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The Education and Employment of Engineering Graduates

Engineering Workforce Project Report # 1

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Prepared for
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ENGINEERING WORKFORCE PROJECT

The Education and Employment of Engineering Graduates

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With a foreword by Robert Weatherall

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ABOUT THE ENGINEERING WORKFORCE PROJECT

The Engineering Workforce Project (EWP) is a multi-directorate program in the National Science Foundation (NSF) that describes and analyzes important dynamics of the U.S. engineering workforce. The project provides information on a range of topics related to engineering education, engineering degree graduates, and engineering occupations. Data come principally from the Scientists and Engineers Statistical Data System (SESTAT) in NSF's Division of Science Resources Statistics (see www.nsf.sestat.gov). Project findings are disseminated in NSF reports, journal articles, conference proceedings, and other presentations. This report concentrates on the profession of engineering, including the demographic characteristics and educational backgrounds of U.S. engineers. A complementary report about the engineering profession and other EWP reports and papers may be found at: www.abtassociates.com/Engineering_Workforce .

The Engineering Workforce Project has received major staff and funding support from the Directorate for Engineering and the Directorate for Social, Behavioral, and Economic Sciences. It has also received funds from the Directorate for Computer and Information Sciences and the Engineering Directorate for Education and Human Resources.

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The Engineering Workforce Project (EWP) evolved from the belief in the early 1990s that what was then a brand-new, highly detailed source of national science and engineering workforce data, the Scientists and Engineers Statistical Data System (SESTAT), provided great analytical potential to shed light on the full dimensions of the engineering workforce. In time, the Project's purpose became the empirical examination of a range of rich topics about the engineering workforce. The resulting reports, journal articles, presentations, etc. addressed specific portions of the engineering workforce to provide decisionmakers in academia, industry, and government with objective information not previously available.

Sustained encouragement and support for the Project's work during the 1990s came from the following individuals who saw the value of what EWP was trying to achieve and actively supported dissemination of results broadly:

Lawrence Burton, Program Director (on detail), Division of Computer and Network Systems, CISE

Marshall Lih, former Director, Division of Engineering Education and Centers, ENG

Bruce Kramer, Director, Division of Engineering Education and Centers, ENG

Lynn Preston, Deputy Director for Centers, Division of Engineering Education and Centers, ENG

Susan Kemnitzer, Deputy Director for Education, Division of Engineering Education and Centers, ENG

Mary Golladay, Director, Education and Human Resources Statistics Program, Division of Science Resources Statistics, SBE, retired

Carlos Kruytbosch, Director, R&D Personnel Program, Division of Science Resources Statistics, SBE, retired

Ongoing technical contributions were provided by Nimmi Kannankutty and Kelly Kang, Analyst and Senior Analyst, respectively, Division of Science Resources Statistics, SBE.

Many people and organizations worked on the preparation of this report:

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Susan Hills, Technical Editor (consultant)

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Susan Kemnitzer, Deputy Director for Education, Division of Engineering Education and Centers, ENG

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Finally, the report was edited following review by Nita Congress. When it became possible to update the report with 1999 SESTAT data—the most recent data available until data collected in 2003 become available in 2005—staff at SRI International (EEC 02-19097) reviewed the narrative against the updated data in the text, graphics, and tables to ensure that the narrative remained consistent with the data.

Linda Parker
Project Coordinator
Division of Engineering Education and Centers, NSF

FOREWORD

"There is, in the genius in the people of this country, a peculiar aptitude for mechanic improvements," wrote Alexander Hamilton in 1791 (Syrett and Cooke 1966). In his celebrated *Report on Manufactures*, he proposed that this aptitude be cultivated as an asset. Among the benefits he envisioned were the creation of new employment opportunities, increases in productivity, improvement in the terms of trade, a more diverse economy, and the ability of the country to support itself in time of war.

The extraordinary growth of the American economy over the last two centuries has amply confirmed his judgment. The wealth of the country can only be accounted for if technology is factored into the equation. A much-quoted estimate is that technical progress has been responsible for as much as 80 percent of the rise in personal incomes, capital investment for no more than 20.[1] Technical skill has been hailed as "human capital."

The creative individuals who transformed the American economy in the last century learned their skills mostly in the shop. They called themselves mechanics or "mechanicians" rather than engineers.[2] As late as the 1890s, the pioneers of the electrical power industry similarly called themselves "electricians" (McMahon 1984, p. 36). The title of "engineer," originally applied exclusively to the builders of such military and civilian structures as forts, bridges, canals, and railroads, was adopted haltingly in other technical fields.

Before the Morrill Act of 1862, which provided support for education "in agriculture and the mechanic arts," only six schools in the country offered degrees in engineering. In the next few decades, engineering schools proliferated. It was not until the first decades of this century, however, that a majority of engineers—which was now the commonly accepted term—had college degrees (Society for the Promotion of Engineering Education 1930, pp. 816 and 1021).

[1] Krugman (1994) quoting Robert M. Solow. Solow's original paper, "Technical Change and the Aggregate Production Function" (1957), is reprinted in Rosenberg (1971), pp. 344-62.

[2] Calvert (1967), passim; Blank and Stigler (1957), p. 4 ("The heroic age of the industrial revolution was presided over by the untutored entrepreneur, not the engineer or scientist").

Our Growing Engineering Workforce

Since 1900, the engineering workforce—including graduates in engineering (see table), graduates from other disciplines, and individuals without a college degree whose occupation is engineering—has mushroomed from less than 40,000 to close to 2 million. Between 1900 and 1930, it increased in size nearly sixfold. This workforce grew more slowly during the Depression but picked up speed again after World War II, more than doubling between 1950 and 1970. In the last 30 years it has continued to grow but at a more moderate rate, a little under 2 percent a year.

In 1900, engineers still formed a tiny group among the Nation's professional workers (scientists, engineers, lawyers, doctors, teachers, etc.)—scarcely more than 3 percent. By 1960, they accounted for over 12 percent. Today, with other and newer professions like computer science growing faster, engineers account for roughly 10 percent. Engineering has become an established profession, like law and medicine, against which other professions measure themselves (U.S. Bureau of the Census 1975 and 1997).

Foreword table

Bachelor's degrees awarded in engineering as a percentage of all bachelor's degrees: 1901-2000

Award Year	Number of Bachelor's Degrees in Engineering	Percent of all Bachelor's Degrees
1901-05	4,900	3.3
1906-10	7,500	4.3
1911-15	12,500	6.0
1916-20	20,100	9.3
1921-25	37,100	10.3
1926-30	38,800	7.0
1931-35	54,800	8.0
1936-40	62,600	7.6
1941-45	68,500	8.8
1946-50	159,600	11.3
1951-55	143,118	8.9
1956-60	168,791	9.5
1961-65	175,970	8.3
1966-70	196,055	6.0
1971-75	220,810	4.8
1976-80	239,677	5.1
1981-85	357,572	7.3
1986-90	353,051	6.9
1991-95	313,216	5.4
1996-2000	245,916	5.1

NOTE: From 1901-60, bachelor's degrees also include first professional degrees.

SOURCES: Data from 1901-55: Dael Wolfle, America's Resources of Specialized Talent *(New York: Harper, 1954), pp. 292-95, as quoted by David M. Blank and George J. Stigler,* The Demand and Supply of Scientific Personnel *(New York: National Bureau of Economic Research, 1957), p. 75; data from 1956 to 1965: National Center for Education Statistics,* Digest of Education Statistics *(Washington, DC, 1971); data from 1966 on: National Center for Education Statistics, Survey of Degrees and Other Formal Awards Conferred, and Completions Survey. Last group of years is a 4-year, rather than 5-year, period because no data are available for 1999.*

Surveying the Scientific and Engineering Workforce

An attempt to tally the Nation's workforce engaged in manufacturing was made as early as 1810. In 1820, the Census Office (as the Bureau of the Census was then called) set out to count the workforce in each of the main fields of economic activity—agriculture and commerce as well as manufacturing. But it was not until 1850 that it sought information on individuals' occupations.

The census-takers for the 1850 census counted 512 civil engineers, 11,626 engineers whom they did not classify further, and 16,004 mechanics. How many were engineers as we would now understand the term? There is no way of knowing. The Superintendent of the Census acknowledged in his report that his staff had difficulty classifying workers satisfactorily. He invited the reader to "judge for himself, and frame any other tables" if he preferred (Census Office 1853).

What Makes an Engineer an Engineer?

The same difficulty that faced the Superintendent of the Census in 1850 faces anyone counting engineers to this day. By what criteria should one judge whether someone is an engineer? His self-identification as such? Her job description and job title? Having an engineering degree? Having a degree in a related field? Indeed, does an engineer have to have a degree? Should someone still be counted an engineer if she has become a manager?

There is room for different views. An employer may be ready to accept job description as a sufficient measure. An academic is likely to want to see a degree. A policy analyst assessing the numbers of strictly technical practitioners may wish to exclude the engineer who has become a manager. Someone wishing to recommend engineering as a career may well want to include him. Clearly, differences in the criteria one uses will give different counts of the engineering workforce. They will be counts of somewhat different sets of people—though all may share, in some sense, Hamilton's "peculiar aptitude."

Until recently, the leading criterion used to identify the Nation's engineers and scientists has been employment

as one, following the practice of the Census Bureau. In 1962, in a first effort to learn more about their education, degrees, work activities, and other characteristics, the National Science Foundation (NSF) joined forces with the Bureau to survey a representative sample drawn from the science and engineering workforce identified as such in the 1960 census (U.S. Bureau of the Census 1969). The two agencies conducted another survey in 1972 (following up on the 1970 census), asking similar questions and adding others (U.S. Bureau of the Census 1974).

Besides gathering much valuable information on a population that had previously been little studied, the surveys pointed up the opportunity for discrepancies in counts taken using different criteria. For example, only 70 percent of those the 1970 census had counted as engineers on the basis of their occupation declared in 1972 that they regarded themselves professionally as engineers. Eleven percent thought of themselves as administrators, managers, or business proprietors. Nine percent classified themselves as technicians or technologists—not a surprising statistic, given that one-third of the engineers surveyed held at most an associate's degree (U.S. Bureau of the Census 1974, p. 5, table 2.1, and p. 85, table 9).

The National Science Foundation decided that in future surveys it should not frame its definition of the science and engineering workforce solely on the basis of occupation but should also take into consideration education, degree level, and professional self-identification (U.S. Bureau of the Census 1974, pp. 113-14). It developed a carefully balanced, multidimensional definition for use in its next survey (conducted in 1974) and continued to use it in surveys based on the 1980 census (NSF 1976, pp. 18-19).

The new definition countered objections that one should not decide whether a person was an engineer or scientist simply on the basis of occupation. (Who was to say that employers were hiring qualified people? What of the amply qualified engineer who was currently doing something else?) It opened the door to other criticisms, however. A recurring complaint was that the new definition gave a count of the science and engineering workforce that did not tally with those generated by other agencies, notably the Bureau of the Census and the Department of Labor. Further, the definition's complexity made it difficult to determine where the problem lay, whether in the differences in definition or differences in sampling technique (NRC 1989, pp. 101-107). Perhaps worse, the

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resulting population was neither fish nor fowl: it was neither the whole population of those employed as engineers or scientists, nor the whole population of those trained in engineering or science, nor the whole population of those who considered engineering or science their profession. The definition could also be accused of bias. A college president whose highest degree was in engineering or science was counted regardless of whether he considered himself an engineer or scientist professionally. A graduate with the same credentials who was president of a company or head of a government agency was only counted if she identified engineering or science as her occupation or profession (not, as she very well might, management or administration).

Meanwhile, NSF had launched two other survey programs—one a biennial survey of Ph.D. graduates (and holders of equivalent degrees); the other a periodic survey of new entrants to the science and engineering workforce tracking bachelor's and master's recipients 1 to 2 years after graduation. In the 1980s, NSF merged the data from these surveys of graduates with the data from its census-based surveys to create an integrated data system covering the science and engineering workforce.

In 1986, NSF asked the National Research Council (NRC) to appoint a committee to review the component parts of this data system and to make recommendations on how the Foundation should use the 1990 census in its subsequent surveys. Besides making recommendations on system design, the committee urged the Foundation to abandon its multidimensional screen for deciding whether an engineer or scientist identified by the census should be counted as one (NRC 1989, pp. 101-107). Instead, NSF should permit inquirers "to apply their own definitions … to suit their particular research and analysis purposes" (pp. 55-56). To this end it should collect and publish data on "the full range of people with academic training in science and engineering fields, not all of whom [may] have related work experience, and [on] the full range of people who are employed in science and engineering, not all of whom [may] have related training" (p. 153). In the latter case, however, it should no longer include engineers who were not college graduates. The committee urged this mostly for reasons of convenience. It was difficult to get a statistically representative sample of nondegreed engineers, and, in any case, their numbers were dropping: in 1985, less than 19 percent of engineers under the age of 40 had not completed 4 years of college (p. 34).

Querying a Unique Resource: The Scientists and Engineers Statistical Data System

NSF has incorporated these principles in the management of its Scientists and Engineers Statistical Data System (SESTAT). The system is set up to answer an inquirer's questions regardless of how he or she defines an engineer or scientist—whether by occupation, training, or some combination of the two. Analysis is based on returns from some 100,000 individuals responding to NSF surveys fielded in 1993 and from 87,000 responding to surveys fielded in 1999. The 1993 respondents represent about 11 million people who have science and engineering degrees or who work in science and engineering. The 1999 respondents represent about 13 million scientists and engineers. SESTAT is probably the world's most comprehensive database on a nation's technical talent.

SESTAT data are available both on compact discs and on the World Wide Web at http://sestat.nsf.gov, making it possible for users to "frame" their own tables in a way that the superintendent of the 1850 census could only dream of.

The report that follows is the first in a series that will examine SESTAT's extensive data on the Nation's engineers. The intent is to present in "hard copy" what can be learned from the database and to highlight key findings.

This first report of the Engineering Workforce Project focuses on the population of engineering graduates, looking at the degrees they hold in engineering and in other fields and at the variety of occupations—technical and non-technical—for which their education has prepared them.

Subsequent reports will examine the population of those occupied in engineering specifically, both those with and without engineering degrees; the work activities of engineers, including their authorship of papers and obtaining of patents; their membership in professional societies and continuing education; the participation of engineers in management; and the changing demographics of the profession over time.

Robert Weatherall
Ipswich, Massachusetts
December 1998
(updated with 1999 data)

EXECUTIVE SUMMARY

Engineering degree programs in the United States have always been more geared to practice in the private sector than have most science degree programs. At the end of the 20th century, engineering practice was challenged by a proliferation of occupations requiring technical education; by rapidly changing technological advances; and by a perennial—if not heightened—concern with the relationship between engineering degree programs and occupational outcomes.

This study illuminates the role of engineering education in ways not heretofore possible. It uses empirical data from a sample of 24,700 engineering graduates to provide information needed by people engaged in engineering education and engineering practice. These include employers who strive to build and retain highly qualified staffs, engineering school faculty who design course and program content, and both potential and actual engineering graduates as they weigh their educational choices and career options.

As of 1999, approximately 2.8 million people in the United States had an engineering degree at the baccalaureate level or above. Some of these engineering graduates—about 1.3 million of them—were employed as engineers. At the same time, nearly a million were applying their engineering knowledge and skills to solve problems in other technical areas or were engaged in a surprising variety

of non-engineering careers. Many had chosen to acquire degrees in other fields, opening new career paths or expanding their abilities to contribute to the engineering specialties in which they were working. This study provides a close look at the available data on how engineering graduates have chosen to structure their formal education and how their formal education relates to their employment.

Degree Patterns of Engineering Graduates. The majority of engineering graduates (59%) hold only one degree, usually at the baccalaureate level. Though 80 percent of graduates with any engineering degree hold only engineering degrees, the others demonstrate a rich variety of degree combinations. Engineering graduates have combined engineering degrees with degrees in management, fine arts, the humanities, and the full range of scientific disciplines. Data suggest that in coming years, a higher proportion of engineering graduates at all ages will earn two or more degrees during the course of their lives.

Multiple Degrees and Degree Levels. Engineering graduates with multiple degrees display a wide variety of degree patterns. Those with two or more degrees did not necessarily acquire them in the same field, nor was an engineering degree necessarily the first acquired. Graduates also may not acquire their degrees at successively higher levels. People who attain the master's degree show particular flexibility in degree field mixing and are also more widely dispersed across the spectrum of engineering and non-engineering occupations. Master's level engineering graduates with any non-engineering degree become senior managers at higher rates than those with only engineering degrees. Engineering graduates whose most recent degree was at the master's level are divided

almost evenly between people with only engineering degrees and people with degrees in other subjects.

Engineering and Business Degrees. A growing proportion of younger engineering graduates hold both engineering and business degrees. Of those engineering graduates who chose to combine engineering degrees with one or more degrees in a non-engineering field, the largest number—250,000, or 46 percent—combined engineering and business degrees. At the master's level, those who have engineering and business degrees are twice as likely as those who have only engineering degrees to become senior managers at some point in their careers.

Engineering graduates have combined engineering degrees with degrees in management, fine arts, the humanities, and the full range of scientific disciplines.

Engineering and Science Degrees. Overall, engineering graduates demonstrate an apparent ease of movement between educational programs in scientific and engineering disciplines. This study found only a small difference in the proportions of engineering graduates, regardless of degree level, who move from engineering degrees to scientific degrees versus from scientific to engineering degrees. There is only a slight net "gain" from those moving from science to engineering degrees, and only at the baccalaureate and master's level; engineering graduates who obtain a Ph.D. and have a science degree are equally as likely to obtain the Ph.D. in science as in engineering. These patterns may indicate intentional combinations of science and engineering degree programs to prepare for occupations requiring multidisciplinary knowledge and skills.

Degree Patterns of Female Engineering Graduates. Some differences were apparent in the type and sequence of degrees acquired by male and female engineering graduates. Women have obtained

degrees outside engineering slightly more frequently than men. They also differ in their choice of non-engineering degree fields: while most of men's non-engineering degrees are in business or management, women have more often paired engineering with science degrees. Further, they are more likely to be attracted to engineering degree fields that tend to have a significant science component such as biomedical/bioengineering, environmental engineering, and chemical engineering.

Engineering Graduates With Degrees and Occupations in Science. Nearly one-third of engineering graduates who complemented their engineering degree with one in another discipline earned a degree in a scientific field. On the other hand, only one-fifth (21%) of engineering graduates working as scientists hold a science degree. Engineering graduates working as scientists are commonly found in computer-related occupations.

Careers in Engineering and Other Occupations. The majority of engineering graduates (57%) are employed in some engineering specialty. However, the data strikingly show that they are progressively less likely to be employed in engineering positions as they mature. The tendency to acquire additional degrees during their 30s and 40s corresponds with a decrease in the proportion of engineering graduates who report their occupation as "engineer" during these years. Still, 70 percent of engineering graduates working in non-engineering occupations have earned no degrees other than engineering degrees.

Thus the findings of this study show that engineering graduates have a wide variety of occupational choices, both in the engineering

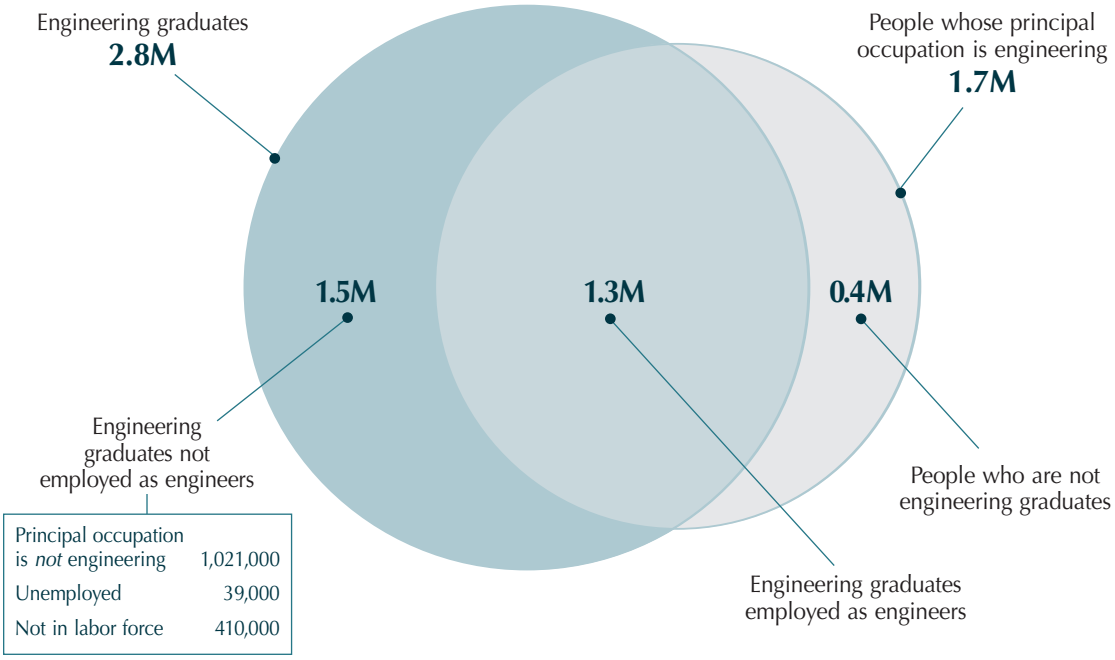
specialties and in non-engineering occupations. While analysis of the educational histories of engineering graduates shows that most have obtained only the baccalaureate in engineering, younger cohorts have more often earned additional degrees than have their older colleagues. When individuals earn a degree beyond a single engineering baccalaureate, it is just about as often in engineering as in some other field. Of the latter, almost half of the degrees earned are in business.

Occupations of engineering graduates with one or more degrees, solely in engineering or combined with other fields, are often associated with multidisciplinary skills, especially those related to management. The mixing of science degrees with engineering degrees as a strategy in educational choice is shown in this study to result in considerable flexibility for both employees and employers who hire them. The next study of the Engineering Workforce Project will explore these themes further, focusing on the occupation of engineering, including practicing engineers who have no degree in engineering.

INTRODUCTION

In 1999, approximately 2.8 million people in the United States had been awarded an engineering degree at the baccalaureate level or above (figure 1). Some of these engineering graduates—about 1.3 million of them—were employed as engineers. At the same time, 1 million of their colleagues were applying their engineering knowledge to solve problems in a surprising variety of non-engineering careers.

Figure 1
Engineering graduates and engineering occupations: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Terms Used Throughout This Study

Engineering graduate: An individual who has at least one degree in engineering at the baccalaureate, master's, or Ph.D. level; a few engineering graduates with "other professional" engineering degrees are also included, but no additional information about these degrees is available. All people referred to in this study have at least a degree at the baccalaureate or higher level.

Highest degree: The highest level formal degree attained. For the purposes of this analysis, the highest degree is usually the most recent degree. In a few instances, the highest degree was earned prior to the most recent degree, e.g., a master's degree preceded a baccalaureate. In most of the following analysis these individuals are not included, as noted.

Most recent degree: The last degree attained as of the week of the study reference date, April 15, 1999. In almost all cases, the most recent degree is also the highest; the few instances in which the highest degree was not the most recent were not included in the study.

Occupation or principal occupation: The principal job held during the week of April 15, 1999. Second jobs were not included in this study.

Senior manager: People who described themselves as "top and mid-level managers, executives, and administrators (people who manage other managers)." The category excludes "all other managers, including the self-employed." No attempt has been made to distinguish between technical and nontechnical senior managers. First-line supervisors and project managers were coded as engineers, not managers.[3]

[3]Details of the SESTAT occupational coding process are described in Hardy and Eisenhower (1994).

Many had chosen to acquire degrees in other educational fields, opening career paths outside of engineering or expanding their abilities to contribute to engineering occupations in specific areas.

Questions This Study Addresses Include:

What are the patterns among engineering graduates in obtaining degrees?

- How many degrees do engineering graduates hold?
- What combinations of degrees are found and at what levels?
- In what sequence do engineering graduates tend to seek degrees?

How do the different patterns among engineering graduates in obtaining degrees relate to their employment?

- What are the general patterns for participation in the labor force among engineering graduates?
- How do the differing educational backgrounds of engineering graduates—combination, level, and sequence of degrees—relate to their occupations?

This study provides a close look at the available data on how engineering graduates have chosen to combine their formal education in engineering with degrees in other disciplines. It also considers how the formal education of engineering graduates relates to their employment. By analyzing degree histories as well as the occupations of engineering graduates, researchers are now able, for the first time, to test anecdotes and received wisdom against hard data and to forge empirically based answers to important questions about the roles that engineering graduates are playing in the workforce. Questions that can now be addressed include those related to differences in degree attainment patterns of male and female engineering graduates; different patterns in degree attainment among younger versus older engineering graduates; and the different effects these patterns have on employment. The broad dispersion of engineering graduates throughout the economy is also portrayed in new detail in this study.

The first section of this study highlights the formal education of engineering graduates. It reports the number and combinations of degrees they hold, as well as the level of these degrees. It also points up significant patterns in the sequence in which these degrees are sought. The second section explores the relationship between these diverse educational pathways and the occupations of the 2.3 million engineering graduates working in 1999.[4]

[4] Degree attainment is an imperfect indicator of education. Although the educational data in this study are restricted to degrees attained, individuals may have formal educational experiences not reported here. They also may have earned pre-baccalaureate degrees and/or certificates.

SECTION 1

PATTERNS IN OBTAINING DEGREES

SECTION 1

PATTERNS IN OBTAINING DEGREES

The adequacy of the supply of engineering graduates has been of continuing concern to engineering faculty and administrators, as well as employers needing to hire people with specific engineering backgrounds. Until now, planning could only be based on counts of *degrees* as a proxy for the actual supply of *individuals* with particular knowledge and skill specialties and combinations of these counts. In other words, it has not been possible to understand the dynamic of movement of people with a degree in one field to degree programs in other fields. This section describes this dynamic to a considerable extent, answering such questions as:

- What is the inflow of people with degrees in other fields into engineering degree programs and subsequently the supply of engineering graduates?
- What is the outflow of engineering graduates to degree programs in other fields?

This section explores the diverse educational pathways engineering graduates have chosen in their formal education, regardless of how that education may be or has been applied in their occupations. First, it focuses simply on the number of degrees held by engineering

graduates in different age groups. Then it highlights some patterns in degree combinations, levels, and sequences. Section Two incorporates the occupation of engineering graduates into the analysis.[5]

Number of Degrees

How many degrees do engineering graduates earn? Looking at this population as a whole,[6] the majority (59%) hold only one degree, usually at the baccalaureate level. Thirty-one percent have two degrees—which may include degrees in fields other than engineering—and 10 percent have three or more.

This Section Addresses the Following Questions:

What patterns exist among engineering graduates in obtaining degrees?

- How many degrees do engineering graduates earn?
- What combinations of degrees are found, and at what level?
- In what sequences do engineering graduates tend to seek degrees?

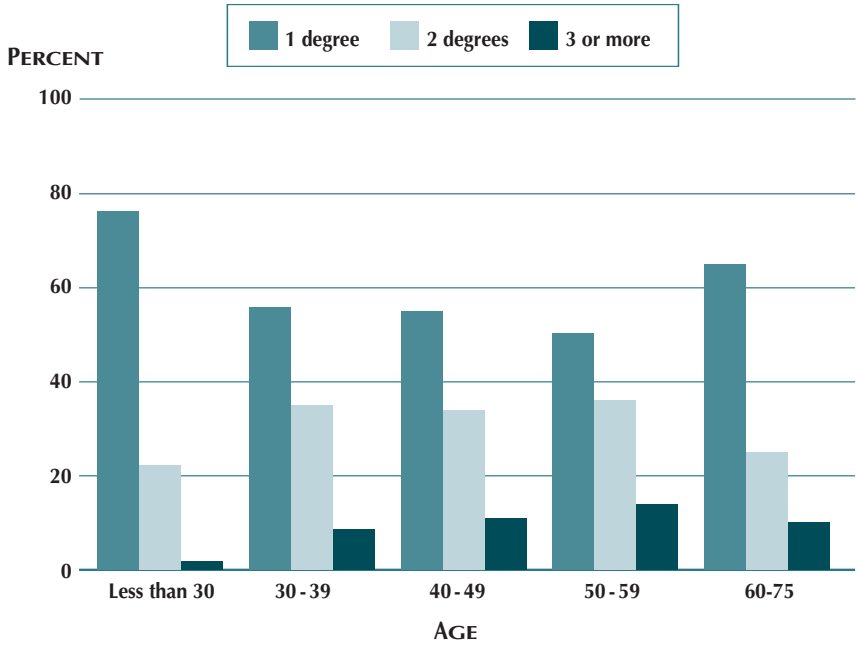
[5] Although this study does not focus on doctorate-level engineers, it partially responds to the recommendation of the Committee on Science, Engineering, and Public Policy (COSEPUP) of the National Academy of Sciences that "The National Science Foundation should continue to improve the … analysis of the data on the education and employment of scientists and engineers." See COSEPUP 1995, p. ES-6.

[6] The population in this section is all engineering graduates up to 75 years old, regardless of occupation or employment status.

As figure 2 demonstrates, the number of degrees held varies distinctively by age group. Not surprisingly, engineering graduates younger than age 30, many of whom have not yet finished their formal education, have the fewest additional degrees. The numbers of people who have earned two degrees increase among cohorts in their 30s, 40s, and 50s. Acquisition of a third degree follows a similar pattern, increasing up through the cohort of 50- to 59-year-olds. Half of engineering graduates in the 50-59 age group hold two or more degrees.

Figure 2

Number of degrees earned by engineering graduates, by age: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

The pattern of an increasing number of degrees with increasing age does not hold for engineering graduates 60 years or older. A much higher percentage of this age group—for whom degree-earning is virtually over—has earned only one degree compared to the next oldest age group (65% versus 50% of those in their 50s).

This difference in pattern may reflect changes in norms in educational attainment, career development, employment options, and job activities that have led a larger proportion of individuals who were under 60 years of age in 1999 to hold multiple degrees, often in diverse fields. While these data are drawn from a cross-section of the population of engineering graduates and therefore can provide no information about the behavior of individuals over time, by taking age cohorts into account it is possible to make strong inferences about how this population as a whole is changing. As the current population of engineering graduates ages, and if current patterns persist, the oldest cohort will begin to reflect the changes in degree acquisition patterns now observable among younger and middle-aged engineering graduates. Unless some unknown factor influences relatively younger engineering graduates to obtain fewer degrees compared to their mid-career colleagues, the overall educational level of engineering graduates will continue to ratchet gradually upward in the coming decades.

Degree Combinations, Levels, and Sequence

Four-fifths of engineering degree recipients hold only engineering degrees, and the majority have only a single baccalaureate degree in engineering. The remainder, however, demonstrate a wide variety of patterns in degree attainment.[7] A close inspection of the entire range of degree combinations

[7] Data used in this study were limited to a maximum of four degrees for each individual. In the few cases in which more than four degrees were reported, degrees were ranked by level (high to low, e.g., Ph.D. to baccalaureate) and then by latest date of award within degree level.

at the detailed field level confirmed that for every imaginable combination of degree fields, at least one engineering graduate followed just such an educational path. Engineering graduates have combined engineering degrees with degrees in law, medicine, fine arts, the humanities, and the full range of scientific disciplines.

This subsection begins by highlighting overarching patterns in degree attainment for engineering graduates, focusing in turn on disciplines combined with engineering, the sequence in which these degrees are acquired, and the levels of degrees achieved. Next, the subsection points up patterns in degree attainment that occur within these different degree combinations.

Degree Combinations

Degree combinations for engineering graduates fall into four large groupings:

- engineering degrees only;
- engineering and business degrees;
- engineering and science degrees; and
- engineering and degrees in other disciplines.

As shown in table 1, 80 percent (2,154,000) of engineering graduates hold only engineering degrees.[8] Of those engineering graduates

[8]This percentage is based on the population total used in table 1, which excludes some 75,000 engineering graduates—about 3 percent of the total population of engineering graduates. An individual was not included if any one of the following was true:

- The individual earned degrees in three or more disciplines.
- The individual earned degrees in reverse order (i.e., a Ph.D. followed by a master's or bachelor's degree).
- The individual failed to identify the field or level of a degree.
- The individual earned a degree not recognized by the SESTAT system (i.e., something other than a bachelor's, master's, Ph.D., or professional degree).

who chose to combine engineering degrees with one or more degrees in a non-engineering field, the largest number—250,000, or 46 percent—combined engineering and business degrees. The majority of engineering graduates, however, selected a field other than business for their non-engineering field. The next most frequent combination, engineering and science, was chosen by nearly one-third (177,000). A broad range of other combinations is found among the remaining engineering graduates. Overall, for people who hold more than one degree, as many hold degrees in fields *other* than engineering—543,000—compared to 527,000 graduates who earned all of their degrees in engineering fields.

Table 1

Degree combinations of engineering graduates: 1999

DEGREE COMBINATION	
TOTAL ENGINEERING GRADUATES	**2,696,000**
Engineering only	**2,154,000**
Bachelor's is most recent degree	1,627,000
Master's is most recent degree	433,000
Ph.D. is most recent degree	94,000
Engineering and non-engineering	**543,000**
Engineering and business	250,000
Engineering and science	177,000
Engineering and other	116,000

NOTE: Combinations do not imply degree order. The table excludes some 75,000 engineering graduates—about 3 percent of the total population of engineering graduates. Excluded were people who earned degrees in three or more disciplines, earned degrees in "reverse" order (i.e., a Ph.D. followed by a master's degree), failed to identify the field or level of a degree, or earned a degree not recognized by the SESTAT system (i.e., something other than a bachelor's, master's, Ph.D., or professional degree). Numbers rounded to nearest thousand.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Degree Sequence and Levels

Engineering graduates with two or more degrees have not necessarily acquired them in the same field or acquired their engineering degree first. They also may not have acquired their degrees at successively higher levels. Approximately 12 percent of those who have two degrees—about 94,000 people—have chosen to acquire two baccalaureate-level degrees. Of these, approximately 33,000 individuals have bachelor's degrees in both engineering and science, with no higher degree. Others have gone on to obtain two or more master's degrees.

Table 2 shows the most recent degree received by engineering graduates who have achieved degrees in each of the four degree combinations.

Note that:

- the table shows the number of *people* whose most recent degree was at the stated level and in the particular discipline, not the total number of *degrees* in that discipline held by engineering graduates;
- individuals within each cell could have several degrees at the same level (for example, two master's degrees); and
- individuals may have more then one degree in a given discipline.

Table 2 illustrates that, while most engineering graduates have no advanced degrees, those who do have often used their graduate education to broaden their knowledge and skills into non-engineering fields. While the engineering baccalaureate combined with the MBA or equivalent degree is a pattern often noted, the table also shows the extent to which engineering graduates have combined engineering with science degrees as well as degrees outside business and science. These latter degrees often are professional credentials such as the MD or JD.

Table 2

Degree combinations of engineering graduates, by discipline and level of most recent degree: 1999

	Level and Discipline of Most Recent Degree								
Degree Combination	Bachelor's	Master's	Doctorate	Other*	Bachelor's	Master's	Doctorate	Other*	Total
	Most Recent Degree in Engineering								
Engineering only	1,627,000	433,000	94,000	s	0	0	0	0	2,154,000
	Most Recent Degree in Engineering				Most Recent Degree in Business				
Engineering and business	6,000	8,000	1,000	0	11,000	221,000	3,000	0	250,000
	Most Recent Degree in Engineering				Most Recent Degree in Science				
Engineering and science	18,000	60,000	16,000	0	16,000	51,000	15,000	0	177,000
	Most Recent Degree in Engineering				Most Recent Degree in Other Discipline				
Engineering and other discipline	11,000	14,000	2,000	0	10,000	37,000	5,000	36,000	116,000
Totals	1,662,000	515,000	113,000	s	37,000	310,000	22,000	36,000	2,696,000

**Other professional degrees, for example, MD, DDS, and JD.*

s = Suppressed estimate due to small cell count.

NOTE: Combinations do not imply degree order. The table excludes some 75,000 engineering graduates—about 3 percent of the total population of engineering graduates. Excluded were people who earned degrees in three or more disciplines, earned degrees in "reverse" order (i.e., a Ph.D. followed by a master's degree), failed to identify the field or level of a degree, or earned a degree not recognized by the SESTAT system (i.e., something other than a bachelor's, master's, Ph.D., or professional degree). Double majors were too rare to analyze separately. In the case of an engineering/non-engineering double major, the engineering degree was coded as the first degree. In the case of a double engineering major, these awards were randomly assigned an order. Numbers rounded to thousands.

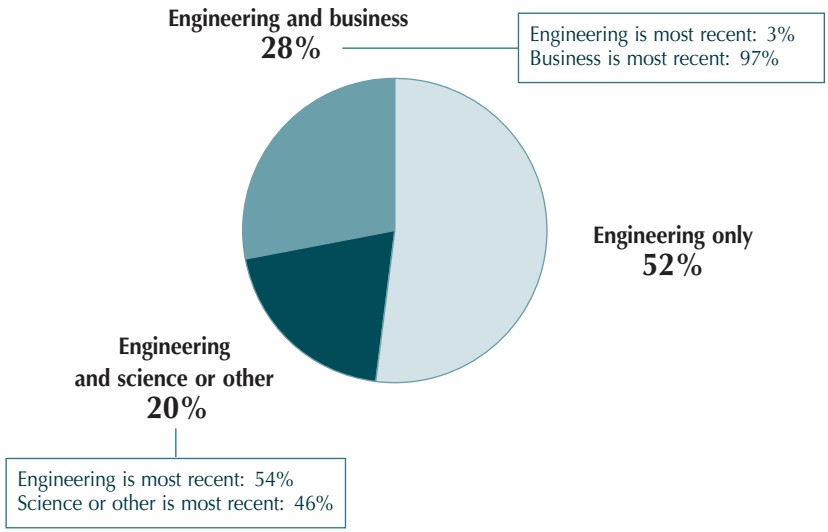
SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Figure 3 shows that people whose most recent degree was at the master's level exhibit a wide range of variation in the field of most recent degree, and are divided almost evenly between people with only engineering degrees and people with degrees in other subjects as well as engineering.

In comparison, figure 4 reveals that a sizable majority of engineering graduates whose most recent degree was a doctorate—69 percent—have degrees exclusively in engineering. In other words, in terms of degree

Figure 3

Engineering graduates whose most recent degree was a master's, by degree field combination and field of the master's: 1999



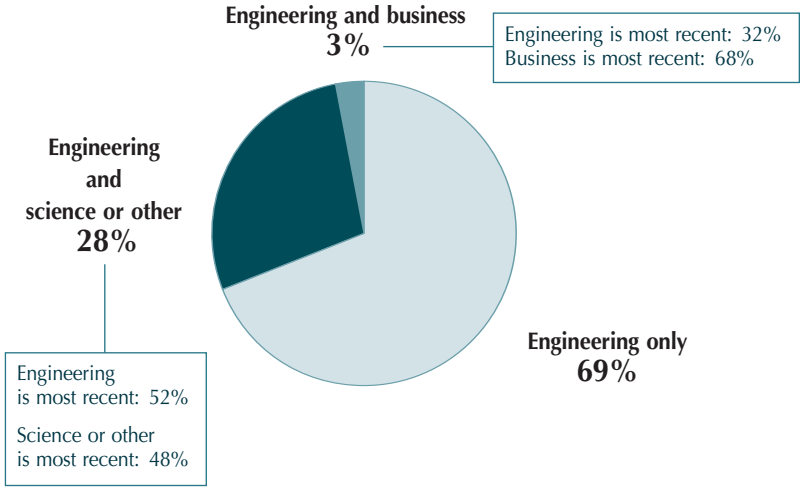
NOTE: See notes on Table 2.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

combinations, for most people whose most recent degree is a Ph.D. in engineering, this is a culmination of a sequence of degrees in engineering fields. In contrast, people whose most recent degree is a master's are more likely than doctorate-earners to have a non-engineering degree in their educational portfolio. At the master's level, engineering graduates who attain a non-engineering degree are somewhat more likely to choose a degree in business as a degree in other non-engineering disciplines, including science.

Figure 4

Engineering graduates whose most recent degree was a Ph.D., by degree field combination and field of the Ph.D.: 1999



NOTE: See notes on Table 2.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

What Business Degrees Are Included in the "Engineering and Business" Combination?

For the purposes of this study, a business degree includes a degree in any of the following fields:

- accounting;
- agricultural business and production;
- business administration and management;
- general business;
- business/managerial economics;
- financial management; and
- other business management/administrative services.

These degrees are excluded from the category of business:

- actuarial science;
- business marketing/marketing management;
- marketing research; and
- operations research.

Degrees in the growing specialty of engineering management were not a choice offered in the surveys underlying this study, and thus are not considered in this analysis. In any event, the Engineering Workforce Commission's annual surveys of degree awards show that counting these degrees would not lead to major changes in the findings of this report (Ellis 1999).

Patterns Within Degree Combinations

Distinctive patterns in degree level and sequence emerge when each of the four degree combinations is considered separately.

Engineering and Business Degrees. As shown in table 1, people who have combined degrees in engineering and business in their formal postsecondary education comprise 9 percent of all engineering graduates, or about 250,000 people. See the text box for a listing of what business degrees are included in this combination; note that management degrees have been included with business for this analysis.[9]

The pattern of degree attainment among these engineering graduates has been striking: 94 percent of them hold a business or management degree, *not* the engineering degree, as their most recent. Engineering graduates with a business degree and whose highest degree is a master's have shown particular energy in obtaining degrees. Sixteen percent of them have earned multiple degrees at the same level. Of these 37,000 engineering graduates, 30,000 have earned two master's degrees—one in business and one in engineering.

Engineering and Science Degrees. About 7 percent of engineering graduates, or 177,000 people, hold degrees in both engineering and science. Most of them (63%) have a master's degree as their most recent degree. The text box lists the science degrees included in this category.

The increasing proportion of science-engineering program combinations at successively higher degree levels may reflect not only the greater opportunity

[9]These educational degree designations are different from the occupational designation "senior manager" used later in this study.

to mix degrees in different disciplines as an individual earns more of them, but also the desire or need for specific technical knowledge from more than one discipline (table 3). People interested in bioengineering, for example, may move from engineering to biology or vice versa to enhance their qualifications or knowledge.[10]

In contrast with the engineering-business degree combination, in which virtually all of the engineering graduates succeeded the engineering degree with the business degree and then stopped earning degrees, engineering graduates who also earned science degrees displayed very different patterns. In short, the engineering "pipeline" is actually widened somewhat by the migration of science graduates to engineering degree programs, in contrast to the narrowing caused by engineering graduates migrating to business degree programs.

[10]Ellis (1999) observes that "specific areas of practice in engineering and science have often become close collaborations, and many individual practitioners have served in both scientific and engineering capacities. Dozens of examples could be cited."

Table 3

Engineering graduates who also have science degrees, by science degree field: 1999

TOTAL, ALL SCIENCE FIELDS	**212,000**
Physical sciences	**82,000**
Physics	46,000
Chemistry	22,000
Other physical sciences	6,000
Geology	4,000
Atmospheric sciences and meteorology	2,000
Other geological sciences	2,000
Oceanography	1,000
Computer science-related fields	**59,000**
Computer science	39,000
Computer/information sciences, general	9,000
Information services and systems	5,000
Computer/information sciences	3,000
Other computer and information sciences	2,000
Computer systems analysis	2,000
Mathematics	**40,000**
Mathematics, general	18,000
Operations research	7,000
Applied mathematics	7,000
Other mathematics	5,000
Statistics	2,000
Biological/life sciences	**22,000**
General biology	10,000
Other biological sciences	5,000
Biochemistry	3,000
General zoology	2,000
Microbiology	1,000
Physiology	1,000
Environmental sciences, total	**3,000**
Agricultural sciences, total	**3,000**
All other scientific fields	**4,000**

NOTE: A small number of engineering graduates have more than one degree in the listed science fields. Fine fields may not total to broad fields due to rounding. Table includes all persons with an engineering and science degree, and it includes persons excluded from Table 2. Numbers rounded to thousands.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

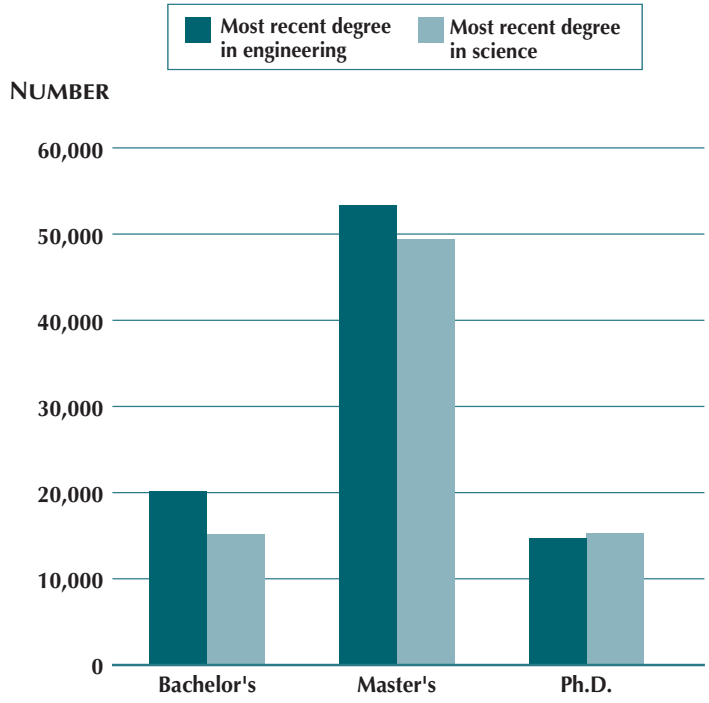
As shown in figure 5, there is a slight net "gain" from those moving from science to engineering degrees at the baccalaureate and master's levels; engineering graduates who obtain a Ph.D. and have a science degree are equally as likely to obtain their Ph.D. in science as in engineering. Overall, engineering graduates demonstrate an apparent ease of movement between educational programs in scientific and engineering disciplines.[11]

Like people who combine engineering and business degrees, those who have earned engineering and science degrees tend to be enthusiastic degree-earners. Over one-third of those whose most recent degree was at the master's level have earned *three* degrees, including either two bachelor's degrees or two master's degrees. Those with two master's degrees tend to have one each in science and engineering. At the doctoral level, the vast majority of engineering graduates with science degrees (78%) have three degrees. If the Ph.D. is in engineering, the master's degree is typically in a scientific field.

[11] The nature of these data do not permit estimation of success rates of students in completing a degree in a particular educational program, or take into account departures from one degree program in science or engineering that become successful degree-earners in the other. See Seymour and Hewitt (1997) for a recent study of factors affecting retention in engineering and science. Another study of student field migration that uses course-taking data from undergraduate college transcripts is Adelman (1998).

Figure 5

Engineering graduates who also have a science degree, by level and discipline of most recent degree: 1999



NOTE: See notes on Table 2.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

What Science Degrees Are Included in the "Engineering and Science" Combination?

For the purposes of this study, a science degree includes a degree in any of the following fields:

- computer sciences;
- mathematics and related sciences;
- agricultural sciences;
- biological sciences;
- environmental sciences;
- chemistry;
- earth sciences;
- physics and astronomy;
- other sciences, unclassified; and
- a few health-related fields that—at the doctorate level only—are considered science degrees by the National Science Foundation.

Degrees in some scientific or technical fields that may be considered "science" in other reports of the National Science Foundation are not designated as such in this study; these are:

- social sciences;
- psychology; and
- health professions and related sciences.

Engineering and Other Fields. As shown in table 1, 4 percent of engineering graduates, or about 116,000 people, have combined engineering with degrees in a field other than science or business. Examples of other degree fields include the social sciences, humanities, technology, elementary or secondary teaching, public administration, law, architecture, and medicine. Nearly one-third of these engineering graduates—about 36,000 people—has as their most recent degree a professional degree in a field such as law, medicine, or architecture.[12,13]

For people with an engineering degree and another degree in a field other than engineering, science, or business, the order in which they earned their degrees varied according to the level of their highest degree. Among those whose highest degree is the baccalaureate, about the same number of degree-earners have achieved a degree in the other field after completing their engineering program as in the opposite order. At the master's and Ph.D. levels, however, the most recent degree earned tends to be the one *outside of* engineering, indicating a clear pattern of cross-fertilization through movement toward other, non-engineering fields.[14]

Among those whose most recent degree was at the master's level, 25 percent have three degrees. As with the other combinations discussed above in which one's most recent degree is a master's, engineering graduates frequently have two master's, one in engineering and the other in a field that is neither engineering, science, nor business. Doctoral recipients almost always have three degrees (78%), each at a successively higher level (97%).

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[12]In this study, professional degrees are distinct from doctorates.

[13]Ellis (1999) warns that "One must be careful not to underestimate the extremely wide range of professional engineering assignments." He gives the example of combining an engineering degree with law or accounting for practicing engineering in the insurance industry, "which employs significant numbers of engineers to assess risk."

[14]In the case of two degrees earned at the same time, the authors of this study recorded the engineering degree as the first degree. There were too few of these double majors to affect the observations made throughout this report.

Female Engineering Graduates With Science Degrees

A few differences were discovered between men and women who hold degrees in engineering. Women have obtained degrees outside engineering slightly more frequently than men. They also differ in their choice of non-engineering fields: while most non-engineering degrees for men are in business or management, women are more likely to pair engineering with science degrees.

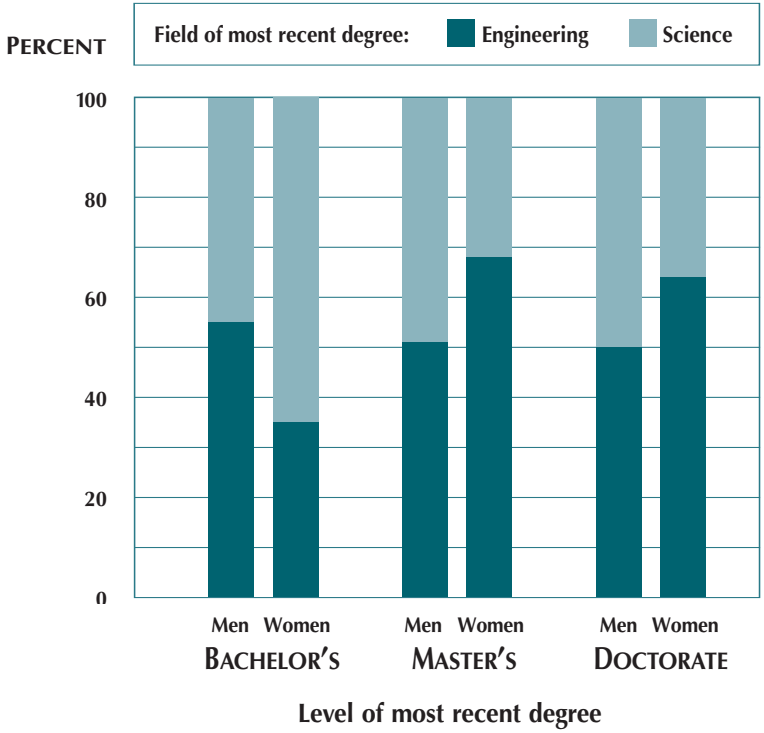
Figure 5, in which male patterns dominate, shows a slight net movement from science to engineering degrees; figure 6 shows that women who choose the engineering-science degree combination are even more likely than men to be attracted to an engineering degree program after completing one or more science degrees.

Two finer patterns were also discovered. First, engineering occupations that have a significant science component—such as biomedical/bioengineering, chemical engineering, and environmental engineering—attract relatively high proportions of women engineering graduates, and women more often than men in those engineering occupations have a degree in science. Second, even in engineering occupations where women are less well represented—civil engineering, electrical engineering, materials/metallurgical engineering, and engineering faculty—women more often have earned science degrees than have men.

A hypothesis for further study with longitudinal data is that women with educational backgrounds only in science are first attracted into these engineering occupations, then pursue an engineering degree. In any case, educators and heads of degree programs intent on increasing the participation of women in engineering might consider the implications of this strong pattern discovered in this study.

Figure 6

Engineering graduates who also have a science degree, by sex, level, and field of the most recent degree: 1999



NOTE: See notes on Table 2.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

SECTION 2

EDUCATION AND EMPLOYMENT OF ENGINEERING GRADUATES

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EDUCATION AND EMPLOYMENT OF ENGINEERING GRADUATES

This section explores the relationship between the broad categories of occupations in which engineering graduates are working and their formal educational backgrounds. It also considers the relationship between age and both employment status and occupation.

The section begins with an overview of patterns in labor force participation for engineering graduates, and discusses reasons for nonparticipation and unemployment (i.e., not participating in the labor force and actively seeking work), and for part-time work in engineering. It then relates educational background and occupation in two ways: (1) by examining the educational backgrounds of engineering graduates working in four broad occupational categories; and (2) where appropriate, by viewing relationships between specific combinations of degrees and employment in particular occupations.

This Section Addresses the Following Questions:

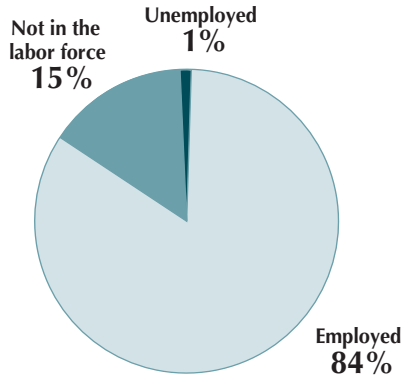
- How do these different patterns in obtaining degrees relate to employment?
- What are the general patterns for participation in the labor force among engineering graduates?
- How do degree combination, level, and sequence relate to graduates' occupations?

Patterns in Employment

In 1999, of the 2.8 million people in the population who held an engineering degree at the bachelor's level or higher, over 2.3 million (84%) were in the workforce. These engineering graduates accounted for 2 percent of the civilian labor force 25 years old and older.[15]

Figure 7 shows that another 15 percent of engineering graduates were out of the labor force, i.e., *not* actively looking for work;

Figure 7
Engineering graduates, by labor force status: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

[15] U.S. Bureau of Labor Statistics, Bulletin 2307, and *Employment and Earnings,* monthly, January issues. Reprinted (table No. 580) in *Statistical Abstract of the United States,* 2001, U.S. Bureau of the Census, Washington, DC, 2001.

the vast majority of these were retired. Only 1 percent of engineering graduates—39,000 people—were unemployed and actively seeking work.[16] The following subsection examines the reasons these individuals gave for being out of the labor force or unemployed. It also considers patterns of workforce participation for people in different age groups.

Participation in the Labor Force

Employment patterns of engineers vary widely by region of the country and industry. The available data do not permit a full description of the dynamics driving the patterns of employment and unemployment for practicing engineers. However, they are useful in describing the reasons why some engineering graduates were not working during the period studied (March 15 to April 15, 1999).

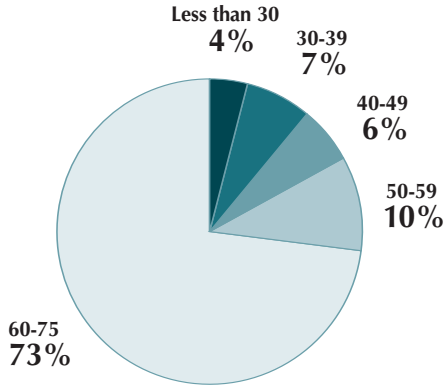
In 1999, employment was highest among the under 30 and 40- to 49-year-old cohorts: 96 percent were employed. Only 20 percent of those age 60 to 75 were working.

[16]Unemployment is defined as having looked for work during the 4 weeks prior to April 15, 1999, regardless of the reason given for being out of work.

As shown in figure 8, most engineering graduates who were not working were 60 years old or over. They accounted for 73 percent of the people who described themselves, in the language of the survey, as *not* "working for pay (or profit) during the week of April 15, 1999." The next oldest group of engineers, those aged 50-59, accounted for the next largest group of engineers not working during this period (10 percent of the total).

Figure 8

Engineering graduates who were not working, by age: 1999



NOTE: Includes engineering graduates either not in the labor force or unemployed. Omits engineering graduates over age 75.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Individuals often had multiple reasons for not working, but the most frequent was *retirement:* 77 percent of the engineering graduates not in the labor force were retired (table 4). Among engineering graduates over 60 years of age, 96 percent of those who were not working for pay or profit gave this explanation (table 5). *Layoffs* were a significant factor for 5 percent of the total not working. Layoffs were a prevalent reason for being unemployed only among engineering graduates in mid-career or later. One-fifth of engineering graduates aged 40 to 59 cited layoffs as a reason for not working.

Table 4
Engineering graduates who were not working, by reasons for not working: 1999

TOTAL NOT WORKING	**449,000**
Reason:	***Percent***
Retired	77
No need to work	12
Family reasons	7
Student	5
Laid off	5
No job available	5
Illness	4
Other reasons, unspecified	2

NOTE: Details total more than 100 due to multiple responses. Omits engineering graduates over age 75.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Table 5

Engineering graduates who were not working, by age and top three reasons for not working: 1999

TOTAL NOT WORKING	**449,000**
Less than 30 years of age:	**18,000**
Reason for not working:	
Student	75%
No need to work	36%
No job available	10%
Age 30-39 years:	**32,000**
Reason for not working:	
Family reasons	52%
No need to work	31%
Student	24%
Age 40-49 years	**25,000**
Reason for not working:	
Family reasons	36%
No need to work	25%
Laid off	20%
Age 50-59 years	**45,000**
Reason for not working:	
Retired	59%
Laid off	19%
No need to work	13%
Age 60-75 years	**329,000**
Reason for not working:	
Retired	96%
No need to work	8%
Illness	3%

NOTE: Details may total more than 100 due to multiple responses. Omits engineering graduates over age 75. Top three reasons for each age group are listed except when the reason was "other, unspecified." Numbers rounded to thousands.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Engineering Graduates Working Part Time

Only 10 percent of engineering graduates working part time were doing so because no suitable full-time position was available (table 6).

Table 6
Employed engineering graduates who were working part time, by reasons: 1999

TOTAL WORKING PART TIME	**134,000**
Reason:	***Percent***
No need to work full time	49
Family reasons	21
Student	15
No job available	10
Other reasons, unspecified	9
Illness	3

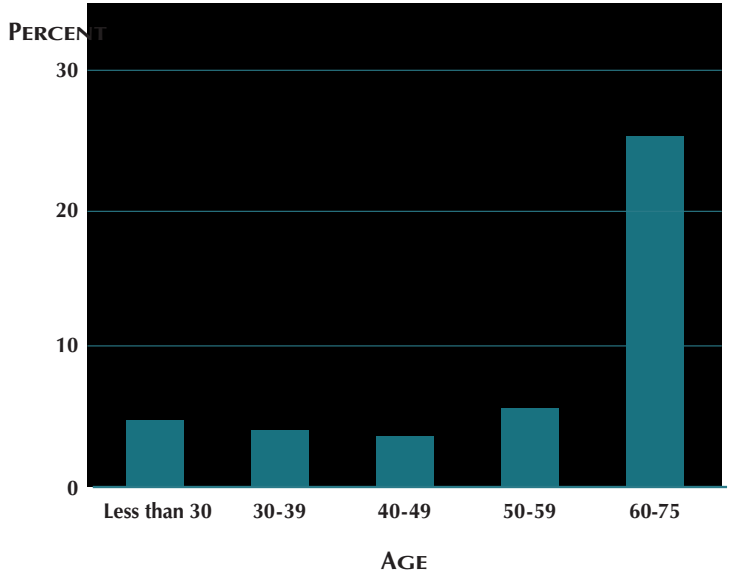
NOTE: Details total more than 100 due to multiple responses.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

The number of people working part time was highest among the oldest engineering graduates (figure 9). The largest number of engineering graduates who were working part time were 60 years old or over. Approximately 25 percent of employed people in this age group held part-time jobs. Among people under the age of 30 and among the 50- to 59-year-olds, approximately 5 percent were working only part time. Employed engineering graduates aged 40 to 49 were the *least* likely age group to hold part-time rather than full-time jobs.

Figure 9

Employed engineering graduates who were working part time, by age: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

By far the most common reason given by engineering graduates for not working full time was that they had no need for full-time employment; this reason was common for people at the end of their careers or still in school. (An examination of data not presented here shows that most engineering graduates aged 60 to 75 who are working part time had no need for full-time employment.)

REMINDER: Who Is an "Engineering Graduate"?

Throughout this study, the term "engineering graduate" is used to refer to an individual who has at least one degree in engineering at the baccalaureate, master's, or Ph.D. level.

Educational Background and Occupation

The remainder of this section relates the findings in Section 1 on the detailed degree histories of engineering graduates to the occupations these graduates held in April 1999. Two analytical approaches are used that take the data from more or less opposite ends:

1. The first looks at people engaged in particular occupations and considers the patterns that emerge from examining their age and educational backgrounds. Employers wishing to fill certain jobs might want to use this approach to uncover the degree histories of employees in similar jobs.

2. The second looks at the range of educational paths of engineering graduates and examines how they have distributed themselves across an array of occupations. Students might want to use this approach when evaluating whether to pursue a master's degree in engineering or in a non-engineering field in light of a particular occupational goal.

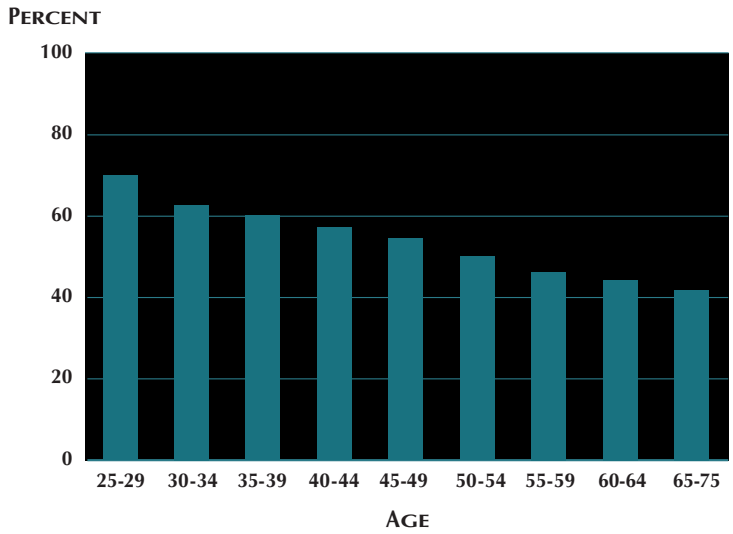
The discussion is presented in the following order and focuses on those strong patterns involving significant numbers of engineering graduates:

- engineering graduates and their occupations,
- engineering graduates in senior management,
- engineering graduates in scientific occupations, and
- engineering graduates in other non-engineering occupations.

Engineering Graduates and Their Occupations

Overall, the majority of working engineering graduates (56%) are employed in the occupation of engineering.[17] Thirty percent of engineering graduates are not working as engineers by the time they are 30 years old, and they are progressively *less* likely to be employed in engineering positions as they grow older (figure 10).

Figure 10
Employed engineering graduates reporting their occupation as engineer: 1999



NOTE: Omits engineering graduates over age 75.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

[17] Forthcoming reports of the Engineering Workforce Project will treat occupational specialties in engineering in detail.

How Are Engineering Occupations Defined?

For the purposes of this study, engineering occupations include:

- aeronautical, aerospace, and astronautical engineering;
- agricultural engineering;
- bioengineers and biomedical engineering;
- chemical engineering;
- civil—including architectural and sanitary—engineering;
- computer hardware engineering;
- computer software engineering;
- electrical or electronics engineering;
- environmental engineering;
- industrial engineering;
- marine engineering or naval architecture;
- materials or metallurgical engineering;
- mechanical engineering;
- mining or geological engineering;
- nuclear engineering;
- petroleum engineering;
- sales engineering; and
- other engineering.

They do *not* include:

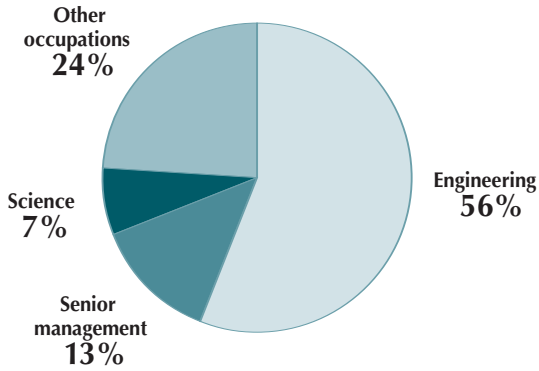
- engineering technology and technical occupations; or
- senior management.

NOTE: Computer software engineering has been included as an engineering occupation in this study. Other publications of the National Science Foundation treat them as computer science occupations, and in other statistical reports of the Federal Government they may be counted as computer science.

Seventy percent of the youngest cohort of engineering graduates identified their principal occupation as engineering, but this percentage drops to below 50 percent for engineering graduates in their middle age or older.[18]

Figure 11 summarizes the jobs of employed engineering graduates into four large groups of occupations. Seventy-six percent reported occupations in engineering, science, or senior management;[19] the remaining 24 percent reported a variety of other occupations.

Figure 11
Employed engineering graduates, by occupation: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

[18]Figure 2 showed that older engineering graduates were less likely to have multiple degrees than younger engineering graduates. Since older engineering graduates are also more likely to work in non-engineering occupations, it is logical to conclude that this broad shift from engineering to non-engineering occupations with age is a matter of choice that may or may not involve the strategic addition of degrees to further career development.

[19]No attempt is made here to distinguish between technical and nontechnical senior management. Another study of the Engineering Workforce Project focused on the management activities of engineering graduates, including senior management that is technical and nontechnical. See Burton and Parker (1998).

The broad category of "other" occupations, which encompasses over one-half million people, is extremely diverse. These engineering graduates hold a wide range of jobs, such as machinery and equipment sales, intellectual property law, graphic arts, and medicine. Details of these non-engineering occupations are shown in table 7.

Table 7
Non-engineering occupations of engineering graduates: 1999

TOTAL	**1,021,000**
Senior management	306,000
Sales and marketing	130,000
Computer sciences	117,000
Administration	66,000
Construction and production*	55,000
Finance and personnel	47,000
Engineering technology	36,000
Computer programming	34,000
Architecture	24,000
Health care	22,000
Physical and related sciences	22,000
Law and justice	21,000
Arts and humanities	11,000
Social services	9,000
Mathematical sciences	7,000
Life and related sciences	7,000
All other	107,000

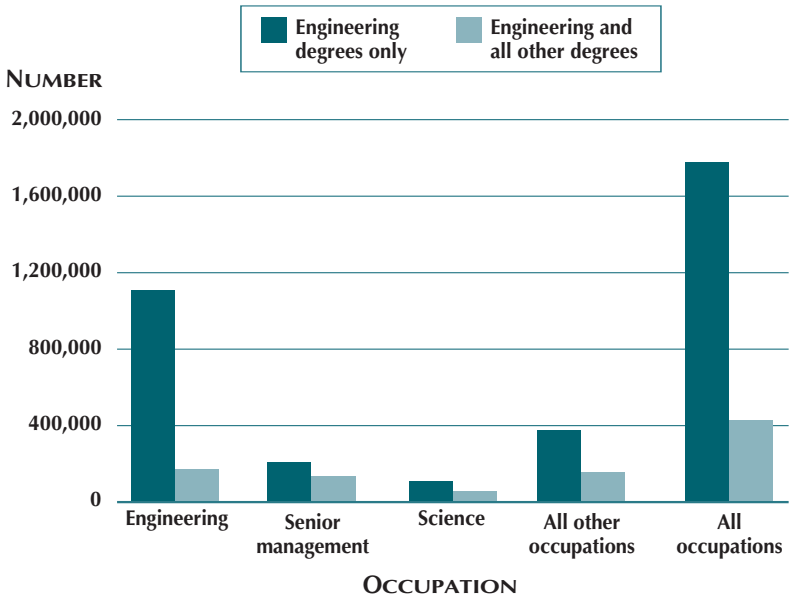
**A group of occupations including construction trades, mining and well drilling, mechanics and repairing, precision/production occupations, operators and related occupations, and transportation/material moving occupations. Numbers rounded to thousands.*

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

The main purpose of this study was to analyze and explain patterns between the formal education of engineering graduates and their occupations. Figure 12 shows employed engineering graduates in the four occupational categories used throughout this study, and whether they have added a non-engineering degree during the course of their formal education. The figure vividly demonstrates the overwhelming number of engineering graduates with only engineering degrees, regardless of occupation. Yet it is also clear from figure 12 that engineering graduates with different educational backgrounds were found in the four occupational categories at different rates.

Figure 12

Occupation of engineering graduates, by degree combination: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

These patterns are especially dramatic when the analysis takes into account particular mixes of degree fields and the field and level of the engineering graduate's most recent degree (table 8). For example, 86 percent of engineering graduates working in engineering occupations have no degrees outside of engineering, compared with 70 percent working as scientists. The remainder of this report analyzes these various patterns.

Engineering graduates with only engineering degrees reported employment as senior managers at the same rate regardless of the level of their most recent degree: between 10 and 12 percent of bachelor's, master's, and doctoral engineers had moved into senior management positions (table 9).

Table 8
Employed engineering graduates, by occupation and degree combination: 1999

	Degree Combination (in percent)				
Occupation	Engineering only	Engineering and business	Engineering and science	Engineering and other	Number
Engineering	86	6	7	2	1,277,000
Senior management	70	20	6	4	295,000
Science	70	7	21	2	143,000
All other occupations	70	14	5	11	540,000
Total, all occupations	79	10	7	4	2,255,000

NOTE: Table contains persons employed full time or part time with a bachelor's degree or higher in engineering. See notes on Table 2.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Further, engineering graduates who earned only engineering degrees at the master's or doctoral levels were more likely to identify their occupation as engineering than were those who held only bachelor's degrees (by 9 percentage points and 16 percentage points, respectively); these latter reported employment in "other" occupations almost twice as often. This finding supports the hypothesis that the higher the degree level of the engineering graduate with exclusively engineering degrees—and thus the higher the level of investment in his or her education—the stronger the professional identification of the engineering graduate with an engineering occupation.[20]

Table 9

Employed engineering graduates who have only engineering degrees, by level of the most recent (highest) degree and occupation: 1999

	Occupation (in percent)				
Highest Degree	Engineering	Science	Senior management	All other	Number
Total	62	6	12	21	1,786,000
Bachelor's	59	5	12	24	1,324,000
Master's	68	6	11	14	377,000
Doctorate	75	8	10	7	84,000
Other professional	s	s	s	s	s

s = Suppressed due to small cell count.

NOTE: See notes on Table 2.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

[20]Ellis (1999) notes that another interpretation is that engineers who are especially interested in a technical versus a managerial career may be more likely to seek advanced technical degrees.

Engineering Graduates in Senior Management

The largest group of people with at least one engineering degree who were not primarily employed as engineers described themselves as "top and mid-level managers, executives, administrators (people who manage other managers)." This study refers to people with these occupations as *senior managers* (table 7). They accounted for 13 percent of all employed engineering graduates, or about 306,000 people working in April 1999. The category *excludes* "all other managers, including the self-employed."

Seventy percent of engineering graduates who are senior managers obtained their position with only engineering degrees (table 8).[21] However, engineering graduates who are senior managers have acquired non-engineering degrees at a higher rate than those who are engineers, and most of these degrees are at the master's level.

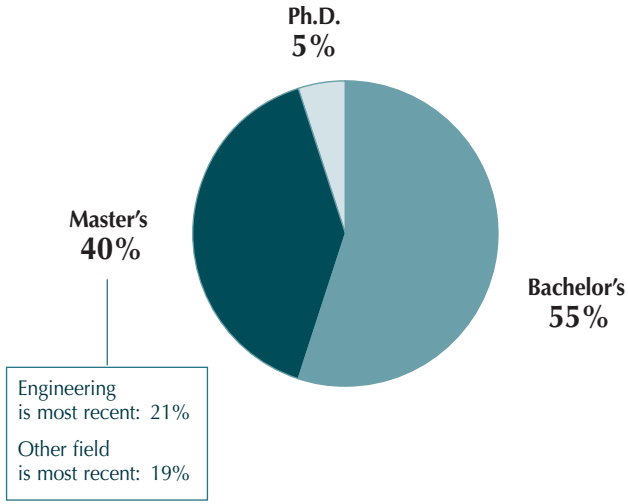
Senior managers whose highest *engineering* degree is a baccalaureate account for 76 percent of the engineering graduates who had become senior managers, but only 55 percent when all degree fields and degree levels are taken into account.

Figure 13 shows that of these senior managers whose most recent degree is a master's, the master's degree is about as likely to be in engineering as in some non-engineering field.

[21] Ellis notes that "Engineering has long been a widely recognized path to management, both in corporations and in large-scale public utilities. Engineering also leads to entrepreneurial careers as inventors form their own companies." He also points out that in his study of data from the American Society of Mechanical Engineers (Ellis 1997), he anticipated many of the findings in this study (Ellis 1999).

Figure 13

Engineering graduates who were senior managers, by level of most recent degree and field of most recent master's degree: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

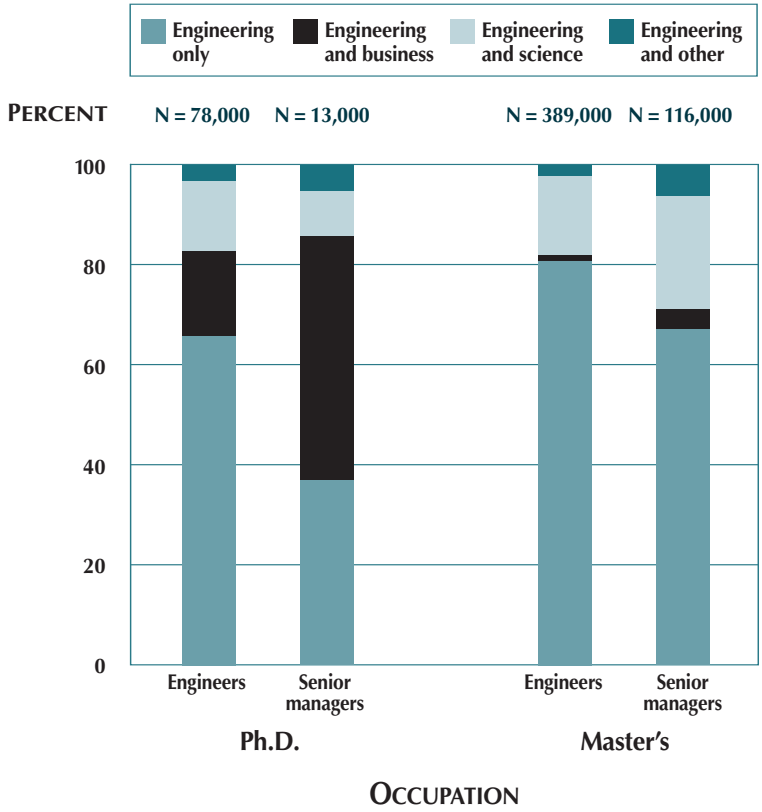
To what extent do these patterns differ for doctoral engineering graduates who have become senior managers? Figures 3 and 4 in Section 1 above showed the degree combinations of engineering graduates at various degree levels. Figure 14 adds occupational data to those degree backgrounds; it compares the degree background of engineering graduates who hold a master's degree or Ph.D. (in any field) and who identify themselves as engineers or senior managers. Those with Ph.D.s, whether employed as senior managers or engineers, are far more likely to have only degrees in engineering than the larger group of engineering graduates whose highest degree was at the master's level. Few doctorate-holders have chosen the engineering and business degree combination. Similarly, compared to the larger group of master's level senior managers, doctoral senior managers are much more likely to have chosen to combine engineering and science degrees.

From the point of view of engineering graduates who contemplate adding a business degree, how much does obtaining this postsecondary degree affect the likelihood of becoming a senior manager? Those who have this combination of degrees are more likely to become senior managers at some point in their careers. However, possessing this combination of degrees does not mean the individual will necessarily work as a senior manager. In fact, more people with the engineering and business degree combination are engineers than senior managers. Far from being automatically destined for careers in senior management, many people with this combination of degrees were in engineering jobs where they apply the knowledge and skills the business degree provides.[22] These engineering graduates are also more likely than those with other degree combinations to be working in "other" occupations (those outside engineering that are neither business nor science).

[22] Readers are reminded that first-line supervision, and project management, are omitted from "senior management" being discussed here. See definition of senior management, p. 44 above.

Figure 14

Engineering graduates with a master's or Ph.D. who were engineers or senior managers, by degree field combination: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Table 10 shows that at the master's level, employed individuals with a business degree are 25 times more likely to have their most recent degree in business as opposed to engineering. Of the overwhelming majority of engineering graduates with this degree combination—202,000 of them—97 percent had a master's degree in business as their most recent degree.

Table 10

Employed engineering graduates with business degrees, by discipline and level of the most recent degree and occupation: 1999

Discipline and Level of Most Recent Degree	Occupation (in percent)				
	Engineering	Science	Senior management	Other	Number
Total	33	5	28	35	215,000
Engineering					
Bachelor's	57	s	s	s	4,000
Master's	38	s	21	32	8,000
Doctorate	51	s	s	s	1,000
Business					
Bachelor's	s	s	s	s	6,000
Master's	32	5	28	35	194,000
Doctorate	s	0	s	s	2,000

s = Suppressed due to small cell count.

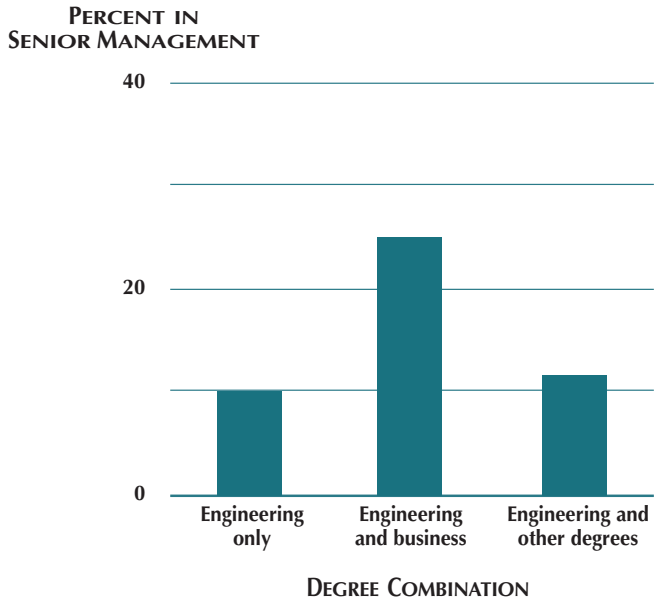
NOTE: Numbers rounded to thousands.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Figure 15 shows that over one-fourth of engineering graduates who have a master's degree and who also hold a business degree have become senior managers. As of April 1999, engineering graduates with a master's degree who also had a business degree were more than twice as likely to be senior managers as those who had only engineering degrees.

Figure 15

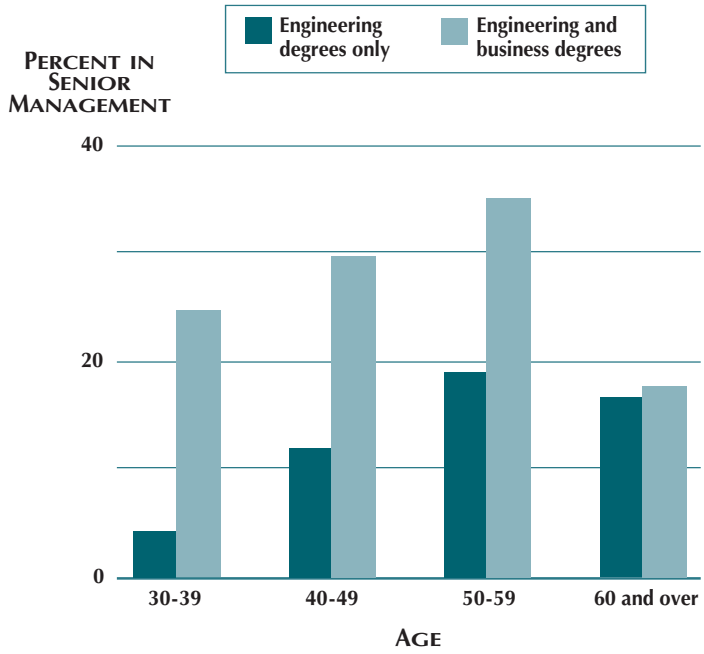
Engineering graduates with a master's degree who were senior managers, by degree combination: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

When analyzed by age, the data indicate that the likelihood that having a business degree will increase the probability of working as senior manager is more pronounced in the earlier age groups than in the older (figure 16).[23]

Figure 16
Engineering graduates with a master's degree who were senior managers, by degree combination and age: 1999



SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

[23]By definition, the master's field of those with only engineering degrees is engineering. For those with engineering and business degrees, the master's or bachelor's degree could have been in either discipline. However, given the numerical predominance of engineering graduates at the master's level whose most recent degree is in business (96%), in practical terms this paragraph addresses engineering graduates whose most recent degree is an MBA or related degree.

Further research will be needed to determine whether these different patterns are driven by age, degree combination and/or level, some combination of these variables, or unknown factors such as the types of managerial jobs these more recent engineering graduates hold. When taken together, these data demonstrate that a baccalaureate in engineering has been sufficient to enable many engineering graduates to move into senior management. However, given the trend for younger cohorts to hold more degrees than those aged 60 and above, the frequency of encountering older top-level managers who hold only an engineering bachelor's degree—and possibly only engineering degrees—is likely to decrease over time.[24] Nevertheless, the sheer number of senior managers with only engineering degrees will continue to dwarf the number of senior managers who hold graduate degrees (in any field) for some time to come (see figure 12).

Engineering Graduates in Scientific Occupations

The approximately 143,000 engineering graduates employed as scientists are the smallest of the four broad occupational groups used in this study.

Engineering graduates who work as scientists tend to hold either an engineering degree with clear links to a scientific field (such as bioengineering) or a degree in a scientific field proper. For example, approximately 19 percent of biomedical and bioengineering degree-earners collectively are in science occupations; in comparison, fewer than 4 percent of civil and architectural degree-earners have science occupations.[25]

[24] The MBA has increased in popularity only over the last three to four decades; thus older senior managers are less likely to have earned that degree.

[25] Earlier research used NSF and other data from the 1970s and early 1980s to study migration of scientists and engineers into emerging computer- and biology-related occupations (Ailes 1985).

How Are Scientific Occupations Defined?

For the purposes of this study, scientific occupations include:

- computer and information science;
- mathematics, operations research, and statistics;
- agricultural and food science;
- biological science;
- environmental science, including forestry and conservation science;
- chemistry;
- atmospheric and space science, geology, and oceanography;
- physics and astronomy; and
- postsecondary teaching of the fields listed above.

They do *not* include:

- computer software engineering;
- social science;
- practices in health diagnosis and treatment; and
- science technology.

Looking across the occupational groups shown in table 8, engineering graduates working as scientists are the most likely to hold a degree outside of engineering; over one-fifth (21%) of this group have acquired one or more degrees in a scientific field.

Numerically, the majority of scientists who are engineering graduates have only an engineering baccalaureate (table 9). Yet a comparison shows that engineering graduates who hold one or more degrees in science (table 11) are more likely to work as scientists than are those who do not hold science degrees (table 9). The rate is notably higher if the engineering

graduate's most recent (highest) degree is in science, especially if the degree is at the master's or doctorate level. Those who hold doctorates in science are more likely to be employed in a scientific occupation than in any other occupational group.

However, when the doctorate is in engineering and the science degree is an earlier degree, the effect of the science degree on occupation is relatively small. Sixty-two percent of engineering Ph.D.s who also have a science degree are engineers by occupation, while only 17 percent are scientists.

Table 11
Employed engineering graduates with science degrees, by discipline and level of most recent degree and occupation: 1999

Discipline and Level of Most Recent Degree	Occupation (in percent)				
	Engineering	Science	Senior management	Other	Number
Total	53	19	10	18	158,000
Engineering					
Bachelor's	63	s	s	22	17,000
Master's	57	15	11	17	54,000
Doctorate	62	17	12	9	15,000
Science					
Bachelor's	56	7	s	24	14,000
Master's	49	23	9	20	46,000
Doctorate	27	52	9	13	13,000

s = Suppressed due to small cell count.

NOTE: Numbers rounded to thousands.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Engineering Graduates in Other Non-Engineering Occupations

Engineering graduates working in non-engineering jobs pursue a variety of occupations, as shown in table 7. These occupations are diverse and virtually without pattern.

People working in this broad-ranging occupational category are considerably more likely to have a degree outside engineering than are those working as engineers. Approximately 3 people in 10 in this group of occupations have non-engineering degrees (table 8).

To qualify for the professional positions they hold, a significant number of engineering graduates also have professional degrees in such fields as architecture, law, and medicine. In almost all cases in this study, professional degrees enabling entry into such professional fields were earned *after* the most recent engineering degree. However, it should be noted that, depending on the nature of their jobs, people with engineering degrees could still be using their engineering backgrounds in their current occupations. For example, an orthopedic surgeon who has an engineering background may use it in the development of surgical approaches and equipment.

In terms of degree patterns and their effects on occupation, the data show two patterns relating to degree level and discipline of the most recent degree (table 12). First, at the master's level, 15 to 20 percent of engineering graduates with another degree in a field other than science or business are in senior management. In addition, the majority with master's outside of business or science hold occupations outside engineering, science, or senior management.

A close inspection of all these individual educational pathways and occupations revealed *no distinguishing characteristic or pattern,* beyond an extremely wide range of educational fields and occupational specialties.

Relatively high numbers of individuals at the master's level had paired their engineering degrees with degrees in marketing, architecture, technology, public administration, social science fields, education, etc., but the majority of the degree mixes occurred too infrequently to be mentioned here.

Table 12

Employed engineering graduates with other* degrees, by discipline and level of most recent degree and occupation: 1999

Discipline and Level of Most Recent Degree	Occupation (in percent)				
	Engineering	Science	Senior management	Other	Number
Total	24	3	11	61	95,000
Engineering					
Bachelor's	62	s	s	30	11,000
Master's	45	s	20	30	11,000
Doctorate	57	12	12	19	2,000
Other					
Bachelor's	12	s	s	6	9,000
Master's	27	5	15	53	28,000
Doctorate	s	s	14	71	4,000
Other professional	s	0	s	91	31,000

** "Other" degrees are neither science nor business degrees.*

s = Suppressed due to small cell count.

NOTE: Numbers are rounded to thousands.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

A second educational/occupational pattern among engineering graduates who obtained a non-science, non-business degree involved those who combined engineering with professional degrees and then entered the practice of law or medicine.[26] About 28,000 engineering graduates hold a professional degree in law, and 14,000 hold a professional medical degree. In contrast with engineering graduates whose last degree is at the master's level, fewer than 10 percent of engineering graduates with professional degrees report their occupation as senior manager.

[26] A handful of professional degrees in disciplines other than law and medicine were also identified, but were too few to analyze.

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APPENDIX A

TECHNICAL NOTES

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TECHNICAL NOTES

General Information

All publications prepared for the Engineering Workforce Project (EWP) are based on data contained in NSF's Scientists and Engineers Statistical Data System (SESTAT), which is a comprehensive and integrated system of information about the employment, educational, and demographic characteristics of scientists and engineers in the United States. SESTAT is intended for both policy analysis and general research, having features for both the casual and more intensive data user.

SESTAT currently contains data from three NSF-sponsored demographic surveys, which provide compatible data that have been merged into a single integrated data system. This integration gives SESTAT its analytical power and makes it unique around the world. This report relies on the 1999 survey responses. More recent SESTAT data will be available in approximately 2005, at which point the data collected in 2003 will have been integrated and added to SESTAT.

SESTAT Data System

In the 1990s, NSF's Division of Science Resources Studies (SRS) redesigned its data system covering scientists and engineers. Termed SESTAT, the new data system integrates data from the Survey of Doctorate Recipients,

the National Survey of College Graduates, and the National Survey of Recent College Graduates. The integration of the SESTAT surveys requires complementary sample populations and reference periods; matching survey questions, procedures, and field definitions; and weighting adjustments for any overlapping populations. SESTAT's analytical power comes from this data integration.

The surveys provide data on individual respondents' educational background, occupation, employment, and demographic characteristics. They currently have a combined sample size of about 87,200, representing a population of about 13 million scientists and engineers. SESTAT defines scientists and engineers as those who either received a college degree (bachelor's level or higher) in a science or engineering field or who worked as a scientist or engineer in 1993. Each of the three surveys in the SESTAT data system collects new data every 2 years. The data reported in this publication were collected in 1999.

SESTAT has as its target population residents of the United States with a baccalaureate degree or higher who, as of the study reference period, were noninstitutionalized, age 75 or less, and either educated or working as a scientist or engineer. A baccalaureate or higher degree is a bachelor's, master's, doctorate, or professional degree. To meet the scientist or engineer requirement, the U.S. resident had to (1) have at least one baccalaureate or higher degree in a science or engineering field, or (2) have a baccalaureate or higher degree in a non-science or -engineering field but worked in a science or engineering occupation as of April 15, 1993. For the 1999 SESTAT surveys, the reference period was the week of April 15, 1999.

Some elements of SESTAT's desired target population were not included within the target populations of any of the three SESTAT component

surveys. Bachelor's- and master's-level science and engineering educated personnel missing from the survey frames are predominately:

- residents whose bachelor's and/or master's degrees in science and engineering were received prior to April 1990 or from a foreign institution, who resided outside the United States on April 1, 1990, but not with the U.S. armed forces stationed abroad; or
- residents with no baccalaureate or higher degree in any field as of April 1, 1990, who were awarded a degree in science and engineering after June 1998 by a U.S. institution or after April 1990 by a foreign institution.

Persons with at least a bachelor's degree who are working in science and engineering jobs, but have no degree in a science or engineering field, are underrepresented in the SESTAT database after 1993 because the surveys do not capture new people entering these occupations who were not educated in science and engineering fields in this decade.

Doctorate-level science- and engineering-trained personnel missing from the survey frames are predominately:

- residents with doctorates in science and engineering received after June 1998 or from a foreign institution, with no baccalaureate or higher degree in any field as of April 1, 1990, and no bachelor's or master's degree in science and engineering received from a U.S. institution between April 1, 1990, and June 1998; or
- residents with doctorates in science and engineering received after June 1998 or from a foreign institution but with no bachelor's or master's science and engineering degree received from a U.S. institution between April 1, 1990, and June 1998, who resided outside the United States on April 1, 1990, but not with the U.S. armed forces stationed abroad.

SESTAT classifies the following broad categories as science and engineering occupations: computer and mathematical scientists, life and related scientists, physical and related scientists, social and related scientists, and engineers. Postsecondary teachers are included within each of these groups.

The following are considered non-science and -engineering occupations: top- and mid-level managers; teachers, except science and engineering postsecondary teachers; technicians/technologists, including computer programmers; people in health and related occupations, social services and related occupations, and sales and marketing occupations. Other non-science and -engineering occupations include artists, broadcasters, editors, entertainers, public relations specialists, writers, clerical and administrative support personnel, farmers, foresters, fishers, lawyers, judges, librarians, archivists, curators, actuaries, food service personnel, historians (except science and technology), architects, construction tradespeople, mechanics and repairers, and those involved in precision/production occupations, operators (for example, machine set-up, machine operators and tenders, fabricators, assemblers) and related occupations, transportation/material moving occupations and protective and other service occupations. Information on SESTAT can be found on the Web at http://sestat.nsf.gov.

SESTAT Component Surveys

National Survey of College Graduates (NSCG). The National Survey of College Graduates (NSCG) is designed to provide data on the number and characteristics of individuals with training and/or employment in science and engineering in the United States. This survey is designed to complement the other surveys of scientists and engineers conducted by SRS in order to provide a comprehensive picture of the number and characteristics of individuals with training and/or employment in S&E in the United States. More information about this survey is available at http://www.nsf.gov/sbe/srs/nscg/start.htm.

National Survey of Recent College Graduates (NSRCG). The National Survey of Recent College Graduates (NSRCG) provides information about individuals who recently obtained bachelor's or master's degrees in a science or engineering field. This group is of special interest to many decisionmakers, because it represents individuals who have recently made the transition from school to the workplace. Details regarding the sample selection and collection of data are available at http://www.nsf.gov/sbe/srs/snsrcg/rcgmeth.htm.

Survey of Doctoral Recipients (SDR). The Survey of Doctorate Recipients (SDR) is designed to provide demographic and career history information about individuals with doctoral degrees. The results of this survey are vital for educational planners within the Federal Government and in academia. The results are also used by employers in all sectors (education, industry, and the government) to understand and predict trends in employment opportunities and salaries in S&E fields for doctorate holders and to evaluate the effectiveness of equal opportunity efforts. Additional information about this instrument's design, sampling, and data collection are available at http://www.nsf.gov/sbe/srs/ssdr/sdrmeth.htm.

Sampling Errors

Sampling errors occur when estimates are derived from a sample rather than from the entire population. The sample used for any particular survey is only one of a large number of possible samples of the same size and design that could have been selected. Even if the same questionnaire and instructions were used, the estimates from each sample would differ from the others. This difference, termed sampling error, occurs by chance, and its variability is measured by the standard error associated with a particular estimate.

The standard error of a sample survey estimate measures the precision with which an estimate from one sample approximates the true population value, and thus can be used to construct a confidence interval for a survey parameter to assess the accuracy of the estimate. Standard errors for the numbers in the tables are provided where available. The following formula can be used for estimating the standard error of totals:

$$SE(\hat{Y}) = [\beta_0 \hat{Y}^2 + \beta_1]^{1/2}$$

Approximate standard errors for percentages can be calculated from the following formula:

$$SE(P) = [\beta_1 / \hat{Y}\ (P(100\text{-}P))]^{1/2}$$

Where SE(P) is the predicted standard error for the percentage, $\hat{Y}$ is the estimated number of persons in the base of the percentage, and β_1 is the regression coefficient. A 95 percent confidence interval for an estimate can be calculated by multiplying 1.96 by the standard error of the estimate, and adding and subtracting the resulting amount from the estimate. Additional information about sampling error in SESTAT is available at http://srsstats.sbe.nsf.gov/docs/stderr00.html.

Standard error table 1

Degree combinations of engineering graduates: 1999

Degree Combinations	B0	B1	Estimated total	Standard error	95% confidence interval Lower	95% confidence interval Upper
Total, engineering graduates	-0.00003	173.72197	2,696,000	15,820.93	2,664,990.97	2,727,009.03
Engineering only	-0.00003	173.72197	2,154,000	15,329.89	2,123,953.41	2,184,046.59
Bachelor's is most recent degree	-0.00003	173.72197	1,627,000	14,255.94	1,599,058.36	1,654,941.64
Master's is most recent degree	-0.00003	173.72197	443,000	8,430.38	426,476.45	459,523.55
Ph.D. is most recent degree	-0.00003	173.72197	94,000	4,008.09	86,144.14	101,855.86
Engineering and non-engineering	-0.00003	173.72197	543,000	9,245.84	524,878.15	561,121.85
Engineering and business	-0.00003	173.72197	250,000	6,446.35	237,365.14	262,634.86
Engineering and science	-0.00003	176.72197	177,000	5,508.17	166,203.99	187,796.01
Engineering and other	-0.00003	173.72197	116,000	4,443.88	107,290.00	124,710.00

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 2 (part 1 of 2)

Degree combinations of engineering graduates, by discipline and level of most recent degree: 1999

Discipline of Most Recent Degree, Degree Combination, and Most Recent Degree Level	B0	B1	Estimated total	Standard error	95% confidence interval Lower	95% confidence interval Upper
Total, most recent degree in engineering						
Bachelor's degree	-0.00003	173.72197	1,662,000	14,347.77	1,633,878.36	1,690,121.64
Master's degree	-0.00003	173.72197	515,000	9,028.29	497,304.55	532,695.45
Doctorate	-0.00003	173.72197	113,000	4,387.20	104,401.09	121,598.91
Other professional	-0.00003	173.72197	s	na	na	na
Engineering only						
Bachelor's degree	-0.00003	173.72197	1,627,000	14,255.94	1,599,058.36	1,654,941.64
Master's degree	-0.00003	173.72197	433,000	8,342.48	416,648.74	449,351.26
Doctorate	-0.00003	173.72197	94,000	4,008.09	86,144.14	101,855.86
Other professional	-0.00003	173.72197	s	na	na	na
Engineering and business						
Bachelor's degree	-0.00003	173.72197	6,000	1,020.42	3,999.98	8,000.02
Master's degree	-0.00003	173.72197	8,000	1,178.07	5,690.98	10,309.02
Doctorate	-0.00003	173.72197	1,000	416.76	183.14	1,816.86
Other professional	-0.00003	173.72197	0	na	na	na
Engineering and science						
Bachelor's degree	-0.00003	173.72197	18,000	1,765.58	14,539.46	21,460.54
Master's degree	-0.00003	173.72197	60,000	3,211.75	53,704.98	66,295.02
Doctorate	-0.00003	173.72197	16,000	1,664.89	12,736.81	19,263.19
Other professional	-0.00003	173.72197	0	na	na	na
Engineering and other						
Bachelor's degree	-0.00003	173.72197	11,000	1,381.05	8,293.13	13,706.87
Master's degree	-0.00003	173.72197	14,000	1,557.64	10,947.03	17,052.97
Doctorate	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Other professional	-0.00003	173.72197	0	na	na	na

s = Suppressed estimate due to small cell count.

na = Not applicable.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 2 (part 2 of 2)

Degree combinations of engineering graduates, by discipline and level of most recent degree: 1999

Discipline of Most Recent Degree, Degree Combination, and Most Recent Degree Level	B0	B1	Estimated total	Standard error	95% confidence interval Lower	95% confidence interval Upper
Total, most recent degree not in engineering						
Bachelor's degree	-0.00003	173.72197	37,000	2,527.18	32,046.73	41,953.27
Master's degree	-0.00003	173.72197	310,000	7,139.38	296,006.81	323,993.19
Doctorate	-0.00003	173.72197	22,000	1,951.25	18,175.56	25,824.44
Other professional	-0.00003	173.72197	36,000	2,493.01	31,113.70	40,886.30
Most recent degree in business						
Bachelor's degree	-0.00003	173.72197	11,000	1,381.05	8,293.13	13,706.87
Master's degree	-0.00003	173.72197	221,000	6,076.79	209,089.50	232,910.50
Doctorate	-0.00003	173.72197	3,000	721.73	1,585.41	4,414.59
Other professional	-0.00003	173.72197	0	na	na	na
Most recent degree in science						
Bachelor's degree	-0.00003	173.72197	16,000	1,664.89	12,736.81	19,263.19
Master's degree	-0.00003	173.72197	51,000	2,963.41	45,191.72	56,808.28
Doctorate	-0.00003	173.72197	15,000	1,612.17	11,840.15	18,159.85
Other professional	-0.00003	173.72197	0	na	na	na
Most recent degree in other field						
Bachelor's degree	-0.00003	173.72197	10,000	1,316.90	7,418.88	12,581.12
Master's degree	-0.00003	173.72197	37,000	2,527.18	32,046.73	41,953.27
Doctorate	-0.00003	173.72197	5,000	931.59	3,174.08	6,825.92
Other professional	-0.00003	173.72197	36,000	2,493.01	31,113.70	40,886.30

s = Suppressed estimate due to small cell count.

na = Not applicable.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 3

Engineering graduates who also have science degrees, by science degree field: 1999

Science Field	B0	B1	Estimated total	Standard error	95% confidence interval Lower	95% confidence interval Upper
Total, all science fields	**-0.00003**	**173.72197**	**212,000**	**5,956.57**	**200,325.12**	**223,674.88**
Physical sciences	**-0.00003**	**173.72197**	**82,000**	**3,747.46**	**74,654.97**	**89,345.03**
Physics	-0.00003	173.72197	46,000	2,815.62	40,481.38	51,518.62
Chemistry	-0.00003	173.72197	22,000	1,951.25	18,175.56	25,824.44
Other physical sciences	-0.00003	173.72197	6,000	1,020.42	3,999.98	8,000.02
Geology	-0.00003	173.72197	4,000	833.31	2,366.71	5,633.29
Atmospheric sciences and meteorology	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Other geological sciences	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Oceanography	-0.00003	173.72197	1,000	416.76	183.14	1,816.86
Computer science-related fields	**-0.00003**	**173.72197**	**59,000**	**3,185.15**	**52,757.11**	**65,242.89**
Computer science	-0.00003	173.72197	39,000	2,594.13	33,915.50	44,084.50
Computer/information sciences, general	-0.00003	173.72197	9,000	1,249.43	6,551.12	11,448.88
Information services and systems	-0.00003	173.72197	5,000	931.59	3,174.08	6,825.92
Computer/information sciences	-0.00003	173.72197	3,000	721.73	1,585.41	4,414.59
Other computer and information sciences	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Computer systems analysis	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Mathematics	**-0.00003**	**173.72197**	**40,000**	**2,626.95**	**34,851.17**	**45,148.83**
Mathematics, general	-0.00003	173.72197	18,000	1,765.58	14,539.46	21,460.54
Operations research	-0.00003	173.72197	7,000	1,102.08	4,839.92	9,160.08
Applied mathematics	-0.00003	173.72197	7,000	1,102.08	4,839.92	9,160.08
Other mathematics	-0.00003	173.72197	5,000	931.59	3,174.08	6,825.92
Statistics	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Biological/life sciences	**-0.00003**	**173.72197**	**22,000**	**1,951.25**	**18,175.56**	**25,824.44**
General biology	-0.00003	173.72197	10,000	1,316.90	7,418.88	12,581.12
Other biological sciences	-0.00003	173.72197	5,000	931.59	3,174.08	6,825.92
Biochemistry	-0.00003	173.72197	3,000	721.73	1,585.41	4,414.59
General zoology	-0.00003	173.72197	2,000	589.34	844.89	3,155.11
Microbiology	-0.00003	173.72197	1,000	416.76	183.14	1,816.86
Physiology	-0.00003	173.72197	1,000	416.76	183.14	1,816.86
Environmental sciences, total	**-0.00003**	**173.72197**	**3,000**	**721.73**	**1,585.41**	**4,414.59**
Agricultural sciences, total	**-0.00003**	**173.72197**	**3,000**	**721.73**	**1,585.41**	**4,414.59**
All other scientific fields	**-0.00003**	**173.72197**	**4,000**	**833.31**	**2,366.71**	**5,633.29**

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 4

Engineering graduates who were not working, by reasons for not working: 1999

Reason for Not Working	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval	
					Lower	Upper
Retired	77	449,000	0.8278	0.0108	75.38	78.62
No need to work	12	449,000	0.6392	0.0533	10.75	13.25
Family reasons	7	449,000	0.5019	0.0717	6.02	7.98
Student	5	449,000	0.4287	0.0857	4.16	5.84
Laid off	5	449,000	0.4287	0.0857	4.16	5.84
No job available	5	449,000	0.4287	0.0857	4.16	5.84
Illness	4	449,000	0.3855	0.0964	3.24	4.76
Other reasons, unspecfied	2	449,000	0.2754	0.1377	1.46	2.54

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 5

Engineering graduates who were not working, by age and top three reasons for not working: 1999

Age and Top Three Reasons for Not Working	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
Less than 30						
Student	75	18,000	4.2539	0.0567	66.66	83.34
No need to work	36	18,000	4.7156	0.1310	26.76	45.24
No job available	10	18,000	2.9472	0.2947	4.22	15.78
Age 30-39						
Family reasons	52	32,000	3.6811	0.0708	44.79	59.21
No need to work	31	32,000	3.4077	0.1099	24.32	37.68
Student	24	32,000	3.1468	0.1311	17.83	30.17
Age 40-49						
Family reasons	36	25,000	4.0013	0.1111	28.16	43.84
No need to work	25	25,000	3.6096	0.1444	17.93	32.07
Laid off	20	25,000	3.3344	0.1667	13.46	26.54
Age 50-59						
Retired	59	45,000	3.0559	0.0518	53.01	64.99
Laid off	19	45,000	2.4375	0.1283	14.22	23.78
No need to work	13	45,000	2.0895	0.1607	8.90	17.10
Age 60 and up						
Retired	96	329,000	0.4503	0.0047	95.12	96.88
No need to work	8	329,000	0.6234	0.0779	6.78	9.22
Illness	3	329,000	0.3920	0.1307	2.2	3.77

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 6

Employed engineering graduates who were working part time, by reasons: 1999

Reason for Not Working	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
No need to work full time	49	134,000	1.7999	0.0367	45.47	52.53
Family reasons	21	134,000	1.4666	0.0698	18.13	23.87
Student	15	134,000	1.2857	0.0857	12.48	17.52
No job available	10	134,000	1.0802	0.1080	7.88	12.12
Other reasons, unspecified	9	134,000	1.0304	0.1145	6.98	11.02
Illness	3	134,000	0.6142	0.2047	1.80	4.20

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 7

Non-engineering occupations of engineering graduates: 1999

Non-Engineering Job	B0	B1	Estimated total	Standard error	95% confidence interval Lower	95% confidence interval Upper
TOTAL	-0.00003	173.72197	1,021,000	12,087.06	997,309.37	1,044,690.63
Senior management	-0.00003	173.72197	306,000	7,095.76	292,092.31	319,907.69
Sales and marketing	-0.00003	173.72197	130,000	4,698.60	120,790.74	139,209.26
Computer sciences	-0.00003	173.72197	117,000	4,462.60	108,253.30	125,746.70
Administration	-0.00003	173.72197	66,000	3,366.74	59,401.18	72,598.82
Construction and production	-0.00003	173.72197	55,000	3,076.35	48,970.34	61,029.66
Finance and personnel	-0.00003	173.72197	47,000	2,845.81	41,422.20	52,577.80
Engineering technology	-0.00003	173.72197	36,000	2,493.01	31,113.70	40,886.30
Computer programming	-0.00003	173.72197	34,000	2,423.19	29,250.54	38,749.46
Architecture	-0.00003	173.72197	24,000	2,037.66	20,006.19	27,993.81
Health care	-0.00003	173.72197	22,000	1,951.25	18,175.56	25,824.44
Physical and related sciences	-0.00003	173.72197	22,000	1,951.25	18,175.56	25,824.44
Law and justice	-0.00003	173.72197	21,000	1,906.55	17,263.16	24,736.84
Art and humanities	-0.00003	173.72197	11,000	1,381.05	8,293.13	13,706.87
Social services	-0.00003	173.72197	9,000	1,249.43	6,551.12	11,448.88
Mathematical sciences	-0.00003	173.72197	7,000	1,102.08	4,839.92	9,160.08
Life and related sciences	-0.00003	173.72197	7,000	1,102.08	4,839.92	9,160.08
All other	-0.00003	173.72197	107,000	4,271.39	98,628.07	115,371.93

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 8

Employed engineering graduates, by occupation and degree combination: 1999

Occupation and Degree Combination	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
Total occupations						
Engineering only	79	2,255,000	0.3575	0.0045	78.30	79.70
Engineering and business	10	2,255,000	0.2633	0.0263	9.48	10.52
Engineering and science	7	2,255,000	0.2239	0.0320	6.56	7.44
Engineering and other	4	2,255,000	0.1720	0.0430	3.66	4.34
Engineering occupations						
Engineering only	86	1,277,000	0.4047	0.0047	85.21	86.79
Engineering and business	6	1,277,000	0.2770	0.0462	5.46	6.54
Engineering and science	7	1,277,000	0.2976	0.0425	6.42	7.58
Engineering and other	2	1,277,000	0.1633	0.0816	1.68	2.32
Senior management occupations						
Engineering only	70	295,000	1.1121	0.0159	67.82	72.18
Engineering and business	20	295,000	0.9707	0.048	5 18.10	21.90
Engineering and science	6	295,000	0.5763	0.0961	4.87	7.13
Engineering and other	4	295,000	0.4755	0.1189	3.07	4.93
Science occupations						
Engineering only	70	143,000	1.5972	0.0228	66.87	73.13
Engineering and business	7	143,000	0.8893	0.1270	5.26	8.74
Engineering and science	21	143,000	1.4197	0.0676	18.22	23.78
Engineering and other	2	143,000	0.4880	0.2440	1.04	2.96
All other occupations						
Engineering only	70	540,000	0.8219	0.0117	68.39	71.61
Engineering and business	14	540,000	0.6224	0.0445	12.78	15.22
Engineering and science	5	540,000	0.3909	0.0782	4.23	5.77
Engineering and other	11	540,000	0.5612	0.0510	9.90	12.10

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 9

Employed engineering graduates who have only engineering degrees, by level of the most recent (highest) degree and occupation: 1999

Most Recent Degree and Occupation	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
All degrees						
Engineering occupation	62	1,786,000	0.4787	0.0077	61.06	62.94
Science occupation	6	1,786,000	0.2342	0.0390	5.54	6.46
Senior management	12	1,786,000	0.3205	0.0267	11.37	12.63
Other occupation	21	1,786,000	0.4017	0.0191	20.21	21.79
Bachelor's degree						
Engineering occupation	59	1,324,000	0.5634	0.0095	57.90	60.10
Science occupation	5	1,324,000	0.2496	0.0499	4.51	5.49
Senior management	12	1,324,000	0.3722	0.0310	11.27	12.73
Other occupation	24	1,324,000	0.4892	0.0204	23.04	24.96
Master's degree						
Engineering occupation	68	377,000	1.0014	0.0147	66.04	69.96
Science occupation	6	377,000	0.5098	0.0850	5.00	7.00
Senior management	11	377,000	0.6717	0.0611	9.68	12.32
Other occupation	14	377,000	0.7449	0.0532	12.54	15.46
Doctorate						
Engineering occupation	75	84,000	1.9692	0.0263	71.14	78.86
Science occupation	8	84,000	1.2337	0.1542	5.58	10.42
Senior management	10	84,000	1.3643	0.1364	7.33	12.67
Other occupation	7	84,000	1.1603	0.1658	4.73	9.27
Other professional						
Engineering occupation	s	s	na	na	na	na
Science occupation	s	s	na	na	na	na
Senior management	s	s	na	na	na	na
Other occupation	s	s	na	na	na	na

s = Suppressed estimate due to small cell count.

na = Not applicable.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 10

Employed engineering graduates with business degrees, by discipline and level of the most recent degree and occupation: 1999

Most Recent Degree and Occupation	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
Total degrees						
Engineering occupation	33	215,000	1.3366	0.0405	30.38	35.62
Science occupation	5	215,000	0.6195	0.1239	3.79	6.21
Senior management	28	215,000	1.2763	0.0456	25.50	30.50
Other occupation	35	215,000	1.3558	0.0387	32.34	37.66
Engineering						
Bachelor's degree						
Engineering occupation	57	4,000	10.3174	0.1810	36.78	77.22
Science occupation	s	4,000	na	na	na	na
Senior management	s	4,000	na	na	na	na
Other occupation	s	4,000	na	na	na	na
Master's degree						
Engineering occupation	38	8,000	7.1527	0.1882	23.98	52.02
Science occupation	9	8,000	4.2172	0.4686	0.73	17.27
Senior management	21	8,000	6.0021	0.2858	9.24	32.76
Other occupation	32	8,000	6.8740	0.2148	18.53	45.47
Doctorate						
Engineering occupation	51	1,000	20.8358	0.4085	10.16	91.84
Science occupation	s	1,000	na	na	na	na
Senior management	s	1,000	na	na	na	na
Other occupation	s	1,000	na	na	na	na
Business						
Bachelor's degree						
Engineering occupation	s	6,000	na	na	na	na
Science occupation	s	6,000	na	na	na	na
Senior management	s	6,000	na	na	na	na
Other occupation	s	6,000	na	na	na	na
Master's degree						
Engineering occupation	32	194,000	1.3959	0.0436	29.26	34.74
Science occupation	5	194,000	0.6522	0.1304	3.72	6.28
Senior management	28	194,000	1.3436	0.0480	25.37	30.63
Other occupation	35	194,000	1.4273	0.0408	32.20	37.80
Doctorate						
Engineering occupation	s	s	na	na	na	na
Science occupation	0	s	na	na	na	na
Senior management	s	s	na	na	na	na
Other occupation	s	s	na	na	na	na

s = Suppressed estimate due to small cell count.

na = Not applicable.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 11

Employed engineering graduates with science degrees, by discipline and level of the most recent degree and occupation: 1999

Most Recent Degree and Occupation	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
Total degrees						
Engineering occupation	53	158,000	1.6550	0.0312	49.76	56.24
Science occupation	19	158,000	1.3008	0.0685	16.45	21.55
Senior management	10	158,000	0.9948	0.0995	8.05	11.95
Other occupation	18	158,000	1.2739	0.0708	15.50	20.50
Engineering						
Bachelor's degree						
Engineering occupation	63	17,000	4.8806	0.0775	53.43	72.57
Science occupation	s	17,000	na	na	na	na
Senior management	s	17,000	na	na	na	na
Other occupation	22	17,000	4.1876	0.1903	13.79	30.21
Master's degree						
Engineering occupation	57	54,000	2.8080	0.0493	51.50	62.50
Science occupation	15	54,000	2.0253	0.1350	11.03	18.97
Senior management	11	54,000	1.7747	0.1613	7.52	14.48
Other occupation	17	54,000	2.1306	0.1253	12.82	21.18
Doctorate						
Engineering occupation	62	15,000	5.2236	0.0843	51.76	72.24
Science occupation	17	15,000	4.0425	0.2378	9.08	24.92
Senior management	12	15,000	3.4971	0.2914	5.15	18.85
Other occupation	9	15,000	3.0798	0.3422	2.96	15.04
Science						
Bachelor's degree						
Engineering occupation	56	14,000	5.5295	0.0987	45.16	66.84
Science occupation	7	14,000	2.8422	0.4060	1.43	12.57
Senior management	13	14,000	3.7462	0.2882	5.66	20.34
Other occupation	24	14,000	4.7575	0.1982	14.68	33.32
Master's degree						
Engineering occupation	49	46,000	3.0721	0.0627	42.98	55.02
Science occupation	23	46,000	2.5862	0.1124	17.93	28.07
Senior management	9	46,000	1.7587	0.1954	5.55	12.45
Other occupation	20	46,000	2.4582	0.1229	15.18	24.82
Doctorate						
Engineering occupation	27	13,000	5.1321	0.1901	16.94	37.06
Science occupation	52	13,000	5.7753	0.1111	40.68	63.32
Senior management	9	13,000	3.3082	0.3676	2.52	15.48
Other occupation	13	13,000	3.8876	0.2990	5.38	20.62

s = Suppressed estimate due to small cell count.

na = Not applicable.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.

Standard error table 12

Employed engineering graduates with other degrees, by discipline and level of the most recent degree and occupation: 1999

Most Recent Degree and Occupation	Estimated percent	Number	Standard error	Coefficient of variation	95% confidence interval Lower	95% confidence interval Upper
Total degrees						
Engineering occupation	24	95,000	1.8263	0.0761	20.42	27.58
Science occupation	3	95,000	0.7295	0.2432	1.57	4.43
Senior management	11	95,000	1.3380	0.1216	8.38	13.62
Other occupation	61	95,000	2.0858	0.0342	56.91	65.09
Engineering						
Bachelor's degree						
Engineering occupation	62	11,000	6.0998	0.0984	50.04	73.96
Science occupation	s	11,000	na	na	na	na
Senior management	s	11,000	na	na	na	na
Other occupation	30	11,000	5.7589	0.1920	18.71	41.29
Master's degree						
Engineering occupation	45	11,000	6.2520	0.1389	32.75	57.25
Science occupation	5	11,000	2.7389	0.5478	-0.37	10.37
Senior management	20	11,000	5.0268	0.2513	10.15	29.85
Other occupation	30	11,000	5.7589	0.1920	18.71	41.29
Doctorate						
Engineering occupation	57	2,000	14.5910	0.2560	28.40	85.60
Science occupation	12	2,000	9.5773	0.7981	-6.77	30.77
Senior management	12	2,000	9.5773	0.7981	-6.77	30.77
Other occupation	19	2,000	11.5620	0.6085	-3.66	41.66
Other						
Bachelor's degree						
Engineering occupation	12	9,000	4.5148	0.3762	3.15	20.85
Science occupation	s	9,000	na	na	na	na
Senior management	s	9,000	na	na	na	na
Other occupation	67	9,000	6.5328	0.0975	54.20	79.80
Master's degree						
Engineering occupation	27	28,000	3.4970	0.1295	20.15	33.85
Science occupation	5	28,000	1.7167	0.3433	1.64	8.36
Senior management	15	28,000	2.8126	0.1875	9.49	20.51
Other occupation	53	28,000	3.9313	0.0742	45.29	60.71
Doctorate						
Engineering occupation	s	4,000	na	na	na	na
Science occupation	s	4,000	na	na	na	na
Senior management	14	4,000	7.2312	0.5165	-0.17	28.17
Other occupation	71	4,000	9.4564	0.1332	52.47	89.53
Other professional						
Engineering occupation	s	31,000	na	na	na	na
Science occupation	0	31,000	na	na	na	na
Senior management	s	31,000	na	na	na	na
Other occupation	91	31,000	2.1423	0.0235	86.80	95.20

s = Suppressed estimate due to small cell count.

na = Not applicable.

SOURCE: National Science Foundation/Division of Science Resources Statistics, SESTAT (Scientists and Engineers Statistical Data System), 1999.