cohort.

Among the newer doctoral cohort, the real median salary gains between 1995 and 2001 for the different broad fields were largely confined to those employed by industry. Only engineering registered a statistically

[5]The analysis of salaries is confined to the full-time employed workforce in order to improve comparability between doctorate fields and survey years.

TABLE 2. Median annual salaries of all full-time employed science and engineering doctorate holders, by field of doctorate, employment sector, and years since doctorate: 1995 and 2001

(Constant 2000 dollars)

	All employment sectors			Education			Government			Industry		
Field of doctorate	All doctorate holders	Doctorate received less than 10 years ago	Doctorate received 10 or more years ago	All doctorate holders	Doctorate received less than 10 years ago	Doctorate received 10 or more years ago	All doctorate holders	Doctorate received less than 10 years ago	Doctorate received 10 or more years ago	All doctorate holders	Doctorate received less than 10 years ago	Doctorate received 10 or more years ago
All science and engineering fields												
1995	70,000	56,900	81,300	60,400	46,500	69,700	70,900	58,100	80,200	83,800	70,900	93,000
2001	77,000	62,000	85,000	63,000	46,500	74,400	78,000	63,000	85,000	92,000	80,000	100,000
Computer/mathematical sciences												
1995	69,700	58,100	76,400	61,100	50,000	69,700	76,700	69,700	84,800	89,500	81,300	98,800
2001	80,000	74,500	85,000	65,000	50,000	72,000	90,000	76,000	97,000	100,000	99,000	110,000
Life/related sciences												
1995	66,200	48,800	76,800	59,300	42,200	69,700	68,700	52,100	77,900	81,300	65,100	91,800
2001	70,000	51,100	82,000	60,000	43,000	74,000	73,000	57,100	81,000	86,000	73,000	100,000
Physical/related sciences												
1995	76,700	58,000	87,100	59,300	43,500	72,000	80,200	59,300	87,100	86,000	69,700	93,000
2001	82,600	67,000	92,000	60,000	45,000	72,000	88,400	68,000	94,900	93,000	80,000	100,000
Social/related sciences												
1995	64,500	52,300	70,900	58,100	46,500	66,400	67,400	58,100	73,200	79,300	68,600	87,100
2001	67,800	52,000	75,000	60,000	47,000	70,000	70,000	61,000	75,900	80,000	70,000	89,000
Engineering												
1995	81,300	69,700	93,000	70,900	58,100	83,700	79,000	67,400	93,000	87,100	75,500	98,800
2001	90,500	80,000	100,000	80,000	62,000	90,000	86,000	74,000	96,600	96,000	86,500	105,000

NOTES: Median salaries are reported for full-time employees only. Salaries are rounded to the nearest hundred dollars. The 1995 median annual salaries were converted to 2000 dollars with a formula found at http://www.bls.gov/cpi. Education includes teaching, administrative, and research positions at all levels of K-12 and higher educational institutions. Self-employed and employees of private nonprofit organizations are included in the industry sector.

SOURCE: National Science Foundation, Division of Science Resources Statistics, 1995 and 2001 Survey of Doctorate Recipients.

significant increase in median salary for the newer cohort within the education sector, and physical scientists had the only statistically significant increase in government. In contrast, social scientists were the only group not to show a statistically significant gain among those employed in industry.

The median real salary increases in constant dollars for the older doctoral cohorts were 11 percent in computer and mathematical sciences, 8 percent in engineering, 7 percent in life sciences, and 6 percent each in social sciences and physical sciences. Statistically significant gains among members of the older doctoral cohort employed in the education sector were realized by life sciences and social sciences. The only statistically significant gain in median salary for the older cohort working in government was attained by the physical sciences. In industry, median salaries of the older cohort for those with doctorates in life sciences, physical sciences, and engineering showed statistically significant increases, while those for computer and mathematical sciences and social sciences did not.

Presentations and Publications

The 2001 SDR posed a series of questions on professional activities.[6] Respondents were asked to provide the numbers of conference presentations made, publica-

[6]This section tabulates conference presentations made and journal articles published, which are summarized here and in table 3 as dichotomous indicators of publication activity (i.e., whether an individual presented or published one or more times in the designated time period).

tions generated, and patents applied for and obtained since April 1995. The last time comparable data were collected was in 1995, but the questions in that year used a 5-year reference span instead of a 6-year period (i.e., asking respondents about their activities since April 1990).[7] This difference means that the counts would be slightly higher in 2001 than the 1995 counts if the levels of such activity were similar in the two periods. However, this was not the case, and reported publication activity was lower (77 percent of all science and engineering doctorate holders compared to 74 percent) in the later period.

In 2001, 86 percent of the S&E doctorate holders employed in education reported one or more presentations or published articles, compared to 74 percent in government and 61 percent in industry (table 3). The breakdowns by doctoral field and employment sector show that, in the 2001 survey, the proportions reporting publication-related activity were similar across doctorate fields for those working in education (82–90 percent). In the government and industry sectors, social and related sciences doctorate holders were substantially less likely than those in other disciplines to pursue publication activities. This disparity largely reflects the lack of publication-related activities on the part of those with psychology doctorates, many of whom are working as professional practitioners rather than researchers; the other social science disciplines are close to the sector averages (tabulations not shown here).

Comparing the 2001 numbers with those from 1995, it appears that the doctoral S&E workforce was slightly less likely in 2001 to report publication-related activity over the 6-year period than were their 1995 counterparts over the 5-year period from 1990 to 1995. Even without any adjustment for the differences in reference periods, the overall decline was statistically significant, as were the declines in the education and industry employment sectors and in all five broad fields of doctorate specialization.

Why the overall decline in publication activity occurred is not obvious and is an important topic for further research.[8] Past research has shown that publication activities tend to be highest in the early stages of the S&E doctorate holders' careers.[9] The SDR data show that pattern for individuals employed both in education and in industry. The proportional representation of younger cohort members in the education sector did not change and actually increased in the industry sector from 1995

TABLE 3. Employed science and engineering doctorate holders engaged in publication-related activities, by field of doctorate and employment sector: 1995 and 2001
(Percent)

Field of doctorate	All employment sectors	Education	Government	Industry
All science and engineering fields				
1995	77.0	88.3	75.4	64.2
2001	73.9	86.3	74.1	61.1
Computer/mathematical sciences				
1995	77.5	84.7	70.7	64.2
2001	72.1	82.2	77.0	58.7
Life/related sciences				
1995	84.6	91.3	87.2	71.8
2001	82.0	89.2	82.6	70.3
Physical/related sciences				
1995	75.7	87.4	82.4	65.2
2001	72.0	85.0	81.6	63.0
Social/related sciences				
1995	69.7	84.8	57.8	52.0
2001	66.7	83.8	55.7	46.4
Engineering				
1995	78.8	93.7	84.4	69.9
2001	74.1	89.9	85.5	66.0

NOTES: Publication-related activities include presenting papers at conferences and/or publishing journal articles one or more times in the designated time period; a 6-year period was used in 2001 and a 5-year period in 1995. Numbers in this table are not adjusted for the time span difference. Education includes teaching, administrative, and research positions at all levels of K-12 and higher educational institutions. Self-employed and employees of private nonprofit organizations are included in the industry sector.

SOURCE: National Science Foundation, Division of Science Resources Statistics, 1995 and 2001 Survey of Doctorate Recipients.

[7]The 2001 SDR included an additional question, not asked in 1995, about the number of books or monographs the respondents had published since 1995. A fifth (21 percent) of those in the education sector reported publishing one or two books or monographs, followed by 14 percent in government and 10 percent in industry.

[8]A decline in the number of scientific and technical articles published by United States authors is also documented in National Science Board, *Science and Engineering Indicators – 2002* (Arlington, VA: National Science Foundation, 2002, NSB-02-01), Chapter 5, pp. 39-41; this report also provides a useful discussion of possible reasons for the decline.

[9]See P.E. Stephan and S.G. Levin, *Striking the Mother Lode in Science*. New York: Oxford University Press, 1992.

to 2001. The lower rates of publication in 2001 were evident both for newer cohort and older cohort members in the education and industry sectors. (These additional tabulations are available upon request).

Patent Applications and Patents Granted

The 2001 SDR questionnaire asked respondents, "Since April 1995, have you been named as an inventor on any application for a U.S. patent?" Those who responded yes were asked to provide the numbers of patents applied for, patents granted, and patents granted that "resulted in commercialized products or processes or have been licensed." The same set of questions, but with a reference date of April 1990 (that is, a 5-year instead of a 6-year span), was also asked in 1995.[10]

Patent-related activities were markedly less frequent among the S&E doctoral workforce than were publication-related activities and were pursued by only about 16 percent of this population in 2001. S&E doctorate holders in industry were much more likely than those employed in education or government to have been named as an inventor on a U.S. patent application or award. In 2001, about a fourth (25 percent) of S&E doctorate holders in industry reported having engaged in one or more patenting activities during the past 6 years, compared to 8 and 9 percent in education and government, respectively (table 4).

In 2001, engineering doctorate holders were the most likely to have engaged in patent-related activities, whereas social science doctorate holders were by far the least likely. In all five broad doctoral fields, those employed in industry were more likely to be involved in patent-related activities than those employed in the other sectors. Among those employed in industry in 2001, engineering and physical sciences doctorate holders were more likely to report having applied for and/or obtained patents (38 percent and 37 percent, respectively) than were those in the remaining fields. Within the education sector, those with engineering doctorates were the most likely to have applied for and/or obtained patents.

TABLE 4. Employed science and engineering doctorate holders engaged in patent-related activities, by field of doctorate and employment sector: 1995 and 2001

(Percent)

Field of doctorate	All employment sectors	Education	Government	Industry
All science and engineering fields				
1995	12.4	6.2	6.9	20.9
2001	15.7	8.2	8.7	24.9
Computer/mathematical sciences				
1995	6.1	2.1	1.3	14.6
2001	12.5	3.3	9.6	24.8
Life/related sciences				
1995	11.4	7.6	7.4	19.6
2001	15.3	11.7	9.8	22.6
Physical/related sciences				
1995	22.6	9.4	12.5	35.0
2001	24.8	10.5	14.0	36.8
Social/related sciences				
1995	0.7	0.5	0.2	1.2
2001	1.3	0.6	0.4	2.6
Engineering				
1995	24.6	16.5	16.8	30.0
2001	31.3	20.5	17.2	37.6

NOTE: Patent-related activities include applying for and/or obtaining patents one or more times in the designated time period; a 6-year period was used in 2001 and a 5-year period in 1995. Numbers in this table are not adjusted for the time span difference. Education includes teaching, administrative, and research positions at all levels of K-12 and higher educational institutions. Self-employed and employees of private nonprofit organizations are included in the industry sector.

SOURCE: National Science Foundation, Division of Science Resources Statistics, 1995 and 2001 Survey of Doctorate Recipients.

Patent-related activities were reported by a higher percentage of the doctoral workforce in 2001 than in 1995 (16 versus 12 percent), but the apparent increase may be exaggerated slightly by the different reference periods used in the 2001 and 1995 surveys. With that caveat, the reported percentages of patenting activity were higher in 2001 than 1995 in all three sectors and all five broad fields.[11] In the broad fields of specialization, patenting activity increased the most among the computer and mathematical science doctorate holders, who went from 6 to 13 percent overall in reporting pat-

[10]Patent-related activities are, like publication-related activities, summarized in this report with a single dichotomous indicator of whether the individual applied for or was granted a patent during the referent period (since April 1995 for the 2001 SDR; since April 1990 for the 1995 SDR). The percentages responding that they had applied for or were granted one or more patents are broken down by employment sector and doctoral field in table 4.

[11]The apparent increase in patenting activity for the S&E doctorate population is consistent with the increases in the numbers of patents granted to U.S. inventors in the period 1995-99 compared to the period 1990-94 documented in National Science Board, *Science and Engineering Indicators – 2002* (Arlington, VA: National Science Foundation, 2002, NSB-02-01), pp. 6-21.

enting activity, and among engineering doctorate holders, who increased from 25 to 31 percent.

Summary

Among 575,000 total S&E doctorate holders in the workforce in 2001, about 46 percent worked in education, 45 percent in industry, and 10 percent in government. In recent years, the doctoral S&E workforce has expanded. Over the period from 1995 to 2001, the S&E doctorate workforce grew in all sectors of the economy, but employment in industry increased the most.

The growth in the doctoral S&E workforce coincided with increases in real annual salaries. Median salary gains since 1995 were greatest in the newer doctoral cohorts among those employed in industry, especially for those who earned their doctorates in computer and mathematical sciences, engineering, and physical sciences. Salaries have been relatively flat for those in the newer doctoral cohorts employed in the education sector.

Comparisons of the 1995 and 2001 SDR publication data indicate declining rates of involvement in publication-related activities. Declines in publication-related activities were observed in the education and industry employment sectors and in all five broad fields of doctorate specialization.

For further information about this InfoBrief, the Survey of Doctorate Recipients, or related reports, contact

Kelly Kang
Human Resources Statistics Program
Division of Science Resources Statistics
National Science Foundation
4201 Wilson Boulevard, Suite 965
Arlington, VA 22230
703-292-7796
kkang@nsf.gov

NSF 04-328