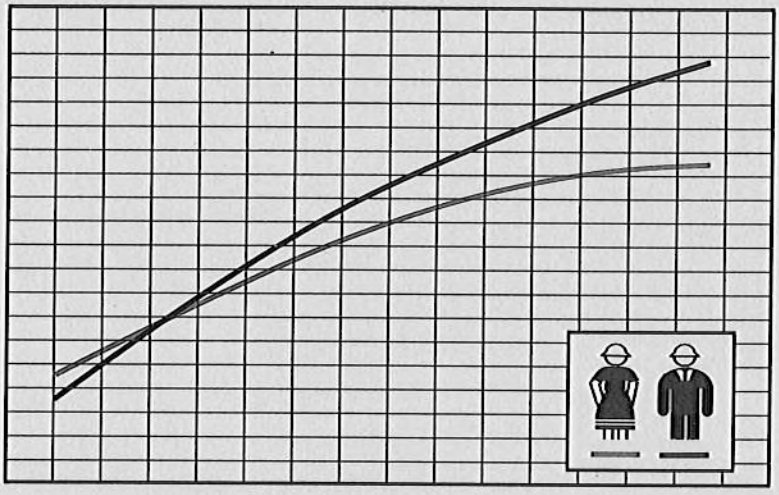
A National Survey of Women and Men Engineers:

A Study of the Members of 22 Engineering Societies



PART I: Introduction to the Survey

PART II: Gender Differences in Engineering

SOCIETY OF WOMEN ENGINEERS
New York, New York

SWE Mission Statement

The Society's mission is to:

- Stimulate women to achieve full potential in careers as engineers and leaders,
- Expand the image of the engineering profession as a positive force in improving the quality of life and
- Demonstrate the value of diversity.

SWE Goals and Objectives

The goals and objectives of the Society are:

- To inform young women, their parents, counselors and the general public of the qualifications and achievements of women engineers and the opportunities open to them,
- To assist women engineers in readying themselves for a return to active work after temporary retirement,
- To serve as a center of information on women in engineering, and
- To encourage women engineers to attain high levels of education and professional achievement.

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A National Survey of Women and Men Engineers:
A Study of the Members of 22 Engineering Societies

PART I: Introduction to the Survey

PART II: Gender Differences in Engineering

SOCIETY OF WOMEN ENGINEERS

120 Wall Street, 11th Floor
New York, New York 10005-3902

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Republication of material in this report about specific individual engineers will not be authorized under any circumstances, to provide extra support for the privacy of the survey respondents.

ACKNOWLEDGMENTS

As is customary in surveys, many people contributed to this project. The Society of Women Engineers would like to thank Conoco Corporation, the General Electric Foundation, the General Motors Foundation, and the Alfred P. Sloan Foundation for their support.

SWE would also like to express its appreciation to its fellow engineering societies and their members for their cooperation with this survey. The other societies which participated are:

American Academy of Environmental Engineers
American Institute of Aeronautics and Astronautics
American Institute of Chemical Engineers
American Institute of Plant Engineers
American Nuclear Society
American Society for Engineering Education
American Society of Agricultural Engineers
American Society of Civil Engineers
American Society of Heating, Refrigerating and Air-Conditioning Engineers
American Society of Mechanical Engineers
American Society of Safety Engineers
American Welding Society
Institute of Electrical and Electronic Engineers
Institute of Industrial Engineers
National Institute of Ceramic Engineers
National Society of Professional Engineers
Optical Society of America
Society for Mining, Metallurgy and Exploration
Society of Fire Protection Engineers
Society of Manufacturing Engineers
Society of Petroleum Engineers

This study was conceived and supervised by SWE's Statistics Committee, chaired during 1988-1991 by Patricia L. Eng, P.E., a senior member of the technical staff at the Nuclear Regulatory Commission's headquarters in Washington, D.C., and during 1991-1993 by Shelley A. M. Wolff, P.E., project manager for highway design at HNTB Corporation's Kansas City, Missouri office. The pilot phase of the work was conducted entirely as a volunteer effort (support for out-of-pocket costs was provided by a grant from the Procter & Gamble Co.).

This report was written by Richard Ellis, director of the research department at the American Association of Engineering Societies in Washington, D.C. Mr. Ellis provided technical support for this project from its beginning and directed the national survey. In addition to this design and analytical work, other AAES internal and contract staff helped to carry out the project. Programming was done by Dave Galoppo and Claire LeBuffe. Ms. LeBuffe also supervised the collection, editing and entry of data for the survey. Data entry was done by Nicole Foster and Norma Chapman. Michelle Peterson and Adrian LeBuffe provided research assistance. The report was designed by WordWorks, Brunswick, Maryland.

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A National Survey of Women and Men Engineers

A Study of the Members of 22 Engineering Societies

Part I: Introduction to the Survey
Part II: Gender Differences in Engineering

EXECUTIVE SUMMARY

A project of the Society of Women Engineers (SWE), New York, New York

Introduction. This is a report on a survey of a random sample of more than half a million American engineers who belong to one or more of 22 major professional or technical societies. At least two recurring themes can be detected in the findings of the project:

- For the profession, this report documents unusual levels of uncertainty and disorganization in some of today's engineering workplaces. For example, sixty percent of these engineers have gone through major reorganizations during the last five years; this is three times the rate reported for the U.S. population as a whole.
- For women, the essence of the survey may be summarized by the graphic on the cover of this report: in some respects, women in engineering begin careers at parity with men or better, but as one looks at more experienced people, this picture changes.

Demography, Family Issues, and Education. This study begins with details about the demography and family status of engineers. About four percent are members of minority groups that are underrepresented in the profession—African Americans, Hispanics, and American Indians and related Native Americans. Another six percent are of Asian origins. About two percent have disabilities; this is the first national survey of engineers to report on this statistic.

When this survey took place in 1992, on the average men engineers were about nine years older than women engineers. The men are more likely than the women to be currently married, their spouses are less likely to be employed, and the spouses who are employed are less likely to be working full time. Among those with children in their households, use of day care services is reported by 68 percent of the women but by only 28 percent of the men. Among married women engineers, the odds are better than 50-50 that their spouse is another engineer. Two percent of the women are not working because they are caring for children.

Engineers are very educated people. Forty-four percent of SWE's respondents hold advanced degrees. Among younger engineers, women are more likely to have an advanced degree than men. However, in general women seem less likely than men to either seek or obtain professional registration or certification as a licensed Professional Engineer ("P.E."). This difference persists across engineering specialties and types of employers.

Motivations to Enter the Profession. Many aspects of engineering are explored in this report. Reasons to join the profession are considered at length. After realizing that one has the necessary skills, the important motives to pursue engineering are the career opportunities and hopes for good salaries and job security that the profession offers (the hopes have faded to an extent, to judge by the comments of SWE's respondents); and the lure of work that is personally challenging, interesting, and enjoyable.

Employment. Ninety-seven percent of the men engineers and 92 percent of the women were employed at the time of the study, almost all of them as engineers or in a "comparable technical or management job where my engineering background is helpful." About eighty percent of the respondents agree that their engineering skills are "reasonably well utilized" by what they do. If the Department of Labor's conventions are used, about 1.5 percent of the sample was unemployed. The women's unemployment rate is higher, about three percent. Additional respondents do not have appropriate jobs and want to return to engineering.

By the time they are in their fifties, on average the engineers in SWE's study have worked for four different employers. If allowance is made for the relative scarcity of the more experienced women, no significant differences can be found between women and men engineers in the propensity to work for several employers over an entire career.

Women engineers are more likely to be found working for the largest engineering employers. They are relatively unlikely to go into aerospace or civil engineering, and more likely than men to become chemical, computer, environmental, industrial or manufacturing engineers. They are less likely than men to work for consulting and engineering service firms—now the largest single industry sector for engineers—and more likely to work for manufacturers, especially the computer hardware and software industry.

Performance Assessment, Compensation, and Participation in Management. There are few meaningful differences between men and women engineers when they are asked to identify the criteria by which their performance is assessed. For both genders and especially for women, skill in project management and technical competence are the overriding concerns. Other criteria, such as personnel management or contributions to sales, are secondary for most of these workers.

Women engineers appear to fare poorly in at least two ways in this report. First, comparison of salaries suggests that nothing is being done about long-recognized inequities. This analysis indicates that before engineers enter their thirties, men pull ahead in base salary and keep pulling further ahead for the rest of their careers.

Second, two separate indicators of the inclusion of engineers in management—a direct query to the respondents, and a measure of the distance between each respondent and the top—confirm the greater involvement of men than women. This difference does not disappear, although it weakens, when the engineers are compared within matched age groups. This is not to say that women are not engaged in management. They are; but not to the extent of men. When women do manage, their levels of responsibility and authority appear to be comparable to those of the men, at least at the lower levels of the ladder.

Job Discrimination. This is an especially sensitive issue in engineering today, and the perceptions of the men and women do not agree. Twice as many men as women feel that the sexes are always fairly treated. Three times as many women as men feel that there are consistent inequities. The same pattern occurs when respondents are asked about their perceptions of other kinds of discrimination.

The report contains a wide range of hints that older women engineers, in particular, may have their own kinds of needs, interests and problems; it appears that women engineers are more likely than men to retire early.

Pursuit of Careers. Women engineers amass less total time on the job than men, but up to age 40, the difference between the two sexes does not amount to a great deal (about 23 months less total average time in professional employment for women than men). However, the gap in total years of employment widens rapidly for men and women engineers aged 40 or more, as noted above. There are no significant differences between men and women in the number of hours they put into their work each week.

The study includes a report on what arises in the minds of engineers when one asks them about the obstacles they encounter in their careers. The largest obstacle faced by most engineers today is a weak job market, fueled by a generally limp economy, sharp decreases in defense and other aerospace investment, and drastic downsizing on the part of many of the largest technical and manufacturing organizations in the nation. The report includes information on the practical consequences of organizational shakeups and job layoffs.

Job Satisfaction. These engineers gain most of their satisfaction on the job from meeting the challenges of demanding technical work. Some are not being challenged and seek more interesting jobs. Many are dissatisfied with their advancement opportunities.

Assessing their experiences as a whole, the engineers in this study gain their greatest satisfaction from their educations, which they value more highly than their work. They also take satisfaction in their professional accomplishments. They are more reserved about their supervisors, their employers, and their own career prospects.

This report contains numerous detailed examples of engineering work and employment, including job titles, responsibilities, and accomplishments. Engineers are engaged in an astonishing range of activity; this diversity and vigor is celebrated in this study.

Next Steps. This project will continue. There is much more that can be done with the survey data, including a look at a number of items not mentioned in this report. Examples of further efforts being considered at this writing include:

- A doctoral dissertation in organizational behavior at the University of California at Berkeley, focusing on identification and measurement of factors that influence high levels of compensation and job satisfaction for engineers, based on analysis of SWE's data.
- Two special issues of the *Engineering Workforce Bulletin,* scheduled to appear this Fall.
- Several concentrated examinations of issues that call for further analysis of the survey's data, to be presented in forthcoming issues of *SWE: Magazine of the Society of Women Engineers.*

PART I

INTRODUCTION TO THE SURVEY

There have been women in engineering since the "founder" professional and technical societies were organized in the 19th century, but only in the past generation have women begun to make up more than a tiny fraction of the profession.

As recently as the early 1970's, less than one percent of the engineering graduates each year in the U.S. were women. However, by the end of 1992 women accounted for almost 20 percent of the nation's first-year undergraduate engineering students, and since the mid-1980's about 25 percent of the graduates in the disciplines of chemical and industrial engineering have been women. Although the *proportion* of women in other engineering specialties is usually lower (as in civil engineering or electrical and computer engineering where the women's share of new B.S. degrees is currently around 15 percent), the *absolute number* of people represented by these smaller percentages is still very large, reflecting the movement of thousands of women into the profession.

As sociological developments go, this one is relatively sudden. Most women engineers are young; older engineers are from a different era, and women are still rare at the most senior levels of experience.

Such rapid changes can create a mixture of stress and new opportunities. The movement of women into engineering has been accompanied by interest in the effects of this trend on the supply and utilization of high technology workers, curiosity about new career options for students and their parents, complaints about discrimination and reverse discrimination in engineering schools and workplaces, and other issues of concern to engineers, policymakers, the media, and the general public. Responding to these widespread interests, during the 1970's and 1980's the Society of Women Engineers (SWE) published a series of reports, based on surveys of its members, titled *A Profile of the Woman Engineer.*

SWE's *Profiles* were good examples of one common strategy for society studies, in which a simple questionnaire is mailed to the membership and assessed by volunteers with some limited support from staff. This approach can have drawbacks. Levels of response to a survey may fall below 50 percent, raising problems of representativeness and credibility, and the simple nature of the forms can limit analysis to a few descriptive exhibits that seldom contain surprises. SWE wanted to do better, and in 1988 it decided to upgrade the *Profile* project. To obtain technical advice, the Society contacted the research staff at the American Association of Engineering Societies (AAES), which handles survey production for the Engineering Workforce Commission.

Surveys like the *Profiles* can be upgraded in several ways. First, purely technical steps can be taken. For example, instead of mailing questionnaires to everyone, surveys can be limited to more manageable samples of members, using repeated mailings and other devices to reduce problems of response bias.

Other strategies for upgrading surveys are more substantive. When such projects are undertaken by academic or government-sponsored research-

ers, they tend to use complex study designs with lengthy questionnaires and substantial amounts of budgeted time to analyze and report on the results. In particular, such projects usually employ a rough equivalent to scientific controls in the form of comparison groups, so that differences can be tested between a population of interest and other kinds of people. Applied to SWE's case, this suggests that a convincing, influential survey of women engineers should include comparisons with the rest of the profession, that is, with men. Furthermore, if data on both genders were collected, the survey would also support descriptive studies of the entire profession, enabling treatment of many topics of general interest to all engineers.

SWE decided to pursue all of these options, and during 1989 and 1990 the work of upgrading the *Profile* project got underway. A lengthier, more detailed questionnaire, aimed at both women and men engineers, was drafted, refined, and approved by the Society's Board of Directors. A pilot test of this questionnaire was carried out in SWE's Heartland region—Iowa, Minnesota, Illinois, Wisconsin, Indiana, and Michigan. Corresponding state-level affiliates of the National Society of Professional Engineers (NSPE) provided male participants for this test. Technical support was provided by the AAES research staff. To cover the costs of postage and other miscellaneous expenses for the pilot test, Procter & Gamble furnished a small grant, the only funding used during this phase of the work.

A report on the pilot test was published in January 1991 ("A Pilot Survey of Men and Women Engineers," issue number 107 of the *Engineering Workforce Bulletin,* available from AAES). Additional information from the pilot study was presented at SWE's annual convention in June, 1991. With these results in hand, the Society began to solicit support for a national version of its project. By early 1992, adequate funding had been secured, including grants from several foundations, and SWE authorized AAES to proceed with a full-scale survey of the profession. This is the first report on the data from this national study.

The Survey Sample

The national version of SWE's survey of engineers is based on a sample of the members of 22 engineering societies. The mild potential bias of a study limited to those who have joined these organizations is a good tradeoff, given the bargain the strategy presents as a low-cost means of access to representative groups of people. More than half a million American engineers belong to one or more of the societies participating in this project.

Exhibit 1 summarizes the structure of this sample, which is *stratified:* it breaks its population into subgroups and then samples those clusters of people. If all engineers were to be sampled at the same rate, a random selection would contain relatively few women and would not be likely to include many representatives of the smaller specialties. Instead, the SWE sample aims to select substantial numbers of women as well as men, and to provide for adequate representation of the less common specialties as well as the largest groups of engineers. To analyze stratified data, a weight is assigned to each case so that the stratified groups of people can be restored to their proper shares of the overall population. More details on the weighting process are provided later in this part of the report.

The data on targeted sample yields in Exhibit 1 reflect the project's original design goals, not the actual makeup of the final data base. To obtain the targeted 2,020 cases, the design made a number of assumptions about probable levels of response to the survey, allowing for the fact that two

Treatment of the sampling strata: the population of engineers was divided into 14 groups, defined by gender and broad technical specialties. The aim was to spread sample cases more evenly among these strata than would be the case if a pure random sample of the population was drawn. This ensures that gender comparisons can be reliable and fairly precise; it also permits many more groups of engineers to have a meaningful contribution to the results, since a straight random selection will not assemble very many members of the smaller specialties. The actual development of the target figures for the sample was also influenced by many other judgments, including assumptions about the mix of specialists in differing cross-disciplinary societies like the American Society for Engineering Education (ASEE), the National Society of Professional Engineers (NSPE) and SWE; other assumptions about probable rates of response for women and men, and about the numbers of women in societies other than SWE; and some deliberate decisions to permit such variations as somewhat smaller targets for the aerospace and petrochemical specialties, and relatively large targets for others.

1. SAMPLING ENGINEERS FOR THE SURVEY

DESIGN GOAL: 2,000 members of over 20 major professional/technical societies, split 50-50 between women and men

Group	Population Model			Targeted Sample Yield		
	Total	Men	Women	Total	Men	Women
All Engineers	1,500,000	1,385,000	115,000	2,020	1,010	1,010
By Specialty:						
Aerospace	90,000	87,000	3,000	109	82	27
Chemical/Petroleum	60,000	51,000	9,000	131	50	81
Civil/Environmental	220,000	208,000	12,000	264	158	106
Electrical/Computer	500,000	460,000	40,000	504	169	335
Industrial	170,000	150,000	20,000	276	102	174
Mechanical	270,000	257,000	13,000	258	147	111
All Others	190,000	172,000	18,000	478	302	176

Total numbers of women and men engineers: population data in Exhibit 1 are based on results for 1990-1991 from the Bureau of Labor Statistics' Employer and Current Population Surveys, with some adjustments and rounding by AAES staff. Total population numbers are conservative and reflect counts of persons labeled as "engineers" by employers. The ratio of women engineers in the workforce was estimated at 7.7 percent; more recent data released since the project was designed show that this proportion has now risen to 8.2 percent. Ideally, the weighting scheme for the project, discussed below, should have been adjusted to make use of the newer data, but this was not done. The change would not be likely to affect the conclusions of the work.

follow-up mailings would be used and that the pilot test suggested strongly that women would be more willing to cooperate with the project than men. These considerations led to a specification that 3,150 society members should be sampled to reach the targeted goals.

Oversampling to allow for "ineligible respondents" (see the sidebar) raised the sample size to 3,324 (allowing for the elimination of two duplicate cases caused when individuals were sampled from more than one society). In addition, survey packages for 31 cases were returned by the postal service as undeliverable, so the final number of potential respondents is 3,293.

Response to the Survey

The respondents mailed back 1,917 usable forms. Removal of society members who had indicated that they were not eligible for the study lowered the actual number of usable responses by an additional 174 cases, leaving the final number of people in the study at 1,743.

Calculation of a "final" response rate for SWE's survey depends on the conventions one adopts to handle the oversampling to allow for "ineligible respondents." A literal computation uses 1,917 returned forms over 3,293 possible respondents, or 58.2 percent. A more sophisticated approach argues that the oversampling and subsequent exclusion of ineligibles ought to cancel each other out (by sheer coincidence, this is exactly what happened), so a fairer formula would be 1,743 eligible cases compared to the original mailing list number of 3,150, or 55.3 percent. By either standard, response fell short of the design goal of 64.1 percent.

The main reason for the shortfall was the technical director's overly optimistic assumption that, on the basis of their extremely good coopera-

Limitations of scope and "ineligible respondents": the study's design called for cases to be limited to practicing U.S. engineers (including those retired from work if they were still active in societies). This meant excluding students, foreign nationals who were not permanent residents of the United States, and those retired both from work and from active volunteer involvement in the profession. In addition, some societies include non-engineer members. Whenever feasible, these kinds of people were excluded at the outset by screening them out from the original sampling of society members, but many of the participating associations could not identify every potential type of ineligible person. When this was the case, the sample size for the society was increased accordingly, and exclusion of the remaining ineligible members was handled by a screening item at the beginning of the questionnaire. The number of oversampled cases and the number of people eventually screened out by the survey item happened to be the same, 174. These "ineligible respondents" did cooperate with the project by returning forms, but they were not included in the analysis of the data; to minimize the burdens of the study, they were advised that it was not necessary to complete the rest of the questionnaire.

2. SHORTFALLS IN RESPONSE WERE ABSORBED BY THE LARGEST GROUPS OF ENGINEERS

Group	Total			Men			Women		
	Target	Actual	%Δ	Target	Actual	%Δ	Target	Actual	%Δ
All Engineers	2,020	1,722[1]	-15%	1,010	908	-10%	1,010	814	-19%
By Specialty:									
Aerospace	109	102	-6%	82	67	-18%	27	35	+30%
Chemical/Petroleum	131	153	+17%	50	63	+26%	81	90	+12%
Civil/Environmental	264	328	+24%	158	190	+20%	106	138	+30%
Electrical/Computer	504	328	-35%	169	137	-19%	335	191	-43%
Industrial	276	284	+3%	102	144	+41%	174	140	-20%
Mechanical	258	245	-5%	147	139	-5%	111	106	-5%
All Others	478	282	-41%	302	168	-44%	176	114	-35%

[1] Total actual yield does not count 11 cases not responding on gender and 10 cases not responding on technical specialty.

Response by sectors: Exhibit 2 compares the targeted yields specified in the original design for SWE's survey with the actual yields, classified by the gender-and-specialty strata. The impact of the shortfall has been absorbed by the largest gender-and-specialty groups in the original design–in particular, the cluster of electrical and computer engineers, and the group of "other" specialties. The design allowed these groups to be large because it was assumed that a heavy response by SWE members would require allocating many cases to the group of electricals, which are by far the most common engineers, and because it was also assumed that the need to sample many societies in order to fairly represent smaller specialties would require a relatively sizable group of those respondents. In both cases, shortfalls can be absorbed without causing major problems for the design. Among the remaining specialty strata, the groups of aerospace, industrial, and mechanical engineers are close to the original targets, and two of the clusters– chemical and petroleum engineers, and civil and environmental engineers–exceed the design goals.

Determining technical specialties: society affiliations were *not* used to define specialties for the purpose of forming groups in the survey data base which would be matched to the strata defined for the study's population model. Engineers may belong to many societies, and an affiliation with any one of these groups does not always define a practitioner's outstanding area of specialization. Furthermore, some participating societies are cross-disciplinary, including NSPE, ASEE, and SWE itself. Instead, an item from the survey form was used to classify the respondents: "Which of the following TECHNICAL specialties best describes you as an engineer?" Twenty-two choices were provided plus an open-ended option for others or mixed specialties (statistics on this more detailed version of the technical specialties are provided in Part II). The reponses provided by those who used the open-ended option were reviewed individually, taking into consideration additional information provided by the survey data on their academic degrees and the society where they had been originally sampled; the final group of respondents coded in this twenty-third miscellaneous category was restricted to specialists in fire protection, pulp and paper, textiles, safety, a small number of rare specialties including economics and library science, and a few respondents with pure mixed specialties which could not be resolved in favor of any one particular field. All of these specialization categories are precisely comparable to the statistics on engineering enrollments and degrees maintained for the United States since 1967 by the Engineering Workforce Commission.

tion with the pilot project, with two follow-up mailings SWE's own members would reach the very high response level of 80 percent. Their actual response rate was not this high although it was still exceptionally good at 68.9 percent. For more information, see the Appendix.

As it turns out, the actual effect of the response shortfall is relatively minor. It reduces the overall precision of the survey slightly, but there is still more than enough data to support the types of broad, convincing findings that the study is designed to produce. Moreover, Exhibit 2 shows that most of the impact of the shortfall was absorbed by the two largest specialty strata, where such losses can most easily be tolerated.

Weighting the Gender-and-Specialty Strata

Obviously, the sampling approach overrepresents some kinds of people (for example, women aerospace engineers) and underrepresents others (such as male electricals). Weights were used to restore the proper balance of the different gender-and-specialty strata. Exhibit 3 lists these weights and shows how they are applied to adjust the data.

For the purposes of weighting, the respondents' technical specialties were determined (see the sidebar) and then grouped into the seven broader classes used to form the survey strata. In all seven of these clusters, a majority of the respondents had been originally sampled from appropriate societies; the main effect of the use of the item on technical specialties was to resolve the fields of those sampled from cross-disciplinary societies like SWE.

The final weights are based on a comparison of the distribution of women and men among these specialty assignments in the survey's actual data base with the distribution that would be expected with a pure random sample (for further details, see the comments on Exhibit 3). In the weighted tabulations

3. WEIGHTING THE SURVEY DATA

Values for each original case are multiplied by a weight to produce final population estimates

Group	Unweighted Sample			Weights		Weighted Sample		
	Total	Men	Women	Men	Women	Men	Women	Total
All Engineers	1,722[1]	908	814	N/App	N/App	1,609	134	1,743
By Specialty:[2]								
Aerospace	102	67	35	1.50746	0.08571	101	3	104
Chemical/Petroleum	153	63	90	0.93651	0.12222	59	11	70
Civil/Environmental	328	190	138	1.27368	0.10145	242	14	256
Electrical/Computer	328	137	191	3.90511	0.24607	535	47	582
Industrial[3]	284	144	140	1.20833	0.16429	174	23	197
Mechanical	245	139	106	2.14388	0.14151	298	15	313
All Others[3]	282	168	114	1.19048	0.18421	200	21	221

[1] This total does not count 11 cases that did not supply data on gender and 10 other cases that did not supply data on technical specialties; these were assigned weights of zero; they drop out of weighted computations.
[2] Specialty determined by an item in the survey form. See detail sidebars.
[3] Engineering management and manufacturing engineering are treated as part of industrial engineering. "All Others" include agricultural, architectural, biomedical, ceramic, general, nuclear, and systems engineering, engineering science, marine engineering and naval architecture, materials science and metallurgy, mining/minerals and geological engineering, and a miscellaneous group of additional "other" specialties.

How the weights were computed: the distribution of cases in the weighted sample was determined by dividing the overall sample yield of 1,743 unweighted cases by the population total of 1,500,000 engineers. The resulting multiplier of .001162 was then applied to each gender-and-specialty cell of the population model in Exhibit 1 to compute what the weighted sample values should be. To illustrate, the 87,000 men aerospace engineers counted for the population model were multiplied by .001162 to derive the number (101) of men aerospace engineers in the weighted sample figures in Exhibit 3. The use of the figure of 1,743 for this purpose is arbitrary; sample data could as easily be weighted up to (i.e., be the same as) the population totals. The smaller number was used to provide a constant reminder that findings are based on a sample (any weighted result can be divided by the .001162 multiplier to yield estimates of actual numbers of engineers, assuming the conservative population estimate of 1,500,000 practitioners is acceptable). The strata weights are simply the set of additional multipliers needed to change the actual number of usable cases to the desired weighted sample values, and were derived by dividing the latter by the former for each combination of gender and specialty. Actual weights were computed and used to seven decimal places (only five are shown in the exhibit), to minimize rounding errors.

presented in this report, the number of cases for women is small because their share of the overall engineering workforce, while on the rise, is still small; users of the survey data need to bear in mind, however, that the actual number of cases used to derive statistics on women is considerably larger (and that the weighted data exaggerate the number of men in the study). To help keep these distinctions clear, weighted data are presented with both unweighted and weighted numbers of cases. In some instances, when statistics are presented that are based on single gender-and-specialty strata, there is no need to weight the data.

Throughout the study, the main effect of weighting is to allow the men's statistics in SWE's survey to exert more influence on data for the entire engineering population, since women still constitute less than 10 percent of the profession. The weights change the contribution of any given case to a statistic, from that of a single individual to that of some decimal number of people; for example, in the weighted tabulations, each male electrical engineer in the unweighted data counts for nearly four people, while each woman electrical engineer counts only for about a quarter of a person.

A Note on Statistical Significance and Confidence Levels

It is customary in survey reports to provide readers with guidance on the precision of statistical estimates. Applied to proportions and percentages, common measures in these studies, the worst-case situation involves

estimates at the midpoint of all possibilities, that is, of 50 percent. A criteria for precision is required; this study uses 95 percent confidence intervals, that is, readers can assume that estimates are supposed to fall within a given range of variability at least 95 percent of the time. The venerable Clopper-Pearson charts for confidence coefficients (see "The Use of Confidence or Fiducial Limits Illustrated in the Case of the Binomial," *Biometrika,* Vol. 26, 1934, pp. 404-413) show that for overall comparisons between the women and men in this study where the number of supporting cases for each gender is around 800-900, estimates of 50% for either sex are likely to be accurate to within plus or minus three percent; estimates closer to the extremes of the possible results, such as proportions of 10 or 90 percent, will be a little more precise.

Many of the comparisons in the study are based on smaller numbers of cases. An example which will be encountered frequently in this study involves comparisons between women and men in specific matched age groups—those aged 30-39, 40-49, etc. These groups average 215 cases apiece, although the range runs from 48 for women engineers over 50 years old to 377 for women in the 30-39 age category. Precise computations vary according to the specific situation, but in general the worst-case statistic of 50 percent for one of these age-and-gender groups will be accurate to within plus or minus seven percent.

Significance and other indicators of trustworthiness: The fact that a statistic doesn't meet significance criteria does not necessarily mean that it's wrong. It just means one can't be very sure that it's right. Measures of statistical significance help provide guidance in deciding whether to have a lot of, moderate, limited, or no trust in a set of numbers. Survey users sometimes lean too heavily on these tests; unfortunately they address only one of many different kinds of threats to the validity of survey research (there is much literature on this subject–see the work of Donald Campbell). For example, sampling and response biases are at least as important as considerations of statistical significance in drawing conclusions from the data in this survey.

In practical terms, these observations suggest the following guidance. First, one should not make much of minor differences in the data. Second, when statistics appear for groups like age categories, consistent patterns from one class of people to the next—for example, steady increases in a proportion as successively older groups of people are inspected—reinforce the sense that a finding is trustworthy. Third, when findings are suggestive but simple statistical methods cannot yield results that one can trust, more sophisticated approaches may help (the common use of regression models to deal with complex multivariate problems in studies with small numbers of cases is an example).

The rest of this report deals with the substance of the study.

Basic Demographic Characteristics of Engineers

Gender. In terms of raw data, the survey includes data from 821 women and 911 men; 11 cases did not report their gender. The values are determined by the stratification assumptions of the study, which force the share of women in the weighted data to be 7.7 percent, in line with their reported shares in national demographic estimates compiled by federal agencies (new data since the survey was designed show that the actual share has now risen to 8.2 percent). As noted elsewhere in this report, the women's share of each new group of current graduates is much higher.

Too many "Native Americans": The share in SWE's sample of members of Indian tribes, Aleutian Islanders, and other people of indigenous North American ancestry is exaggerated by the tendency of a few other respondents to claim that they, too, are "Native Americans." The actual share is probably closer to 0.2 percent.

Ethnicity. On a weighted basis, 4.1 percent of the engineers in SWE's study are members of minority groups underrepresented in the profession—1.3 percent African American, 2.1 percent Hispanic, and 0.6 percent Native American (here as elsewhere, the components of percentages will not necessarily add up to their exact totals, due to rounding effects). National demographic data for engineers yield slightly higher minority estimates which have long been regarded with suspicion by the Engineering Workforce Commission, because to attain these higher figures the profession would need to include substantially more minority engineers than have actually been graduated from engineering schools. Improving minority representation is a major goal of the profession, and the minority

share of engineering degrees has been increasing slowly but consistently for many years.

Another 5.7 percent of the weighted sample of engineers are members of a minority group that is not underrepresented in the profession, although it is subject to discrimination: Asian Americans (see Paul Wong and Richard Nagasawa, "Asian American Scientists and Engineers: Is There a Glass Ceiling for Career Advancement," *Chinese American Forum,* 6:3, January 1991, pp. 3-6). If those who elected to classify themselves as "other" in their ethnic makeup are added to this group—this group consisted principally of Arabs, Iranians, and East Indians—the share rises slightly, to 6.3 percent. The remaining 89.6 percent of the weighted sample consists of white Caucasians or other non-Hispanics of European origins.

Disability. This is the first national survey of engineers to report on this characteristic, which is now receiving a great deal of attention as a result of the recent passage of the Americans with Disabilities Act. In SWE's survey, 1.9 percent of those in the sample (whether weighted or not) report having disabilities, a plausible minimal share that is consistent with lower estimates reported elsewhere. Note that there is a well-recognized propensity for persons with disabilities to be reluctant to identify themselves.

Types of Disabilities: eight engineers cited physical, orthopedic, or other mobility-related impairments: major back problems, several problems with limbs including a user of an artificial leg, a person with serious problems resulting from a skull fracture, and an engineer who reports that a hand tremor interferes with drafting ability. Seven more cases report impairments related to medical problems: a diabetic, an epileptic, an engineer who is partially paralyzed as a result of a stroke, a polio survivor, and several persons who are impaired as a result of heart disease or cancer.

The survey also turns up people with other commonly recognized types of disabilities: four deaf respondents and another engineer who is hearing-impaired, four vision-impaired engineers including one who is totally blind, two people with speech impairments, and a group of others including a person with chronic fatigue syndrome and an engineer who has been diagnosed as manic depressive.

Age. This is a crucial variable; comparisons between women and men engineers must be controlled to ensure that effects of being a woman are not confused with those of being young. Accordingly, detailed results are provided in Exhibit 4. Both the unweighted and the weighted data are of interest—the former because they indicate which age-and-gender comparisons can be carried out reliably, the latter because they measure the actual extent of age differences between women and men in the profession. Based on the weighted SWE data, on the average this is about nine years (the mean age of the men engineers is 42.7, while that of the women is 33.9).

It was suspected that a sample of society members might tend to underrepresent younger engineers, and comparisons with other sources of data on age reinforce the sense that some bias of this kind may be present (see Exhibit 5). The groups used in this comparison are not ideal. The federal data are for the age of those with four or more years of college education, whether or not they are still active in their professions. The data from the Engineering Workforce Commission's annual compensation surveys are at least specific to working engineers but are not based on a random sample. The best source for such comparisons would be the 1990 Census; unfortunately, occupation-specific age data from this source are still yet to be released. A mild bias against younger engineers and in favor of older engineers is probably present, but it does not seem large enough to lead to any major distortions of the survey results.

Geographic Location. The survey respondents were asked to provide ZIP codes for the location of their residences and work sites. These data were grouped into ten broad regions plus an eleventh code for territorial locations to handle three cases from Puerto Rico. The ten regions follow postal service leading ZIP digit conventions except for codes in the "07000-08999" series, which were adjusted to move New Jersey into a "Central Atlantic" group along with New York, Pennsylvania and Delaware.

There are no significant differences among SWE's respondents in the geographic locations of their residences and those for their work, or between women and men for the residence codes (see Exhibit 6).

4. UNWEIGHTED AND WEIGHTED AGE DISTRIBUTIONS, BY GENDER[1]

Age	Unweighted Sample			Weighted Sample		
	Total	Men	Women	Total	Men	Women
All Cases	1,720	903	817	1,725	1,592	133
22-24	109	30	79	70	57	13
25-29	307	108	199	235	202	33
30-34	342	132	210	259	226	33
35-39	303	136	167	260	232	28
40-44	199	125	74	227	215	12
45-49	156	116	40	224	217	7
50-54	92	67	25	122	118	4
55-59	87	80	7	140	139	1
60-64	65	56	9	92	91	1
65-69	36	33	3	58	58	-
70+	24	20	4	38	37	1

[1] Unweighted data do not include 5 cases not responding on gender, 12 not responding for age, and 6 cases not responding on either item. Weighted data do not include 18 cases not responding on age.

Formation of comparable age groups: in the discussion of statistical significance, it is noted that if the men and women in this study are grouped into ten-year age classes (those less than 30, 30-39, 40-49, and 50 years or more), the resulting unweighted groups average 215 cases in size and range from 48 women over 50 years of age to 377 women aged 30-39. The size of all eight of these groups can be computed from the data in this exhibit. These age-by-gender groups will be frequently used in Part II of this report to examine gender differences among engineers while allowing for effects of the greater age and longer experience of many of the men.

5. COMPARISON OF AGE DISTRIBUTIONS: WEIGHTED SWE DATA, FEDERAL ESTIMATES FOR THOSE WITH FOUR OR MORE YEARS OF COLLEGE, AND DATA FROM EWC SALARY SURVEYS[1]

SWE's data is probably mildly biased against younger engineers

Age Groups	Weighted SWE Data	Federal Data for 4+ Years of College	Age Data from the 1992 EWC Salary Survey
Less than 30	18%	21%	25%
30-39	30	31	35
40-49	26	22	24
50 or more	26	26	16
Total	100%	100%	100%

[1] SWE data from Exhibit 4. Federal data from the *Digest of Educational Statistics, 1989,* U.S. Department of Education, reproduced in Betty Vetter, ed., *Professional Women and Minorities,* 10th edition (June, 1992), Commission on Professionals in Science and Technology, Washington, D.C., pp. 105. EWC Salary data from *Engineers' Salaries: Special Industry Report 1992,* Engineering Workforce Commission of the American Association of Engineering Societies, Washington, D.C., Page 17.

6. GEOGRAPHIC DISTRIBUTION OF ENGINEERS IN SWE'S STUDY
(WEIGHTED DATA ONLY)[1]

Roughly, the darker the shade, the higher the concentration of engineers.

	Men	Women
New England	6%	8%
Central Atlantic	14	14
South Atlantic	13	8
Deep South	8	6
East Central	12	9
Northwest Central	5	5
West Central	7	7
Southwest	12	10
Mountain	6	8
Pacific	17	25[2]

[1] Unweighted number of cases, 907 men, 815 women. Weighted numbers are 1,604 and 133, respectively. Six weighted cases did not respond on location.

[2] Probable effect of response bias: SWE is especially strong in California and its membership provides most of the women's data in the study. Results for women are consistent with the earlier SWE *Profiles*.

Marital Status, Children, and Child Care. Exhibit 7 contains data from a series of items on family status. The men are more likely to be currently married than are the women (81 percent to 61 percent, based on the weighted data). If married, male engineers are less likely than women to have a working spouse, and those working spouses are less likely to work full time. Among married women engineers, the odds are better than 50-50 that their spouse is another engineer.

7. MARRIAGE AND FAMILY: MARITAL STATUS
(WEIGHTED DATA ONLY)

Item	Total	Men	Women
Marital Status:			
Currently Married	80%	81%	61%
Currently Unmarried	20	19	39
Total	100%	100%	100%
No. Cases (Unweighted)	1,727	905	816
No. Cases (Weighted)	1,728	1,595	133
No Data, Marital Status (Weighted)	15	14	1
Total Cases (Weighted)	1,743	1,609	134
If Married: Working Spouse			
Yes	63%	62%	91%
No	37	38	9
Total	100%	100%	100%
No. Cases (Unweighted)	1,238	734	499
No. Cases (Weighted)	1,375	1,294	81
Not Married or No Data (Weighted)	368	315	53
Total Cases (Weighted)	1,743	1,609	134
If Spouse is Working: Full or Part Time			
Full Time	71%	69%	97%
Part Time	29	31	3
Total	100%	100%	100%
No. Cases (Unweighted)	913	450	460
No. Cases (Weighted)	870	796	74
No Data or Not Married (Weighted)	368	315	53
Spouse Not Working (Weighted)	505	498	7
Total Cases (Weighted)	1,743	1,609	134
If Married: Is Spouse Also an Engineer			
Yes	9%	6%	56%
No	91	94	44
Total	100%	100%	100%
No. Cases (Unweighted)	1,236	733	498
No. Cases (Weighted)	1,374	1,293	81
Not Married or No Data (Weighted)	369	316	53
Total Cases (Weighted)	1,743	1,609	134

Exhibit 8 continues with these family issues. Men engineers are more likely than women engineers to have one or more children in their households (49 versus 31 percent), and among those with such children, the men have slightly larger families (2.00 compared to 1.77 children). Such differences are predictable, if only because male engineers tend to be older than the women; many other differences between the two genders may also reinforce such a tendency, such as the fact that men's spouses include a substantial number of full-time homemakers.

8. MARRIAGE AND FAMILY: CHILDREN AND DAY CARE
(WEIGHTED DATA ONLY)

Item	Total	Men	Women
Children in Household:			
None	53%	51%	69%
One or More	47	49	31
Total	100%	100%	100%
Average No. Children, Overall	0.94	0.96	0.54
Average No., If Any	1.99	2.00	1.77
No. Cases (Unweighted)	1,697	888	803
No. Cases (Weighted)	1,701	1,570	131
Missing Data, Any Item (Weighted)	42	39	1
Total Cases (Weighted)	1,743	1,609	134
If Children in Household: Use of Child Care			
Yes	30%	28%	68%
No	70	72	32
Total	100%	100%	100%
No. Cases (Unweighted)	682	429	252
No. Cases (Weighted)	802	761	41
No Children in Household (Weighted)	899	808	91
Missing Data, Any Item (Weighted)	42	40	2
Total Cases (Weighted)	1,743	1,609	134
If Child Care Used: What Type			
Provided in Own Home	33%	34%	29%
Provided in Another Private Home	29	29	29
Provided in Day Care Center[1]	41	40	46
Total[2]	103%	103%	104%
No. Cases (Unweighted)	289	116	173
No. Cases (Weighted)	242	214	28
Don't Use Care (Weighted)	560	547	13
No Children (Weighted)	899	808	91
Missing Data, Any Item (Weighted)	42	40	2
Total Cases (Weighted)	1,743	1,609	134

[1] "Day care centers" include private kindergartens/preschools but do not include "schools" otherwise unspecified, which are assumed to refer to regular school systems. One "other" approach was recorded for a woman who works part time at home; this case drops out of the weighted data.

[2] Percentages total over 100% because more than one type of care may be cited.

Among those with children in the household, there are sharp differences between men and women engineers in the use of day care services, which is reported by only 28 percent of men but by 68 percent of women. Some probable reasons why fewer of the men engineers' households need day care include the fact that on the average the men are older, so their children are also likely to be older; the men are less likely to have working spouses; and those spouses who do work are less likely to be working fulltime.

The type of day care used does not differ significantly between the two genders. Organized day care centers are the most commonly used sources of help, followed by care provided in the respondents' own homes and care in other private homes.

Education. This survey obtains very detailed information on degrees earned by the respondents. Up to five degrees were recorded (only two respondents had this many, if associate or other two-year awards are ignored). School names were recorded, and can be linked with selectivity data or other institutional measures; this will permit an analysis of the effect of attending prestigious schools on engineering careers (this has not been attempted for this report but is planned for the near future).

The resulting data are summarized in Exhibit 9. The level of academic achievement of the people in this study is remarkable. In some cases ambiguities in responses meant that even though it could be determined that a respondent had at least one degree, the total number of awards remained unknown; if all these uncertain cases are ignored, 1,712 of the unweighted survey respondents earned a total of 2,708 degrees (not counting associate or other two-year awards). When the data are weighted, this estimate increases to 2,784 awards. Many respondents have more than one master's degree. The reason that the average total number of degrees earned is not exactly 1.00 plus the average number of higher awards (master's and Ph.D degrees) is that some respondents have more than one bachelor's degree.

There are few significant differences between men and women engineers in their education. Slightly over one percent of the weighted sample lack bachelor's degrees; these non-degreed engineers tend to be older, averaging 48 years of age. Virtually all are men (there is one woman without a degree in the raw data; when weighted, she drops out of these statistics).

A little over six percent of the respondents have no engineering degree. Some of these cases include people with M.S. and doctorate degrees. Typically these are persons trained in closely allied fields such as math, physics, chemistry, or computer science.

Eighty-nine percent of the weighted cases possess bachelor's degrees in engineering. Another two percent do not have B.S. engineering degrees but do have another B.S. plus an advanced degree in engineering. This proportion rises to six percent for women engineers, making up for a slight tendency for the women to be less likely than men to have undergraduate engineering degrees. The remaining cases are respondents whose undergraduate degrees could not be determined but who have advanced degrees.

Forty-four percent of the weighted cases have advanced degrees. Overall, this proportion drops for women, but this is an artifact of age; if one examines degree production for those under 40 years old, as is shown in the exhibit, it is clear that among younger engineers women are *more* likely than men to have earned an advanced degree.

Thirty-seven percent of these engineers have science or engineering master's degrees. Only small numbers of people are involved, but women are a little more likely than men to cross over into engineering after first obtaining a science bachelor's degree. Another seven percent have MBA's or equivalent master's degrees awarded by schools of business administra-

9. EDUCATIONAL ATTAINMENTS OF ENGINEERS (WEIGHTED DATA)[1]

I. Number of All Degrees Earned (Exclusive of Associates)	Total	Men	Women
Total	2,784	2,579	205
Average Number Earned	1.63	1.64	1.54
Number of Advanced Degrees Earned	1,033	969	64
Average Number Earned	.60	.61	.48
II: Details: B.S. Degrees or Less			
No Degree	0.7 %	0.8 %	-
Associate Degree Only	0.6	0.6	-
Subtotal: No Bachelor's or Higher	1.3	1.4	-
Non-Engineering B.S. and No Engineering Degree of Any Kind	6.4	6.2	9.0 %
Non-Engineering B.S., No BSE, But Has Advanced Engineering Degree	2.3	2.0	6.0
B.S. in Engineering	88.7	89.0	85.0
No B.S. or B.S. unknown, but M.S. or Higher	1.3	1.4	-
Subtotal: B.S. or Higher	98.7	98.6	100.0
III: Details: Advanced Degrees			
B.S., but No Advanced Degree	54.6 %	54.0 %	61.7 %
Any Advanced Degree	44.1	44.6	38.3
Control: Age Less Than 40	17.6	16.8	27.1
Control: Age 40 or More	25.7	26.9	12.0
Any M.S. Except MBA's	37.2	37.7	31.6
Engineering M.S.	31.8	32.3	26.3
Other M.S. Degrees (Except MBA's)	6.3	6.3	6.0
MBA's	6.9	6.8	8.3
Any Ph.D	13.7	14.3	6.0
Engineering Ph.D	10.5	11.0	4.5
Other Ph.D	3.2	3.3	1.5
Total Cases (Unweighted)	1,715	898	817
Total Cases (Weighted)	1,721	1,588	133
Degree Status Unknown (Weighted)	22	21	1
Total (Weighted)	1,743	1,609	134

[1] Percentage components will not necessarily sum to exact totals due to rounding, because some respondents have two B.S. or two M.S. degrees, and because use of added items like age may change the number of applicable cases.

Handling data on academic degrees: bachelor of engineering technology degrees were treated as regular engineering degrees, a decision which may be greeted with skepticism by some readers; however, holders of such degrees seemed as likely as others to earn advanced engineering awards. Where degrees were unspecified (as in the simple responses "B.S." or "M.S." with no further details), they were treated as non-engineering awards, with one exception: unspecified Ph.D's were assumed to be engineering degrees if all other previous awards were also engineering degrees. J.D. (law) degrees were coded as professional awards, that is, at the master's level. M.D. degrees were equated with other doctorates. The term "MBA" includes any master's degree awarded by a school of business administration; on the other hand, master's degrees in engineering management were treated as engineering awards, not as MBA's. In counting the numbers of degrees, associate and other awards at the two-year level were ignored.

tion. Fourteen percent have earned doctorates—about twice the share reported in the past. Holders of Ph.D degrees in engineering are probably especially likely to join societies, which helps to explain this result, but there have also been substantial increases in the production of these degrees during the last ten years. Overall, the number of engineering Ph.D's awarded in the U.S. every year has more than doubled, and if only doctoral degrees given to U.S. citizens and permanent residents are counted, the increase is still a very healthy 66.9 percent, suggesting that at least two thirds of the growth indicated by SWE's data on the proportion of engineers with Ph.D's may be real (see Table 5, "Degrees in Engineering, by Level and Type of Student, 1982-1992," in *Engineering and Technology Degrees 1992,* Engineering Workforce Commission of the American Association of Engineering Societies, Washington, D.C., 1992, page xiv).

This concludes the introduction to SWE's survey. Part II of this report takes a look at the the professional and career histories of these engineers.

PART II

GENDER DIFFERENCES IN ENGINEERING

This part of the study looks at the employment experience and career prospects of engineers, with particular attention to distinctions between women and men in the profession. In these analyses, the respondents are often divided into matched age groups. This helps clarify distinctions among those who are beginning their careers, those in the middle ranges of experience, and those who have been practicing their profession for many years (but see the cautionary notes below left). This separation will also facilitate fairer comparisons between women and men, since women engineers tend to be younger.

In some of the other analyses in this section, SWE's respondents are divided along the lines of the broad technical specialty groups reviewed in Part I (e.g., aerospace, chemical and petroleum, etc.; see Exhibits 2 and 3). In some cases, specific combinations of gender and specialty groups are examined in isolation; as was noted in Part I, there is no need to deal with the added complications of weighted data in those tabulations.

Employment and Unemployment

Detailed Specialties. Exhibit 10 breaks down the technical specialties discussed in Part I into all 23 of the specific disciplinary groups recorded for this survey. The distribution of the data is predetermined by the sampling strata conventions used for SWE's study; like the results for the numbers of women and men engineers, these are not "findings," but the data do serve to report on details of the division of labor in the profession, based both on the survey results and on the federal statistics which were used to weight the numbers.

The largest disciplines—electrical and electronic engineering, mechanical engineering, and civil engineering—account for 27, 18, and 12 percent, respectively, of all these engineers, or more than half. If computer engineering is added to the group of EE's (and it is reasonable to do so, because the distinction between the two fields can be somewhat murky and is not consistently applied in either engineering education or practice), then the combined electrical/computer category increases to encompass fully a third of the profession.

Women are not evenly distributed among the specialties. They are most likely to be found in chemical and environmental engineering, and less likely to be aerospace or civil engineers. In general, these statistics are consistent with data on engineering degree production maintained by the Engineering Workforce Commission since 1967.

Motivations to Become Engineers. Why do people become interested in engineering? This question was asked of the respondents, who were provided with a list of ten common motives for interest in engineering; they could also use an open-ended option to add in any other reason they wished to cite. In the discussion that follows of these results, all of the quoted material was taken from these open-ended explanations provided by the people who participated in the survey. The survey participants were invited to give both "best" or predominant reasons and "other important" reasons. In addition, these responses were combined into a third group of "all important" motives, which added the "best" reason selected by a respon-

A cautionary note about the interpretation of cross-sectional and longitudinal data: looking across matched age groups in SWE's survey may suggest what happens over the course of an engineering career. But the findings cannot be conclusive, for such comparisons among age groups are *cross-sectional* in their nature: they contrast the experience of different generations. This is not the same as actual *longitudinal* studies of specific individuals over time. Cross-sectional comparisons are suggestive of the results that a longitudinal study can provide, but they are not conclusive because each new generation of people passes through different eras and waves of influence. A good illustration is provided by the salary data discussed later in this report: as one compares older women and men engineers with younger ones, the gap in compensation gets bigger and bigger. While this is an accurate reflection of how things have worked out for today's population of engineers, only time will tell if the same finding will also apply thirty years from now, when those who are now beginning their careers reach middle age.

10. TECHNICAL SPECIALTIES OF ENGINEERS (WEIGHTED DATA)

Technical Specialty	Unweighted Number of Cases	Engineers With This Specialty: Number	Engineers With This Specialty: Percent	Percentage of Women Among Engineers With This Specialty
Aerospace Engineering	102	104	6.0%	3.0%
Agricultural Engineering	15	15	0.9	7.0[1]
Architectural Engineering	8	7	0.4	-[1]
Biomedical Engineering	7	4	0.2	-[1]
Ceramic Engineering	21	15	0.9	13.0[1]
Chemical Engineering	121	52	3.0	17.0
Civil Engineering	238	215	12.3	3.0
Computer Engineering	80	112	6.4	12.0
Electrical/Electronic Engrg.	248	470	27.0	7.0
Engineering Management	96	67	3.8	10.0
Engineering Science	22	16	0.9	12.0[1]
Environmental Engineering	93	41	2.4	17.0
General Engineering	32	31	1.8	3.0[1]
Industrial Engineering	125	84	4.8	13.0
Manufacturing Engineering	66	46	2.6	11.0
Marine Engrg./Naval Arch.	8	7	0.4	14.0[1]
Materials Engrg./Metallurgy	41	25	1.4	16.0[1]
Mechanical Engineering	246	313	18.0	5.0
Mining/Minerals/Geological	24	24	1.4	4.0[1]
Nuclear Engineering	20	19	1.1	5.0[1]
Petroleum Engineering	33	18	1.0	11.0[1]
Systems Engineering	45	19	1.1	32.0[1]
All Other Specialties[2]	42	39	2.2	5.0[1]
Total	1,733[3]	1,743	100.0%	8.0%

[1] Too few cases to be reliable; dashes are less than one half of one percent.
[2] See text of Part I of this report for details on component fields.
[3] Excludes 10 cases which did not respond to the item on technical specialty.

Statistics on technical specialties: unweighted data in the *first* column indicate the reliability of the data for each specialty; for small disciplines (e.g., architectural engineering, biomedical engineering, and marine engineering/naval architecture), SWE's data base contains only a few cases. The weighted numbers are in the *second* column; percentages in the *third* column are based on these numbers, divided by all 1,743 weighted cases, and are our best estimate of each field's actual share of engineering as a whole. Percentages in the *fourth* column are estimates of the number of women in each specialty; for example, the basis for the figure of 3% for the women's share of aerospace engineering is the weighted total of 104 people for this field. In this study, distinctions of only a tenth of one percent are not significant; such differences are retained in the third column, where the basis for calculations is the full set of 1,743 weighted cases and where these differences may at least suggest variations among some of the smallest disciplines. Tenths are depicted in the fourth column for readability's sake (so that columns of percentages look different than the columns of weighted and unweighted numbers of cases), but the actual calculations were rounded off at whole percents, since finer distinctions are not meaningful.

dent to the list of "other important" motives. Exhibit 11 provides results for the "best" and "all important" groups of choices.

The outstanding "reason" to enter the engineering profession is the realization that one possesses the needed skills, cited as the single best explanation of their decision by 37 percent of these engineers and by 48 percent of the women, and cited as an important motivation by 80 percent (and 90 percent of the women).

The second most frequently cited motive is that engineering is seen as a profession that would be fun and interesting. Many respondents used the word "enjoy," as in "enjoy building..." or "enjoy creating..." or "enjoy design..." or "enjoy tinkering with machines." Several respondents said they "wanted to be an inventor"; such responses, which suggest that engineering is what a person has always wanted to do, were included here. Many respondents noted fascination with cars, aircraft, and spacecraft. And some cited a "thirst for knowledge," a "desire to understand how things work." Women were less likely than men to cite these types of "fun and fulfillment" motives as "best" or dominant reasons to become engineers, but this difference between the two genders narrows substantially when the data for "all important reasons" are examined.

Other motivations deserve comment: Encouragement from teachers, mentors and others to consider the profession was a main reason to join engineering for eight percent of the respondents and an important factor for 26 percent of the men and 37 percent of the women. Having relatives, especially parents, either in the profession or encouraging their children to become engineers was a major influence for nine percent, and an important factor for 26 percent of the men and 34 percent of the women. These influences were not always benign. "Father picked field," one respondent said. Another took advantage of the survey questionnaire's provision to allow respondents to add extended comments to any question, and explained how his father forced him into the profession after the parent had failed to become an engineer himself. Having friends or other less influential acquaintances in the profession was a less important motivator, cited as the major factor by only one percent of the respondents and as an "important" influence by only 13 percent.

The simple desire to be "different" is cited as a main motive by only one percent of the respondents but is an "important" motive for 31 percent of the women.

Scholarship support is not seen by many of SWE's respondents as having been crucial for their career decisions. Only one percent cite scholarships as crucial for their career choices and only nine to ten percent mention them as "important."

The third-place "best" motive cited by these respondents to explain their decisions to join the profession is that engineering is seen as a field that offers good career opportunities and job security; if one inspects the results for "all important reasons," this motive becomes the second most frequently cited one. The poor national economy during recent years, characterized by corporate downsizing and major cutbacks in the defense industry, has made engineering seem more vulnerable in these respects, and many of the respondents express disappointment and anger that their original expectations seem less likely to be fulfilled, a theme that will come up again in later parts of this report.

"Challenges" in jobs or in the more general sense are only cited by nine percent of these engineers as a "best" motive but are named by more than half of the respondents as an "important" consideration. The original checklist item was "Looking for challenging job." The final tabulation also adds responses like "Prove I could do it" and "Told no women can be an engineer" to these "challenge" cases.

A similar pattern of response applies to the motive that engineering jobs pay well, a reason that is at least "important" to 56 percent of the men and 66 percent of the women.

11. MOTIVATIONS TO BECOME AN ENGINEER
(WEIGHTED DATA)

Percentage Citing...	"Best Reasons"			"All Important Reasons"		
	Total	Men	Women	Total	Men	Women
Good at math/science; aptitude	37%	36%	48%	80%	79%	90%
Fun, interesting, enjoyable	22	24	8	58	59	44
Career opportunities; security	16	16	14	67	66	71
Challenges of work or for self	9	9	9	52	52	60
Family influences or examples	9	9	8	26	26	34
Encouraged by other people/events	8	8	10	27	26	37
Good salary prospects	6	6	5	57	56	66
Wanted to be different	1	1	4	9	7	31
Friends/mentors in engineering	1	1	2	13	13	13
Scholarship recipient	1	1	1	9	9	10
All other reasons	1	1	1	2	2	3
Total[1]	111%	112%	110%	400%	395%	459%
Average No. of Reasons Cited	1.1	1.1	1.1	4.0	4.0	4.6
Total Cases (Unweighted)[2]	1,720	897	813	1,737	907	819
Total Cases (Weighted)[2]	1,714	1,581	133	1,741	1,607	134
No Data/Don't Know (Weighted)	29	28	1	2	2	-
Total (Weighted)	1,743	1,609	134	1,743	1,609	134

[1] Totals more than 100 percent due to multiple choices.

[2] Some respondents did not choose "best" motives but did pick "important" ones.

Treatment of more complex motives: many respondents could not settle on a single "best" motivation for their choice of a profession, so the open-ended option was also used to record *combinations* of best reasons to become an engineer. Other kinds of motives recorded in the open-ended option often turned out to be sufficiently similar to one of the ten listed choices to be combined with those responses. For example, some respondents mentioned that a reason they became an engineer was "natural ability" or "results of aptitude tests," a type of reply that was equated with the checklist motive of being "good at math and science."

Professional Registration and the P.E. In most countries around the world, engineers are professionally licensed or registered with boards of certification. In the U.S., this function is handled by the individual States and its use is much less widespread, but still substantial numbers of people in the profession are "registered professional engineers," or "P.E.'s."

Engineering students may take a preliminary step to obtaining the P.E. status by taking the Engineering Intern Exam (until recently, the Engineering in Training Exam or EIT). Fifty-four percent of the SWE respondents report taking this test, and 93 percent of those who took the exam say they passed. The proportions for women are slightly lower, at 46 percent and 84 percent, respectively.

Registration is based on examination after a period of initial practice. Asked if they had taken or planned to take the P.E. exam, 53 percent said "Yes"—54 percent of the men, 37 percent of the women. The proportion of engineers in SWE's weighted data base who actually are P.E.'s is lower: 38 percent overall, 40 percent of the men, 14 percent of the women.

Clearly, women seem less likely to either be registered P.E.'s or to seek this status in the first place. Suspecting that this might be a side effect of the differing distributions of the sexes by technical specialty, the proportions with P.E. status were computed within the gender-and-specialty groups used to stratify the sample (hence, unweighted data could be used). The results appear in Exhibit 12 and show that this difference between women and men is present in every one of these broad technical branches of engineering except aerospace, where registration is very rare for everyone. In further checks not depicted here, these computations were repeated for those under 40 years of age and employed by smaller companies or non-manufacturing employers, to see if allowance for such factors might account for gender differences in professional registration; however, men remained more likely than women to be registered P.E.'s in all of these situations.

12. PROFESSIONAL REGISTRATION BY GENDER AND SPECIALTY STRATA

(UNWEIGHTED DATA; numbers of cases in parentheses)

Women are less likely than men to become registered P.E.'s (Professional Engineers)

Specialty	Men	Women
Aerospace Engineering	4% (67)	3% (35)
Chemical/Petroleum Engineering	33% (63)	13% (90)
Civil/Environmental Engineering	82% (190)	51% (138)
Electrical/Electronic/Computer Engineering	28% (137)	6% (191)
Industrial/Management/Manufacturing Engrg.	27% (144)	11% (140)
Mechanical Engineering	50% (139)	19% (106)
All Other Specialties[1]	35% (168)	11% (114)

[1] See Exhibit 3 for these fields. The data in Exhibit 12 do not include 10 cases which did not provide data on specialty and 11 cases which did not respond on gender. Statistics apply only within strata, so weighting is unnecessary.

How many P.E.'s? The actual proportion of all U.S. engineers who are registered is not clear, due to uncertainties introduced by state reciprocity agreements, lack of data on people who are registered in more than one state, or who have been registered but who are no longer in practice, and other ambiguities; most estimates suggest that somewhere between 20 and 40 percent of the profession has attained the P.E. status. The probability of registration varies sharply by specialty and type of employer; for example, civil engineers are much more likely than most to be registered, while electrical engineers are relatively unlikely to be registered unless they have specialties in fields like electrical power systems, where state regulatory agencies or employing utility companies may encourage the practice.

Statistics in SWE's data on the proportion of registered engineers can be expected to be biased on the high side, for the same reason that statistics on the share of those with doctoral degrees are likely to be biased: registered engineers are probably more likely to join societies (indeed, one of the associations participating in this project, the National Society of Professional Engineers, is specifically for P.E.'s, and some other societies, such as the American Academy of Environmental Engineers, not only are limited to P.E.'s but also have higher-level requirements, such as board certification in designated fields of practice).

13. EMPLOYERS AND YEARS EMPLOYED: AVERAGE NUMBERS, BY GENDER AND AGE
(WEIGHTED DATA)

Age Groups	Average Number of Employers			Average Number Years Employed		
	Men	Women	Total	Men	Women	Total
All Ages	3.0	2.3	2.9	19.6	10.2	18.9
Age Under 30	1.6	1.5	1.5	3.7	3.5	3.7
Age 30-39	2.3	2.7	2.4	11.3	10.6	11.2
Age 40-49	3.5	3.3	3.5	21.4	18.3	21.3
Age 50 or More	4.1	4.0	4.1	35.8	28.6	35.7
Total Cases (Unweighted)			1,639			1,705
Total Cases (Weighted)			1,655			1,717
No Data, Any Item (Weighted)[1]			88			26
Total (Weighted)			1,743			1,743

[1] Respondents were asked to report their number of employers "since receiving your first engineering degree," an error in wording which led some people without such degrees to skip it; hence the relatively high number of unknown cases. Stints of consulting or other kinds of self-employment are treated as another employer. "Number of years employed" was limited to full time positions; periods when respondents were in school at least half-time or on medical or other leave were not counted.

Number of Employers and Number of Years Employed. Overall, the men in the weighted SWE data base have had more employers and have worked longer, but this is mostly an effect of the scarcity of older women engineers. Exhibit 13 shows that the difference in number of employers becomes insignificant when one allows for age. Regardless of gender, the typical mature engineer has worked for four different employers.

The same exhibit suggests that the relative loss of working time for women through the principal child-bearing years is small, only about 23 months (derived by comparing interpolated values for the number of years of employment for women and men at age 40). The greater gender difference in the number of years of employment is with older women engineers, who appear to be more likely than men to take early retirement.

Current Employment Status. Exhibit 14 summarizes the current working status of SWE's respondents. Ninety-six percent are employed—97 percent of the men, 92 percent of the women—and almost all are working as engineers or in a "comparable technical or management job where my engineering background is helpful."

Of the remaining four percent of the cases—those not employed in engineering or comparable positions: first, about one and a half percent of the respondents are retired from work, although not from involvement with the profession.

If they have dropped their society memberships, former engineers who are now in other professions along with those who have temporarily retired, unemployed persons, and other kinds of people with engineering backgrounds are not represented in this study. Accordingly, each of the following groups of people is likely to be *larger* than its representation in SWE's data would suggest. This being said, another one and a half percent of the engineers in SWE's survey are employed in non-engineering jobs. The remaining respondents are unemployed, some voluntarily, some not.

Engineers in non-engineering jobs: about a third of these people—roughly half a percent of the whole sample—have changed careers (typically to pure management or other business careers). Another third have also changed fields but it is less clear that this is really what they would most prefer (for example, a few engineers find themselves engaged primarily in a family business), and a third group, also about half a percent, is employed outside engineering but would prefer to return to the profession. A few of these people have high level positions; one respondent notes that "after being laid off in the 1980's from an engineering job and then getting an MBA, I went to work for a large corporation only to discover that the firm stuck me in administration where I've been trapped ever since." Most of those who would prefer engineering jobs, however, simply cannot find suitable employment and are working in lower-level positions; some had just graduated from college at the time of the study in 1992.

14. CURRENT EMPLOYMENT STATUS (WEIGHTED DATA)

Employment Status	Total	Men	Women
Currently Working...	96.3%	96.8%	91.8%
...As an Engineer	68.3	68.4	66.9
...In Comparable Technical/Management Job	26.6	26.9	23.3
...Neither of the Above, but in Preferred Job	0.4	0.4	0.8
...Neither; Mixed Preferences or Unknown	0.6	0.7	–[1]
...Neither; Can't Find Engineering Job	0.4	0.4	0.8
Currently Not Working...	3.7	3.3	8.3
...Retired or "Semi-retired"	1.3	1.4	0.8
...Seeking to Enter/Reenter Work Force[2]	0.3	0.3	–[1]
...Unemployed due to spouse/family move	0.1	NONE	0.8
...Full Time Student	0.3	0.2	1.5
...Caring for Children/Family Duties	0.2	NONE	2.2
...Layoff or Similar Involuntary Job Loss	1.4	1.3	2.2
...All Other Situations or Unknown Situation	0.1	0.1	0.8
Total[3]	100.0%	100.1%	100.1%
Total Cases (Unweighted)	1,736	907	818
Total Cases (Weighted)	1,738	1,605	133
No Data, Employment Status (Weighted)	5	4	1
Total (Weighted)	1,743	1.609	134

[1] Less than one tenth of one percent.
[2] Newly graduated engineers or persons who had been temporarily retired or otherwise out of the work force, but are now looking for work.
[3] Totals may not sum to exactly 100.0 due to rounding errors. Differences of a tenth of a percent aren't significant; percentages are carried to this level of precision in this table only to avoid gross rounding errors in the totals, which would result if many very small results were rounded out to zero.

As noted, SWE's data probably underestimates the proportion of engineers who are currently unemployed. Recent Bureau of Labor Statistics (BLS) data for early 1993 show that unemployment of engineers remains at historically high levels, in the range of 3.5 to 4.0 percent. If BLS conventions are used, about 1.5 percent of the sample was unemployed—1.3 percent for men, 3.0 percent for women. The rate for women rises in part because only they are subjected to unemployment as a result of spousal transfers; none of the men in this study reported this problem. Another reason for not working, child care, is also reported only by women, and accounts for 2.2 percent of those cases.

Organizational Shakeups and Unemployment. Sixty percent of the engineers in this study have gone through at least one major reorganization in the last five years (see Exhibit 15). This is *three times* the rate reported for the U.S. adult population as a whole in 1991.

In the case of reorganizations, the data suggest that about a third of the engineers involved in an average shakeup, if there is such a thing, are likely to be unaffected by it. Others may be favorably affected by a reorganiza-

(text continues on page 30)

Comparing SWE's results with data from other surveys: in SWE's questionnaire, the items on organizational instabilities and general job satisfaction (discussed separately below) are taken from the General Social Survey or "GSS," a repeated general-purpose study of American adults done by the National Opinion Research Center (NORC) at the University of Chicago. This allows comparison of SWE's results with data on the broader adult population obtained in the 1991 wave of the long-term GSS project. All GSS data are in the public domain and can be accessed for the costs of retrieval by the Roper Center for Public Opinion Research at the University of Connecticut.

15. ORGANIZATIONAL SHAKEUPS / CLOSURES ENCOUNTERED BY SWE'S RESPONDENTS, LAST 5 YEARS
(WEIGHTED DATA)

Type of Shakeup	Percentage of Sample That has had This Happen to Them[1]	Percentage of Adult U.S. population Affected[2]
Reorganization	60%	21%
Layoffs	43	(Not Asked)
Organization Closed	6	10
Organization Merged	19	16

[1]An error in the design of the survey form precluded computation of the number of respondents who simply passed up the question; as a result, inapplicable cases cannot be excluded, so the full data base (N = 1,743) is used. The effect biases estimates on the *low* side, so conclusions in the text are reinforced.

[2]Derived from data in the NORC GSS; see note, page 25.

Personally Affected by the Shakeup?	Number Unwtd. Cases	Unaffected	Affected Favorably	Affected Unfavorably	Both
Reorganization	1118	34%	15%	22%	28%
Layoffs	793	37	9	28	26
Organization Closed	106	16	8	43	33
Organization Merged	346	26	16	28	30

16. EMPLOYER SIZE
(WEIGHTED DATA)

Women are more likely to work for large employers

Size of Employing Organization:	Total	Men	Women
Self Employed	3.9%	4.1%	1.6%
Small: Less Than 50 Employees	15.7	16.1	10.6
Medium: 50-499 Employees	26.9	27.0	26.0
Large: 500-5,000 Employees	33.7	33.8	32.5
Very Large: More Than 5,000	19.9	19.1	29.3
Total[1]	100.1%	100.1%	100.0%
Total Cases (Unweighted)	1,629	874	747
Total Cases (Weighted)	1,672	1,549	123
Not Employed or No Data, Employment Status (Wtd)	71	60	11
Total (Weighted)	1,743	1,609	134

[1] Totals may not sum to exactly 100.0, due to rounding errors.

17. EMPLOYER SECTOR (WEIGHTED DATA)[1]

Women are more likely to work for manufacturers, especially the computer hardware and software industry; men are more likely to work for consulting and engineering service firms

Industry Sector:	Total	Men	Women
All Manufacturing Combined	43.1%	42.3%	53.7%
Aerospace	9.1	9.2	8.1
Automotive Industries	1.3	1.2	2.4
Basic Metals	1.9	2.0	0.8
Chemicals, Drugs, and Plastics	2.9	2.7	4.9
Computer Hardware and Software	4.2	3.6	12.2
Electrical Machinery and Equipment	1.7	1.8	0.8
Electronics (Defense, Consumer, Semiconductors)	6.3	6.0	8.9
Fabricated Metal Products	3.3	3.4	1.6
Non-Electric Machinery (may use electric power)	1.5	1.5	1.6
Petroleum Refining and Distribution	2.3	2.3	2.4
Precision Instruments	1.4	1.4	0.8
All Other Manufacturing	7.2	7.0	8.9
All Non-Manufacturing (Except Gov't/Education)	37.7	38.3	30.9
Communication Services and Utilities	2.6	2.4	4.9
Construction	2.4	2.6	0.8
Consulting and Engineering Services	20.4	20.8	14.6
Electric Power Utilities	4.8	4.9	4.1
Insurance (Risk Assessment/Containment)	1.0	1.0	-
Medical Services Including Hospitals	0.6	0.6	0.8
Research and Development Laboratories	3.2	3.2	3.3
Transportation Services	0.7	0.6	0.8
All Other Non-Manufacturing (Except Gov't/Educ)	2.1	2.1	1.6
Government and Education	19.2	19.5	15.4
Federal Government	7.5	7.5	7.3
State and Local Government	3.7	3.8	2.4
University Faculties	8.0	8.2	5.7
Total	100.0%	100.1%	100.0%
Total Cases (Unweighted)	1,633	878	747
Total Cases (Weighted)	1,678	1,555	123
Not Employed or No Data, Employment Status (Wtd)	65	54	11
Total (Weighted)	1,743	1,609	134

[1] Components may not sum to exact totals due to rounding errors.

Handling data on types of workplaces: the questionnaire provided a list of 20 sectoral categories, chosen to provide reasonable matches with the much more detailed SIC (Standard Industrial Classification) codes widely used for federal statistics; in addition, an open-ended field was provided for those who preferred not to use any of these labels. A similar approach has been used for many years in the Engineering Workforce Commission's annual compensation studies. Many respondents made use of the open-ended option, and inspection of these data led to the creation of several additional non-manufacturing categories, including insurance, hospitals, transportation systems, and a miscellaneous class of "other" non-manufacturing employers which included financial organizations, law firms, and professional societies.

18. PROFILES OF ENGINEERS: SELECTED SPECIALTY/SECTOR COMBINATIONS

NOTE: descriptions of real engineering jobs sometimes need to be sufficiently specific that it becomes difficult to protect the anonymity of respondents. To clearly illustrate the work of engineers, while not betraying our assurances of confidentiality for respondents, some details in this exhibit have been edited.

1. AEROSPACE: aerospace engineers working in the aerospace industry

Number of cases: 52 (weighted; unweighted base = 55)
Average age = 38
Average salary = $57,771

Illustrative cases:

1.1 Senior Engineer, age 30, male. Develops and uses computational tools; part of team which developed an improved scramjet flowpath for the design of the advanced aerospace plane. "Shrinking R&D resources..."

1.2 Program Integrator for a major military aircraft, age 40, female. Responsible to U.S. government for acceptance of this product. Senses significant accomplishment in providing a more capable weapon for deployment in Desert Storm.

1.3 Program Manager, age 51, male. Develops advanced avionics concepts; designed processor used in a number of of fighter/bomber aircraft. "The field is shrinking... "

1.4 Technical Manager, age 59, male. Directs an experimental research group; inventor of new/improved experimental methods in aerodynamics, propulsion, and gas dynamics.

2. PETROCHEMICAL: chemical or petroleum engineers working for the petrochemical industry

Number of cases: 25 (weighted; unweighted base = 61)
Average age = 39
Average salary = $70,154

Illustrative cases:

2.1 Supervisor of quality control management systems, age 35,female. Directs two groups of specialists who develop and support in-house software systems used at manufacturing sites.

2.2 Drilling Engineer, age 36, male. Responsible for bidding, contractors, field coordination, sales and engineering. "No major engineering accomplishments other than daily cost savings using engineering thought processes."

2.3 Business Director, age 44, female. Global responsibility for large specialty chemicals division of Fortune 500 company. Managed scale-up and commercial production of several new chemical products. "Professional engineering societies must become more involved with engineering education and university-industry cooperation and integration..."

2.4 Manager, Petroleum Products R&D Division; age 53, male. Directs organization serving petroleum "downstream" plus process development and other activities for parent corporation. Led project team responsible for company's most successful foreign joint venture.

3. ELECTRONICS: electrical, electronic or computer engineers working for computer hardware/software, electronics, or precision instruments manufacturers

Number of cases: 139 (weighted; unweighted base = 105)
Average age = 37
Average salary = $53,759

Illustrative cases:

3.1 Application Engineer, age 36, female. Responsible for customer support, hardware and software debugging. Kept new technology up and running for a key customer, resulting in large sale to new client.

3.2 Design Engineer, age 37, male. Does hardware and software design for company products. Developed wireless vehicle detector, sports statistics program.

3.3 R&D Section Manager, age 47, male. Manages R&D instrumentation projects. Developed new lightwave test instrumentation for fiber optics customers.

3.4 Software Engineering Supervisor, age 51, female. Directs other engineers in the design, development and support of personal computer networking products. Project Manager of product releases. Two patents (one U.S., one Canadian) for a networking product.

4. INDUSTRIALS: industrial engineers working for any manufacturer

Number of cases: 42 (weighted; unweighted base = 67)
Average age = 34
Average salary = $39,598

Illustrative cases:

4.1 Management Engineer/Industrial Engineer, age 25, female. Internal consultant at a hospital for productivity, efficiency & other assistance. Developing significant cost savings for hospital departments; developed cost model for a surgical procedure. (Compare case 12.1)

4.2 Advisory Industrial Engineer, age 33, female. Responsible for the installation of production control software and hardware for a semiconductor manufacturer.

4.3 Industrial Engineer, age 35, male. Responsible for quality control & improvement. Played a major role in solving a multi-million dollar quality problem using statistical analysis; has worked on numerous other quality & process improvement projects.

4.4 Senior Industrial Engineer, age 51, male. Responsible for support to production, acting as a consultant to management, new product introductions.

5. MECHANICALS: mechanical engineers working for any manufacturer

Number of cases: 147 (weighted; unweighted base = 119)
Average age = 39
Average salary = $51,744

Illustrative cases:

5.1 Senior Engineer, age 34, female. Responsible for design of new medical equipment products. Designed new pressure vessel; filed for 3 patents.

5.2 Area Engineering Supervisor, age 41, male. Directs mechanical and electrical engineers and designers responsible for day-to-day engineering projects in an aluminium mill. Solved inherent design problems with structural integrity of aluminium furnaces; set up program to track maintenance and repairs of critical equipment.

5.3 Advisory Engineer, age 48, female. Project group leader in lithography process development, creating standard model to assess fatigue in semiconductors; introduced new lithography technology to manufacturing line.

5.4 Director, Facilities Engineering; age 58, male. Responsible for all maintenance, repair, and capital budget for 158 acre operation with 700,000 square feet under roof and 10,000 types of equipment; has been instrumental in reducing maintenance costs and improving response time.

6. PUBLIC WORKS: civil and environmental engineers who work for state and local governments

Number of cases: 49 (weighted; unweighted base = 53)
Average age = 41
Average salary = $52,320

Illustrative cases:

6.1 Air Quality Engineer II, age 29, female. Recommends issuance or denial of permits to construct and operate equipment or systems which may cause or control air pollution.

6.2 Resident Engineer, age 40, male. Supervises work on a people mover at a major international airport, a $200 million project.

6.3 Transportation Program Manager, age 44, male. Supervises five year construction program; coordinates local government funding agreements. Developed

programs for vegetation management and erosion control which together save 1-2 million dollars each year.

6.4 State Hydrologist, age 50, female. Reports to her Governor. Ph.D in zoology, M.S. in industrial engineering. Has influenced important decisions on the management of water resources in the state.

7. "TRADITIONAL" CONSULTANTS: civil or environmental engineers working for consulting and engineering services firms

Number of cases: 120 (weighted; unweighted base = 160)
Average age = 45
Average salary = $62,087

Illustrative cases:

7.1 Environmental Engineer, age 28, female. Project manager and engineer on a variety of environmental clean-up assignments. Project engineer for a large feasibility study at a major hazardous waste site.

7.2 Principal and co-owner of consulting firm, and manager of branch office with over 20 employees; age 46, male. Came up with innovative designs for large sediment-control facilities and reclamation plans for several large surface mines.

7.3 Senior Traffic Engineer, age 48, male. Responsible for traffic engineering studies, signal design, maintenance of traffic during construction. Served as the traffic engineer for a major expressway project ($1.4 billion, three years). Many other similar assignments.

7.4 Principal Engineer, age 55, male. Specializes in water resources development and management. Has greatly improved the water supply in Southern California by better management of ground water.

8. OTHER CONSULTANTS AND PROVIDERS OF ENGINEERING SERVICES: all engineers *other than civils or environmentals* who work for consulting and engineering services firms

Number of cases: 220 (weighted; unweighted base = 178)
Average age = 47
Average salary = $62,231

Illustrative cases:

8.1 Process Engineer, age 28, female. Duties include analysis, evaluation, support for projects obtained by company. Participating in satellite production, testing, and launch. "...Felt very good about my contributions and very happy with my job."

8.2 Principal System Safety Engineer Manager, age 36, male. Provides engineering support for system safety to the U.S. Department of Defense; deals with propulsion, ordnance, life support, launch activities. Member of the Challenger incident investigation team.

8.3 Safety Consultant and Trainer; age 52, female. Consults with employers to minimize accidental injuries and comply with safety and health regulations. Has helped reduce fatalities, injuries, illnesses and financial losses to small companies while helping them to comply with state and federal regulations. Self-employed for over six years; incorporated; home office, no employees. "I am doing exactly what I want!"

8.4 President and Director, contract testing lab; age 58, male. "Purchased run-down lab and turned it into successful technical business."

9. RESEARCH AND DEVELOPMENT SPECIALISTS: all engineers working for non-manufacturing research and development laboratories

Number of cases: 54 (weighted; unweighted base = 51)
Average age = 40
Average salary = $61,497

Illustrative cases:

9.1 Researcher, age 26, male. Working on high definition television. Designed key components of an HDTV receiver; developed system for trick play operation for compressed digital VCR.

9.2 Research Engineer, age 31, female. Working on robotics and machine design. Came up with unique suspension system for low signature vehicle; patent being filed. Came up with concept for micro heat pump system.

9.3 Principal Member, Technical Staff; age 53, male. Developed several new cutting tool materials and processes for their production. Holds over 40 patents.

9.4 Senior Staff Advisor, age 57, male. Led major research and development project on national security/emergency preparedness that led to National Security Council and Presidential action.

10. FEDERAL EMPLOYEES: engineers of any specialty who work for the U.S. government

Number of cases: 126 (weighted; unweighted base = 123)
Average age = 40
Average salary = $54,229

Illustrative cases:

10.1 Solid Rocket Motor Facilities Project Manager; age 36, male. Responsible for budget, scheduling, and management of construction of facility, design and procurement of aerospace ground equipment, and turnover of the installation to its agency.

10.2 Supervisory General Engineer and Division Chief; age 44, female. Supervises four engineers working in R&D. Prepares budgets, reviews technical output of engineers. "When I graduated in the early '70's, could not get job in aerospace because of the recession and layoffs at the time. I finally obtained employment with the federal government and have been there since. Most of my work experience is in monitoring technical contracts."

10.3 Deputy to the Chief of Staff; age 44, male. A career military officer, he is an expert on peacetime defense engineering in Europe.

10.4 Supervisory General Engineer, age 54, male. A senior manager of nuclear submarine programs for the U.S. Navy. Manages major materials acquistion and testing programs.

11. PROFESSORS: engineers of any specialty who work in academia

Number of cases: 134 (weighted; unweighted base = 104)
Average age = 48
Average salary = $65,803

Illustrative cases:

11.1 Assistant Professor, age 28, male. Research and teaching; "Turned students on to the field."

11.2 Professor of Systems Engineering, age 48, male. A teacher; accomplishments in course development, technical publications.

11.3 Associate Director of a research group; age 55, female. 50 percent research, 45 percent research administration, five percent teaching. Developed risk management approaches for hazardous chemical facilities.

11.4 Associate Dean and Professor of Mining Engineering; age 57, male. Technical accomplishments include new drill & blast design methods, new slope support systems.

12. MANAGERS: all engineers who say that their specialty is "engineering management," no matter where they work

Number of cases: 67 (weighted; unweighted base = 93)
Average age = 49
Average salary = $75,120

Illustrative cases:

12.1 Management Analyst for a hospital; age 23, male. Provides tools (computer programs, forms, teaching) and services for the continued improvement of the departments and staff. "Still learning." (Compare case 4.1)

12.2 Engineering Department Manager, age 29, female. Supervises over 20 engineers, designers and project managers. Delivered $20 million in projects to business in first two years after earlier, successful technical practice. "Currently, higher paying careers for engineers appear to be in engineering management, compared to technical arenas. Over time, this will negatively impact the country's level of technical mastery..."

12.3 Plant Engineer/Facilities Manager, age 49, male. Responsible for: security, grounds, utilities, buildings, maintenance, sanitation, pest control, processing equipment, maintenance, and environmental issues.

12.4 Director of Public Works; age 56, male. In charge of a water and sewer utility. Responsible for engineering, streets and equipment maintenance, facilities maintenance; managed construction of a quarter billion dollar research facility to completion.

Is there really such a thing as an "average shakeup"? It is possible the data derive from mixtures of extremes: mild and catastrophic reorganizations, with little or nothing in between. If so, impressions of the nature of shakeups that are formed from averaged data, as is done here, could be as misleading as the average income of a group composed of nine paupers plus one person making half a million dollars a year. Additional explorations of SWE's data can clarify what these organizational shakeups have been like and which sectors or specialties have been most vulnerable; it is already clear that people in aerospace are experiencing severe shocks, just as they did twenty years ago in the "aerospace recession" of the early 1970's.

tion. When these two groups are combined, this accounts for roughly half of the exposed engineers. The other half do not fare so well. A majority of them experience mixed outcomes: some effects of reorganization are good, some not so good. The rest of the respondents experience only unfavorable kinds of impact, such as losing their jobs.

SWE's weighted data include 125 persons (seven percent of the total) who have been laid off or otherwise involuntarily separated from a job since the beginning of 1990. About two thirds had been doing engineering or comparable technical work at the time of their separations; most of the rest were engineering managers. These respondents were invited to estimate the income lost as a result of being laid off. They reported a moderate average loss of $28,000. Some observers of the profession have sensed that often unemployed engineers are able to find new work fairly quickly; these results from SWE's survey reinforce this view. Some of the engineers in this study were laid off and had *no* losses (such cases were not included in the computation of the average loss data for the group). The aggregated estimated loss for all 125 weighted cases is roughly $3 million; dividing by the population estimate "multiplier" of .001162 (see Exhibit 3), this yields a conservative estimate of direct losses to U.S. community economies in the range of $2.5 billion over roughly two and a half years. This is part, but not all, of the total economic cost of engineering unemployment.

Hours Worked, Company Size, and Sector. For those who are employed, there is no significant difference between the women and men in this study in the amount of time they spend working; weighted results average 45 hours per week.

Exhibit 16 contains data on the size of the organizations that employ these engineers. The rarity of older women engineers probably accounts for their smaller share of those who are self-employed, but it does not explain the sharp increase in the proportion of women working for very large organizations; in general, the smaller the employer, the more likely its engineers are to be men.

Respondents were also classified in over 20 broad industry sectors. Results are provided in Exhibit 17. Traditionally, large manufacturing organizations have been the most important single source of engineering jobs, but the emphasis has now shifted to services. The largest single industry sector for the engineers in SWE's study is the one for consulting and engineering service organizations, which includes traditional architectural and engineering services firms, but also includes environmental services organizations, service contractors to government, and a wide range of specialty service providers. Male engineers are more likely than women to be found in these organizations. Women engineers are more likely than men to work in manufacturing, especially in the computer hardware and software industry.

The higher propensity of women to work for large manufacturing companies may increase their exposure to organizational shakeups, which would help to further explain their higher rates of unemployment.

Careers

Profiles of Women and Men Engineers. Exhibit 18 provides more details about engineering positions, based on grouping the respondents into combinations of employer sector and technical specialty and drawing on the survey data to provide both summary statistics and specific illustrations of the kinds of job titles, responsibilities and accomplishments that some

←***Who hasn't been profiled:*** the 12 groups of engineers formed for the presentation of the data in Exhibit 18 account for roughly two thirds of the weighted cases (a few respondents are counted in more than one group). The remaining third of the sample is at least as deserving of attention, although none is allowed for it here. Among the groups *not* assessed in Exhibit 18 are electrical and electronic engineers who work outside the electronics manufacturing industry (for example, power engineers employed by electric utilities, many of the engineers who work for telecommunications service companies, and "house electricals" who are the main or perhaps only representative of their specialty, perhaps even the only engineer of any kind, in their organization). Another type of missing group consists of those in smaller specialties like agricultural, biomedical, marine and nuclear engineering. In addition, the data base can support similar descriptive reports for additional disciplines, including manufacturing engineering, materials engineering and metallurgy, and systems engineering.

of these people have. The illustrative cases were selected to fairly represent both their sectors and the sample of SWE respondents as a whole.

Within each occupational cluster in Exhibit 18, the illustrative cases are listed in order of the age of respondents; this facilitates speculation about career paths. Given an extract of just 48 of the cases in the study, conclusive findings about this topic are not to be expected in this report, but there are illustrations here of progress inside such career sectors as the large institution, either private or public. Engineers join these organizations early and remain with them for many years; in some cases they have risen to the top. Other respondents have followed different paths, working for smaller organizations or as consultants.

Exhibit 18 is a sample of the kind of details that the survey can generate. As limited as the examples in the exhibit are, they still illustrate the enormous variety, sweep and impact of the work that engineers are doing.

Criteria for Assessing the Performance of Engineers. There are few if any differences between women and men engineers when they are asked to identify the criteria by which their performance is assessed. For both genders and especially for women, skill in project management and technical competence are the overriding concerns. Other criteria, such as personnel management or contributions to sales, are secondary for most of these workers. See Exhibit 19.

Utilization of Engineering Skills. Although engineers often complain that their skills are not utilized very effectively, more than eighty percent of the women and men studied by SWE say that their engineering capabilities are used "reasonably well" in their current jobs (Exhibit 20).

19. MAJOR FACTORS IN ASSESSING PERFORMANCE OF ENGINEERS (WEIGHTED DATA)

Factors	Total	Men	Women
Task/Project Management	37.2%	36.6%	44.3%
Technical Competence	31.9	31.5	36.9
Research and Development	15.8	16.2	10.7
Administrative Duties	9.3	9.7	4.9
Personnel Management	7.4	7.3	9.0
Production	6.8	6.8	6.6
Sales/Promotion	5.7	5.8	4.1
Reliability/Quality Control	5.2	5.0	6.6
Cost Control	4.1	4.2	3.3
Other Factors (mostly bottom-line: "profit")	2.4	2.5	1.6
Total[1]	125.8%	125.6%	128.0%
Total Cases (Unweighted)	1,640	864	740
Total Cases (Weighted)	1,648	1,526	122
No Data or Not Employed (Weighted)	95	83	12
Total (Weighted)	1,743	1,609	134

[1] Exceeds 100 percent because respondents could choose more than one factor.

20. PERCENT OF ENGINEERS WHO RESPOND "YES" TO THE QUESTION "ARE YOUR SKILLS AS AN ENGINEER UTILIZED REASONABLY WELL IN THIS JOB?" BY GENDER AND SPECIALTY STRATA

(WEIGHTED DATA; numbers of cases in parentheses)

Specialty	Men	Women
Aerospace Engineering	80.3% (66)	77.4% (31)
Chemical/Petroleum Engineering	88.3 (60)	86.2 (80)
Civil/Environmental Engineering	88.7 (186)	84.0 (131)
Electrical/Electronic/Computer Engineering	84.1 (132)	83.0 (171)
Industrial/Management/Manufacturing Engrg.	80.3 (132)	77.3 (128)
Mechanical Engineering	80.6 (134)	84.0 (94)
All Other Specialties[1]	86.2 (161)	71.8 (114)

[1] See Exhibits 3 and 10 for more information on these fields. The data in Exhibit 19 do not include 10 cases which did not provide data on specialty and 11 cases which did not respond on gender. Statistics apply only within strata, so weighting is unnecessary.

Those in the broad chemical/petroleum and civil/environmental groups are more likely than those in aerospace or industrial engineering to feel that their skills are being appropriately used. High proportions of men in the group of "other" specialties think their utilization is good; relatively low proportions of women in this group think so.

Differentials in Pay. For a number of years, data from the College Placement Council have shown that the recruitment offers made to graduating women engineers are as good or better than the offers made to men. SWE's data are consistent with that finding. They also indicate that before engineers enter their thirties, men pull ahead in base salary and and keep pulling further ahead for the rest of their careers. See Exhibit 21.

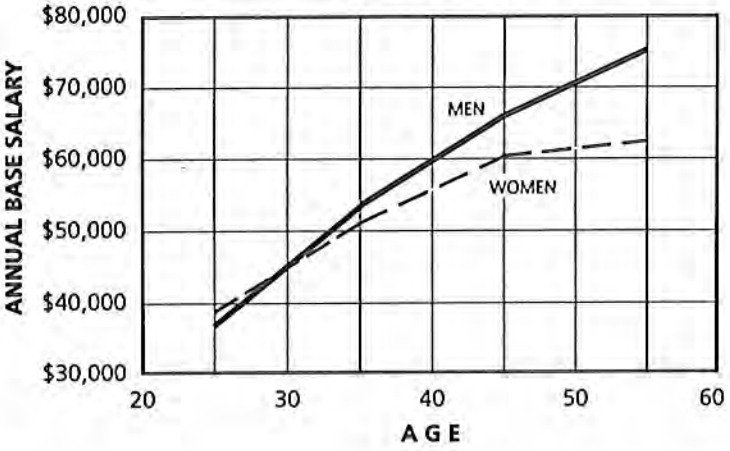
Involvement in Management. 51 percent of the men in this study feel they are part of management; 32 percent of the women do. This difference persists across groups of women and men matched for age or for size of employer, so it is not likely to just be some function of the fact that the average male is older (Exhibit 22).

The same exhibit shows that men have fewer layers of authority between themselves and the top—and that this, too, persists within groups of engineers who are matched on age or other variables. These data are taken from an item in the questionnaire that identifies the number of management levels separating respondents from their CEO's. Overall, women engineers would be expected to be more distanced from top management than men, if only because their age distribution is much younger. Even within groups

Ambiguous Questions: the management items could be ambiguous for at least some respondents. For self-employed people or principals of a business, no management levels are between themselves and a CEO, but this was not identified as a reasonable option. Asking engineers if they "feel" they are in management is too subjective. Clarifications provided by the respondents in their comments helped to resolve some of these problems. Management is an important topic for engineers, and better ways must be created to treat it in surveys.

21. AVERAGE ANNUAL BASE SALARIES OF ENGINEERS, BY AGE

(AS OF FALL, 1992; WEIGHTED DATA)
(Unweighted base N's in parentheses)



Age:	Less than 30	30-39	40-49	50 or More	Total
Men	$37,693 (130)	$52,880 (261)	$66,138 (229)	$75,237 (220)	$59,750 (840)
Women	39,132 (255)	50,721 (321)	60,120 (103)	62,574 (39)	48,555 (718)
Total	37,904 (385)	52,654 (582)	65,896 (332)	75,044 (259)	58,933 (1,558)

22. PARTICIPATION IN MANAGEMENT

(WEIGHTED DATA; unweighted cases inparentheses)

Item	Total	Men	Women
1. Percent who feel they are part of management	50% (1,604)	51% (864)	32% (740)
By Age: Less Than 30	25 (389)	28 (131)	13 (258)
30-39	48 (598)	49 (262)	40 (336)
40-49	55 (338)	55 (234)	51 (104)
50 or More	64 (270)	64 (230)	51 (40)
2. Management levels between you and the CEO	3.11 (1,553)	2.99 (836)	4.58 (717)
By Age: Less Than 30	3.97 (376)	3.69 (126)	5.57 (250)
30-39	3.74 (579)	3.68 (252)	4.27 (327)
40-49	2.85 (326)	2.81 (225)	3.75 (101)
50 or More	2.04 (363)	2.03 (226)	2.68 (137)

that are matched on age, however, men consistently see themselves as less removed from the most senior levels of their organizations than do women.

Among those who manage, women and men are more alike. On the average, they direct the work of 12 other people, seven of whom are other engineers. Women managers have slightly smaller loads but this is a function of their tendency to be relatively young.

Equitable Treatment. Exhibit 23 summarizes from the survey several items about job discrimination. This is a sensitive issue for some engineers, especially at this point in time. Fifty years ago, surveys of women engineers would not have been practical; there were few of them to study, and locating them would have been difficult because organizations like SWE did not yet exist. Fifty years from now, women may make up a large enough share of the engineering profession that there will be no need for complex survey sampling designs in order to collect data on meaningful numbers of them. In the meanwhile, though, the profession is divided between an older generation that entered engineering during the previous era, and a rising tide of young engineers who face different conditions and professional challenges than did those who came of age during between 1940 and 1960.

23. ARE PEOPLE TREATED EQUITABLY? (WEIGHTED DATA)

Item	Total	Men	Women
1. Are men and women treated equally?			
Yes–always equitable	53%	55%	26%
Depends–sometimes equitable, sometimes not	39	38	59
No–consistent inequities	6	5	15
Reverse Discrimination	2	2	-
Total	100%	100%	100%
Cases (Unweighted)	1,580	847	733
2. Are people treated equally regardless of ethnicity, nationality, race, or religion?			
Yes–always equitable	61%	63%	37%
Depends–sometimes equitable, sometimes not	29	27	50
No–consistent inequities	8	8	13%
Reverse discrimination	1%	1%	-
Total[1]	99%	99%	100%
Cases (Unweighted)	1,580	847	733
3. Are you personally aware of instances where women or minorities were overlooked with regard to career opportunities?			
No	78%	81%	39%
Yes–reverse discrimination	1	1	-
Yes–women	17	14	58
Yes–minorities	13	12	28
Total[2]	109%	108%	125%

[1] Does not total exactly 100 percent due to rounding.
[2] Exceeds 100 percent due to multiple choices.

Because of these divisions, SWE's respondents do not agree on issues of discrimination. Abstracted into statistical form, twice as many men as women feel that the sexes are always fairly treated. Three times as many women as men feel that there are consistent inequities. The same pattern occurs when the respondents are asked about their perceptions of other minorities. Over eighty percent of the men say they have no personal awareness of incidents where people have been "overlooked", but 58 percent of the women engineers say they are aware of such incidents with respect to women, and 28 percent are aware of incidents affecting minorities. 65 percent of the non-minority men surveyed by SWE say people are always treated equitably on the job; 44 percent of the minority men say so; 37 percent of the non-minority women agree; 32 percent of the minority women agree.

The respondents' comments on this issue range from bitter accounts of perceived instances of reverse discrimination to harrowing descriptions of sexual harassment at its worst.

Career Obstacles. SWE's survey collected open-ended written information from the respondents on their accomplishments, perceived career obstacles, deficiencies in their education, and other subjects. To illustrate this material, Exhibit 24 summarizes a preliminary review of the responses on career obstacles. Again, a division into the eight gender-and-age groups helps to organize the data. What emerges is a picture of professional people dealing with many common irritants and frustrations of work.

Satisfaction With Work. SWE respondents were invited to rate their satisfaction with 12 various aspects of their current jobs. The resulting scores vary between plus or minus two, with the sign indicating a positive or negative assessment. Exhibit 25 provides these data.

In general, most of the responses in the exhibit are positive, but some are much more positive than others. The first and most general item differs from the rest; it matches a question asked of a national sample of all American adults in 1991 (for more information, see the discussion of organizational shakeups, above). If those responses from a different survey are scored the same way as SWE's, engineers seem to be just a little less likely to be satisfied with their job conditions than most Americans; the overall index value for the weighted SWE data is +1.02, compared to +1.14 for comparable statistics on the general U.S. adult population. Although this can be interpreted to mean that engineers may be a little less satisified with their work than most, it is equally plausible to suggest that they may simply have higher standards and expectations.

Women and men engineers seem to follow different patterns in their assessment of general satisfaction with jobs. Men in their thirties are less "satisfied" than those in their twenties. In their forties, they start becoming more willing to say that they are satisfied, and the level of satisfaction increases again for the oldest men. In contrast, the general satisfaction of women engineers increases steadily during their thirties and forties, but it does not rise as high as that of the men, and satisfaction levels off for the oldest group of women engineers.

The respondents are most satisfied with the content of their jobs and with the personal challenges they have met. They are still fairly approving, overall, of their employers' ability to treat people equitably, and of their salaries and benefits, but the typical levels of satisfaction are not as high as they are for job content and challenges. Women are distinctly less willing than men to express satisfaction with equitable treatment. At the same time,

24. OVERCOMING CAREER OBSTACLES

Initial impressions of open-ended data, as if reporting focus groups

1. Young Engineers

Young women engineers are irritated by attempts to "offload secretarial type work." They want to "obtain equal salary among engineers with equal amounts of experience." Many of these women say they don't have enough time to work on their thesis or prepare for P.E. (Professional Engineer) exams. Some find their jobs less interesting or appropriate than expected: "Work used to be more technical, but since we reorganized and computerized, I'm just doing data entry." "It seems that I spend most of my time worrying about liability and insurance." "I was hired to work in manufacturing, but I was moved to a marketing project that needed more people."

Men under 30 are primarily concerned by the lack of jobs in the early 1990's. Many of these men note that they have a "lack of practical experience since I am a recent graduate." "I have not been able to obtain an entry level position due to stiff competition." One man blames the problem of engineering unemployment on "upper management's unwillingness to look into the future." One man says "minorities are being hired over me. In my experience, blacks and women have been given more chance than white males."

2. Engineers in Their Thirties

Women aged 30 to 39 feel the family-work conflict strongly. "I'm juggling my career with family responsibilities. I want challenging assignments but need to fit them to day care hours." Like men, they are concerned about a lack of available money for engineering projects, and they are beginning to face the choice of technical and management career tracks: "I've reached that awful plateau point in an engineering career where you know you'll only creep along unless you get into management."

Men in their thirties are also concerned about a lack of available money for engineering projects, and they report conflicts with what they percieve as a lack of managerial ethics and long term thinking: "I may have to leave my firm because of principles and values." These engineers are concerned about problems caused by "short term management... We aren't permitted to manage people or maintain equipment with a view to the future." Like the younger women, they are looking for "time from work to take the EIT and PE and other certifications."

3. Engineers in Their Forties

Women engineers aged 40 to 49 are balancing family, business and economic concerns. They are worried about company downsizing. They talk specifically about gender discrimination, and many discuss "the glass ceiling in management." Those who are managers feel a "need to reduce focus on details and current issues, to have time for more conceptual thinking and planning about how things can be accomplished."

Men in their forties are frustrated by their lack of authority and access to "cash for capital investment": resarch and prototype money. One complains about "the trend toward having engineers being responsible but not having clear and absolute authority." Job security and advancement are daily concerns.

4. Older Engineers

Some women engineers over the age of 50 are encountering difficulties with management, particularly in terms of advancement. They see problems of both gender and age. "The upper management in my current company is composed of a bunch of scared old boys hanging on." Another woman defines her major obstacle as "Me! Keeping balance in my life. My engineering education didn't teach me that workaholism is a two-edged sword..."

Men over 50 report age and health concerns as well as trouble keeping current. They are the only group that expresses frustration with government restrictions and regulations. They say it's difficult to "deal and compete, given the regulatory climate in the U.S." They are frustrated by "apathy on the part of the baby boomers" and irritated by upper management, which is "...technically inept, they thrive on it." One man says "my company was acquired and I lost employment again! Second time in four years and fourth time in career." Many older engineers say that their biggest obstacle is "not having proficient computer skills."

5. Beyond Age and Gender

Common concerns of engineers include a lack of time. "I don't have enough time to acccomplish all that I could do. I have to prioritize and give work away, and I don't have time to write or publish."

Several people said that they needed further cultural and/or language training. One planned on "getting updated on new languages to find a new job."

Many engineers, especially aerospace industry specialists and their counterparts in the federal government, are concerned about the Department of Defense's shrinking budget and the decline in aerospace.

25. SATISFACTION WITH WORK, BY SEX AND AGE: OVERALL RESULTS AND COMPONENTS
(WEIGHTED DATA)

(+2 = Very Satisfied, +1 = Satisfied, 0 = Neutral, -1 = Dissatisfied, -2 = Very Dissatisfied; Numbers of Unweighted Cases in Parentheses)

Satisfaction With:	Age Groups	Total	Men	Women
...Work, Overall:	All Ages	+1.02	+1.03	+.95
		(1,612)	(868)	(744)
	Under 30	+.86	+.87	+.84
		(391)	(132)	(259)
	30-39	+.84	+.82	+.98
		(603)	(264)	(339)
	40-49	+1.15	+1.15	+1.05
		(343)	(237)	(106)
	50 or more	+1.23	+1.23	+1.08
		(275)	(235)	(40)
...Job Content:	All Ages	+1.03	+1.04	+.96
		(1,596)	(861)	(735)
	Under 30	+.89	+.90	+.81
		(392)	(132)	(260)
	30-39	+.88	+.87	+.94
		(598)	(265)	(333)
	40-49	+1.16	+1.16	+1.27
		(338)	(234)	(104)
	50 or more	+1.19	+1.19	+1.32
		(268)	(230)	(38)
...Personal Challenge:	All Ages	+1.04	+1.04	+1.01
		(1,592)	(859)	(733)
	Under 30	+.81	+.80	+.85
		(391)	(132)	(259)
	30-39	+.92	+.88	+1.07
		(597)	(265)	(332)
	40-49	+1.14	+1.14	+1.17
		(339)	(235)	(104)
	50 or more	+1.26	+1.26	+1.23
		(275)	(235)	(40)
...Equitable Treatment of People:	All Ages	+.51	+.52	+.34
		(1,571)	(844)	(727)
	Under 30	+.52	+.53	+.45
		(391)	(131)	(260)
	30-39	+.38	+.40	+.27
		(592)	(262)	(330)
	40-49	+.56	+.57	+.32
		(334)	(233)	(101)
	50 or more	+.61	+.62	+.29
		(254)	(218)	(36)
...Salary Compensation:	All Ages	+.47	+.47	+.50
		(1,586)	(859)	(727)
	Under 30	+.37	+.34	+.55
		(390)	(132)	(258)
	30-39	+.37	+.36	+.40
		(597)	(266)	(331)
	40-49	+.43	+.42	+.56
		(334)	(234)	(100)
	50 or more	+.73	+.73	+.84
		(265)	(227)	(38)
...Employee Benefits:	All Ages	+.67	+.67	+.75
		(1,581)	(855)	(726)
	Under 30	+.70	+.68	+.78
		(390)	(131)	(259)
	30-39	+.59	+.58	+.71
		(594)	(265)	(329)
	40-49	+.63	+.62	+.79
		(336)	(235)	(101)
	50 or more	+.82	+.82	+.85
		(261)	(224)	(37)

Satisfaction With:	Age Groups	Total	Men	Women
...Immediate Management:	All Ages	+.61	+.62	+.50
		(1,572)	(851)	(721)
	Under 30	+.69	+.71	+.59
		(391)	(131)	(260)
	30-39	+.43	+.43	+.46
		(591)	(264)	(327)
	40-49	+.71	+.72	+.45
		(332)	(234)	(98)
	50 or more	+.68	+.68	+.39
		(258)	(222)	(36)
...Overall Management:	All Ages	+.16	+.17	+.09
		(1,568)	(847)	(721)
	Under 30	+.10	+.08	+.17
		(391)	(131)	(260)
	30-39	-.05	-.06	+.02
		(591)	(264)	(327)
	40-49	+.23	+.23	+.10
		(332)	(234)	(98)
	50 or more	+.43	+.44	+.14
		(254)	(218)	(36)
...Support Facilities:	All Ages	+.33	+.33	+.32
		(1,572)	(851)	(721)
	Under 30	+.32	+.32	+.33
		(389)	(131)	(258)
	30-39	+.25	+.24	+.33
		(588)	(263)	(325)
	40-49	+.30	+.30	+.26
		(336)	(235)	(101)
	50 or more	+.49	+.49	+.29
		(257)	(222)	(37)
...Training Opportunities:	All Ages	+.29	+.28	+.38
		(1,570)	(847)	(723)
	Under 30	+.47	+.47	+.45
		(388)	(130)	(258)
	30-39	+.22	+.21	+.35
		(593)	(264)	(329)
	40-49	+.17	+.16	+.27
		(333)	(234)	(99)
	50 or more	+.37	+.37	+.50
		(256)	(219)	(37)
...Support for Professional / Technicall Activities:	All Ages	+.31	+.31	+.34
		(1,579)	(854)	(725)
	Under 30	+.35	+.35	+.33
		(390)	(131)	(259)
	30-39	+.18	+.16	+.34
		(593)	(265)	(328)
	40-49	+.30	+.30	+.34
		(336)	(235)	(101)
	50 or more	+.46	+.46	+.40
		(260)	(223)	(37)
...Advancement Opportunities:	All Ages	+.05	+.05	+.10
		(1,571)	(848)	(723)
	Under 30	+.21	+.20	+.23
		(391)	(132)	(259)
	30-39	-.04	-.05	+.05
		(591)	(263)	(328)
	40-49	+.01	+.01	-.04
		(332)	(233)	(99)
	50 or more	+.11	+.11	0.0
		(257)	(220)	(37)

Forming measures of satisfaction: The initial measure of overall satisfaction with one's current work is matched with an item used by the NORC General Social Survey (see notes, above, on the use of comparative data from other surveys on exposure to organizational shakeups). The index value for the NORC data in 1991, the last year the GSS was conducted, is 1.14. NORC's variable offers four choices: "very satisfied" (scored as +2), "moderately satisfied" (+1), "a little dissatisfied" (-1), and "very dissatisfied" (-2). The additional items deal with more specific aspects of engineering jobs. They depart slightly from the NORC format in their response choices, which are "very satisfied" (+2), "satisfied" (+1), "neutral" (scored as zero), "dissatisfied" (-1), and "very dissatisfied" (-2).

they are more satisfied with their salary and benefits than men, even though they are not paid as well. Some engineers are not at all satisfied with their jobs. One simply says "the work I do is boring."

The engineers are mildly positive—"lukewarm" perhaps—in their assessments of employer-provided supports like technical facilities, training opportunities, and support for professional or technical activities.

These engineers are also fairly positive about their immediate supervisors, although the satisfaction of women diminishes over time while that of the men increases. Many of the older men *are* supervisors, of course. The ratings for overall management are much lower. The most experienced engineers are more satisfied than others, but not by very much. An obvious point of departure for additional analysis of these data will be to determine if those who are dissatisfied with their overall managements tend to be clustered with respect to factors like industry sectors, technical specialties, or other key divisions of engineering.

SWE's respondents are more likely to be dissatisfied about their advancement opportunities than any other aspect of their jobs. Those between 30 and 50 years old seem especially concerned.

Overall Satisfaction With Engineering Careers. A final set of data serves to sum up the study (Exhibit 26). Engineers are very satisfied with their educations. There is a consistent tendency for women engineers to be slightly more reserved, but they are still very approving.

The behavior of the data on satisfaction with one's accomplishments is especially interesting. Engineers seem to gain satisfaction over the years with what they do. There are stages or phases of special career tensions, perhaps, for women in their twenties and men in their thirties.

The engineering job market was weak when SWE's survey was being distributed; it is still weak as this is written; it is expected to continue to be weak throughout 1993 and 1994 because of the further employment effects of scheduled cutbacks in U.S. defense programs and other changes in U.S. national priorities. Aware of these facts, engineers are a little gloomy in assessing their current career prospects; they give themselves about the same ratings as they do their supervisors and employers. Eventually, maybe the economy will improve. There are some hopeful signs. One is the increase in levels of effort to create national and global information "highways." Another is signaled by data obtained in this study: the first signs of the application of "engineering thought processes," as one respondent has put it, to what is now the largest economic sector in the U.S., the health care system. Over the long run, the need for engineers is not likely to fade.

Postscript. In some places this report raises as many questions as it resolves. What are the more detailed characteristics of the organizational shakeups these engineers have faced? Which sectors, specialties or societies have high or low shares of engineers who have been exposed to these risks,or who do not feel that their skills are well utilized, or who have exceptionally high or low levels of job and career satisfaction? Which have the smaller or larger gaps between women and men in salaries, involvement in management, and perceptions of discrimination? These kinds of questions need to be given further attention.

26. GENERAL CAREER SATISFACTION FOR ENGINEERS, BY SEX AND AGE
(WEIGHTED DATA)

(+2 = Very Satisfied, +1 = Satisfied, 0 = Neutral, -1 = Dissatisfied, -2 = Very Dissatisfied; Numbers of Unweighted Cases in Parentheses)

Satisfaction With:	Age Groups	Total	Men	Women
...Education	All Ages	+1.27	+1.28	+1.14
		(1,695)	(892)	(803)
	Under 30	+1.26	+1.28	+1.12
		(413)	(137)	(276)
	30-39	+1.17	+1.18	+1.13
		(638)	(266)	(372)
	40-49	+1.30	+1.31	+1.15
		(346)	(237)	(109)
	50 or more	+1.37	+1.37	+1.30
		(298)	(252)	(46)
...Supervisors	All Ages	+.52	+.53	+.46
		(1,641)	(861)	(780)
	Under 30	+.56	+.56	+.55
		(404)	(131)	(273)
	30-39	+.43	+.43	+.41
		(625)	(263)	(362)
	40-49	+.59	+.60	+.36
		(338)	(231)	(107)
	50 or more	+.55	+.55	+.40
		(274)	(236)	(38)
...Employers	All Ages	+.54	+.54	+.50
		(1,639)	(858)	(781)
	Under 30	+.45	+.43	+.53
		(400)	(129)	(271)
	30-39	+.42	+.41	+.53
		(628)	(263)	(365)
	40-49	+.60	+.61	+.34
		(337)	(230)	(107)
	50 or more	+.69	+.70	+.43
		(274)	(236)	(38)
...Accomplishments	All Ages	+.99	+.99	+.86
		(1,694)	(891)	(803)
	Under 30	+.92	+.96	+.71
		(410)	(135)	(275)
	30-39	+.86	+.85	+.93
		(638)	(268)	(370)
	40-49	+1.03	+1.04	+.93
		(351)	(239)	(112)
	50 or more	+1.14	+1.15	+.93
		(295)	(249)	(46)
...Career Prospects	All Ages	+.51	+.52	+.41
		(1,673)	(878)	(795)
	Under 30	+.56	+.57	+.52
		(410)	(135)	(275)
	30-39	+.39	+.39	+.41
		(634)	(267)	(367)
	40-49	+.48	+.50	+.18
		(350)	(239)	(111)
	50 or more	+.64	+.65	+.31
		(279)	(237)	(42)

APPENDIX:

ANNOTATED SURVEY QUESTIONNAIRE

A copy of the cover letter and body of the survey instrument developed for SWE is provided on the following pages.

Established formats are available for many of the items in this questionnaire, such as the demographic and attitudinal measures. Reliable, foolproof ways to ask about the day-to-day realities of engineering work are somewhat less established, if only because the profession moves rapidly and lines of inquiry tend to become dated. A little initial familiarity with SWE's data reveals these and other ways in which the instrument can be improved:

Cover letter strategies. See the comment on the next page.

General Revisions. All filters—branches in the survey where some respondents are advised to skip ahead—should be designed to allow respondents to answer any question in the survey if they wish to. One respondent noted that after just being laid off, it was something of a shock to be told not to respond to the questions about jobs, which of course could be completed on the basis of experience with a previous employer. It is reasonable to design surveys so that they do not needlessly burden respondents; it is not so reasonable to define "burden" as consisting only of the physical effort and time required to complete a form. Respondents may also have other burdens.

This principle can also be applied to the screening item at the beginning of the form. Other than sheer restrictions of time and money, there is no reason why survey research projects can't consider observations and contributions from any interested observer, especially if the observer is a person who has been sent a copy of the form.

To allow such projects to collect data on individuals about their working lives without compromising the integrity of assurances about confidentiality, future surveys should employ filtered subsections specifically dedicated to this information, with the understanding that the respondent gives permission to use these replies in published material in precisely stipulated formats. This gives respondents direct control over the use of the data they have provided.

Item Notes:

Item 2B: Ethnic origins. See the comment on "Too many Native Americans" in Part I.

Item 2I: Day care. Question needs screen for appropriate children, should allow for use of multiple kinds of care, and might be expanded to catch such details as the use of facilities provided by employers. Need to clearly distinguish care provided by regular public school services (or their equivalent), and private facilities used expressedly for day care per se.

Item 3A: Degrees. Improve instructions for details; fields of specialization are needed as well as formal award titles, which may be vague (example: "M.S." with no other specification). It cannot be assumed that degrees will be in the same field as earlier awards or that they will match society affiliations.

Item 4G: Industry Sectors. Needs constant updates/revisions. Respondents who are not industrial economists may not be familiar with all of the nuances of the Standard Industry Classification (SIC) scheme used by most statisticians. No substitute for open-ended clarifications.

Item 4I: Factors for Assessing Performance. Responses cluster around competence and project management, which may therefore support detailing; other options might be simplified.

Item 4K and L: Participation in Management. See comment on "Ambiguous Questions" in Part II.

Item 5K: Organizational Shakeups. An explicit "None of the above" response is needed.

AAES

AMERICAN ASSOCIATION OF ENGINEERING SOCIETIES

CARLETON A. BAYLESS
1992 CHAIR

MEMBER SOCIETIES
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AMERICAN INDIAN SCIENCE & ENGINEERING SOCIETY
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OPTICAL SOCIETY OF AMERICA
SOCIETY OF FIRE PROTECTION ENGINEERS
SOCIETY OF WOMEN ENGINEERS

ASSOCIATE SOCIETIES
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ENGINEERING SOCIETIES OF NEW ENGLAND
ENGINEERING SOCIETY OF DETROIT
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August 15, 1992

ADDRESS LABEL GOES HERE

Dear Colleague:

Engineering careers are being influenced by unprecedented economic, professional, and technical forces. Fresh data on engineers are needed to document trends, and to clarify how engineering careers are evolving, how engineering skills are being utilized, and how problems of equity and opportunity are affecting the people who make up our profession. Now, under the primary sponsorship of the Society of Women Engineers, and with the support of over 20 other major technical and professional societies, this need for information is being addressed.

You have been randomly selected to be a participant in a new national survey of engineers. Unlike the studies conducted by many societies to monitor the effectiveness of member services or to track trends in compensation, this survey is designed to assess broad engineering career situations. Your responses are important. For the project to yield good data, high levels of cooperation with the survey are crucial. Please help us by completing the attached questionnaire and returning it promptly in the enclosed postage-paid envelope.

Don't remove this cover letter when you return the questionnaire! Your responses are confidential, but we need to be able to identify the people who have completed their survey forms, because to obtain a good level of cooperation, we will need to send second (and possibly third) copies of this package to those who haven't replied to earlier mailings. Once we have confirmed your response, we'll remove this cover page. At that point, before the data is entered, your answers become entirely anonymous. This project will be handled by professional research staff at AAES. We have guaranteed the confidentiality of sensitive data like salary statistics for many years.

All societies participating in this project will receive reports from this research by next summer. We appreciate your help. Thank you.

Yours truly,

Mitchell H. Bradley, Executive Director
AMERICAN ASSOCIATION OF ENGINEERING SOCIETIES

Enclosures

The use of the more general AAES letterhead and an appeal from Mitch Bradley was an example of standard survey practice in presenting respondents with as high-level an endorsement of the worthiness of one's cause as possible. Most of the opportunity to obtain a good response for SWE's survey would be with men; SWE's pilot project had obtained a 70 percent response rate from the Society's own members with only one mailing. Getting a good response from the SWE portion of the sample would be no problem, it was thought. It would be the men who would need special attention.

The data on response in Exhibit 2 show clearly that while this approach may have worked for those not sampled through SWE, it was probably counterproductive for SWE itself. The Society's members made up almost 35 percent of the original sampling list of 3,293 names and addresses. They should have gotten more attention and their own cover letter.

A NATIONAL SURVEY OF MEN AND WOMEN ENGINEERS: 1992

PART 1. SCREENING QUESTIONS: If ANY of these four conditions apply to you, you need not complete the rest of the questionnaire, but BE SURE TO RETURN THE FORM so we can check you off the list of people in the study sample. Thanks for your help.

Are you... *(check any that apply)*:

...an undergraduate student who has not yet obtained a bachelor's degree in engineering? [ ]
...permanently retired, both from work and from all volunteer activities in engineering? [ ]
...a nonresident foreign national—neither a U.S. citizen nor a permanent resident of the U.S.? [ ]
...not an engineer, either by training and education, or by any past work experience? [ ]

PART 2. PERSONAL INFORMATION:

A. Gender *(check one)*:
Male [ ]
Female [ ]

B. Ethnic origin *(check one)*:
Asian/Pacific Islander [ ]
Black/Afro-American [ ]
Hispanic (may be any race) [ ]
Native American (American Indians)/Aleutian Islander [ ]
White Non-Hispanic [ ]
Other—PLEASE SPECIFY: [ ]

C. Do you have a disability or handicap? *(check one)*:
No [ ]
Yes [ ]
IF SO, PLEASE SPECIFY NATURE OF DISABILITY: [ ]

D. Age: *(enter number of years)* [ ]

E. ZIP code of your primary RESIDENCE: *(enter five-digit code)* [ ]
ZIP code of your place of WORK: *(enter five-digit code)* [ ]

F. Marital status *(check one)*:
Unmarried [ ]
Married [ ]

G. IF PRESENTLY MARRIED:
Does your spouse work? *(check one)*:
No [ ]
Yes, FULL TIME [ ]
Yes, PART TIME [ ]

Is your spouse also an engineer? *(check one)*:
No [ ]
Yes [ ]

H. Number of children in your own household: *(enter number; if none, enter a zero)*: [ ]

I. IF CHILDREN ARE IN YOUR HOUSEHOLD:
Are day care services provided for them? *(check one)*:
No [ ]
Yes, at home [ ]
Yes, in another private home [ ]
Yes, in a day center center [ ]
Yes, somewhere else—PLEASE SPECIFY: [ ]

PART 3. EDUCATION:

A. Please complete a line for EACH college or graduate degree you have. INCLUDE any non-engineering degrees (for example, an MBA). Be careful to clearly specify the schools—there's more than one "OSU," "USC," etc.!

DEGREE (e.g., "B.S., Mechanical Engineering")	SCHOOL (e.g., "University of Illinois at Urbana")	YEAR GRADUATED

PLEASE GO ON TO THE NEXT PAGE OF THE QUESTIONNAIRE...

B. Here are some reasons why people become interested in engineering. *Check ONE of these in the FIRST column to denote the reason that BEST describes your motivations. Check AS MANY AS APPLICABLE in the SECOND column to indicate the OTHER factors that were important to you:*

	This BEST DESCRIBES why I became interested in engineering (check ONE):	These reasons were also important (check AS MANY as apply):
Good at math and science	[ ]	[ ]
Scholarship recipient	[ ]	[ ]
Someone recommended the field to me	[ ]	[ ]
A relative was an engineer	[ ]	[ ]
Friends in engineering	[ ]	[ ]
Career opportunities	[ ]	[ ]
It's fun and interesting	[ ]	[ ]
Good salary prospects	[ ]	[ ]
Wanted to be different	[ ]	[ ]
Looking for challenging job	[ ]	[ ]
Other motives: PLEASE SPECIFY: [ ]	[ ]	[ ]

C. Did you participate in a co-op or internship program during college? *(check one)*:
No [ ]
Yes [ ]

D. Did you take the EIT (Engineer in Training, also known as the Engineering Intern) exam? *(check one)*:
No [ ]
Yes—passed it [ ]
Yes, but did not pass [ ]

E. Have you taken, or do you plan to take, the PE (Professional Engineer) exam? *(check one)*:
No [ ]
Yes [ ]

F. Are you a registered PE? *(check one)*:
No [ ]
Yes [ ]
IF YES: SPECIFY AREA: [ ]

G. Were you employed while obtaining your undergraduate degree(s)? *(check one)*:
No [ ]
Yes—mostly FULL TIME [ ]
Yes—mostly PART TIME [ ]

H. IF YOU HAVE A GRADUATE DEGREE:
Were you employed while obtaining these degree(s)? *(check one)*:
No [ ]
Yes—mostly FULL TIME [ ]
Yes—mostly PART TIME [ ]

PART 4. EMPLOYMENT EXPERIENCE:

A. Please enter the number of years that you have been employed FULL TIME in EACH of the following periods. DO NOT COUNT YEARS WHEN YOU WERE IN SCHOOL AT LEAST HALF-TIME OR ON MEDICAL OR OTHER LEAVE. If none, enter zero:

Years employed since leaving secondary school, but before obtaining any bachelor's degree: [ ]
Years employed after receiving a NON-ENGINEERING bachelor's degree, but before obtaining a degree in engineering: [ ]
Years employed since receiving your first ENGINEERING degree: [ ]
TOTAL YEARS EMPLOYED *(should equal sum of first three entries for item 4A)*: [ ]

B. IF YOU HAVE AN ADVANCED (GRADUATE) DEGREE:
How many years have you been employed since receiving your HIGHEST earned degree? *(enter number of years)* [ ]

C. How many employers have you had since receiving your first engineering degree? *(Count periods of self-employment or work as an independent consultant as additional employers. Enter number of employers)*: [ ]

D. Are you employed NOW? *(check one)*:
Yes, as an engineer [ ]
Yes, in a comparable technical or managerial job where my engineering background is helpful [ ]
Yes, but NOT as an engineer or comparable technical or managerial position [ ]
No—not currently employed at any job [ ]

IF EMPLOYED, BUT NOT IN ENGINEERING OR COMPARABLE WORK: Why not? Can't find appropriate job? Prefer other job? *(enter reason)*:

IF NOT EMPLOYED AT ALL: Why not? Laid off? Fulltime school? Health? Retired? Family duties? *(enter reason)*:

[ ]

IF YOU ARE **NOT** EMPLOYED NOW AT ALL, YOU MAY **SKIP** THE REMAINING ITEMS IN PART 4.
INSTEAD, GO DIRECTLY TO **PART 5** OF THE QUESTIONNAIRE (STARTING ON THE **MIDDLE** OF PAGE 4).
IF YOU **ARE** CURRENTLY EMPLOYED, GO ON TO PAGE 3...

ALL QUESTIONS ON THIS PAGE ARE FOR THOSE WHO ARE **CURRENTLY EMPLOYED:**

E. On the average, how many actual hours a week do you work? *(enter number of hours)* [ ]

F. About how many people are employed by the organization for which you work?
(Answer in terms of your immediate company or division if a conglomerate, or in terms of your agency, if government. Check one; if you're not certain which group applies, check the SMALLER possibility):

Self employed [ ]
Small organization (less than 50 workers) [ ]
Medium-sized organization (50-499 workers) [ ]
Large organization (500-5,000 workers) [ ]
Very large organization (over 5,000) [ ]

G. Please check the industrial or other employment sector that BEST DESCRIBES your current place of work. *(check ONE; if the categories in the list aren't appropriate, use the open-ended option):*

MANUFACTURING:

Aerospace [ ]
Basic Metals Industries [ ]
Computer Hardware/Software [ ]
Electronic Equipment [ ]
Non-Electrical Machinery [ ]
Precision Instruments [ ]
Other Manufacturing (SPECIFY BELOW) [ ]
Automotive Industries [ ]
Chemicals/Drugs/Plastics [ ]
Electrical Machinery [ ]
Fabricated Metal Products [ ]
Petroleum Extraction/Refining [ ]

NON-MANUFACTURING:

Communication Services/Utilities [ ]
Construction [ ]
Consulting/Engineering Services [ ]
Electrical/Gas Utilities [ ]
Non-Manufacturing R&D Laboratories [ ]
Federal Government [ ]
State/Local Government [ ]
Academic/Teaching [ ]

If the categories above aren't suitable, enter type of employer here: [ ]

H. Enter your job title: [ ]

State your primary work responsibilities: [ ]

I. In your current position, which of the following aspects of your work is the MAJOR FACTOR in assessing your performance? *(check ONE; if a combination applies, use the space for "other"):*

Personnel Management [ ]
Task/Project Management [ ]
Research & Development [ ]
Other: PLEASE SPECIFY [ ]
Administrative Duties [ ]
Production [ ]
Cost Control [ ]
Technical Competence [ ]
Reliability/Quality Assurance [ ]
Sales/Promotion [ ]

J. Are your skills as an engineer utilized reasonably well in this job? *(check one):*
No [ ]
Yes [ ]

K. How many LEVELS of management are there between you and the CEO (Chief Executive Officer) where you work? *(enter number of levels; if none, enter zero)* [ ]

L. Do you feel you are part of management? *(check one):*
No [ ]
Yes [ ]

M. IF YOU ARE PART OF MANAGEMENT:
How many years did you work here before entering management? *(enter number of years; if none, enter zero)* [ ]
How many ADDITIONAL years did you work before reaching your CURRENT management level? *(enter number of years; if none, enter zero)* [ ]
How many people do you manage? *(enter number of persons; if none, enter zero)* [ ]
How many OTHER ENGINEERS do you manage? *(enter number of engineers; if none, enter zero)* [ ]

N. Enter your current ANNUAL BASE SALARY: *(rounded to nearest thousand is okay)* $ [ ]

O. During the last three years, has your organization awarded bonuses based on performance? *(check one):*
No [ ]
Yes—I have received them at least once in the last three years [ ]
Yes, but I haven't received one during the last three years [ ]

P. On the whole, how satisfied are you with the work you do—would you say you are very satisfied, moderately satisfied, a little dissatisfied, or very dissatisfied? *(check one):*
Very satisfied [ ]
Moderately satisfied [ ]
A little dissatisfied [ ]
Very dissatisfied [ ]

PLEASE GO ON TO THE NEXT PAGE OF THE QUESTIONNAIRE...

PART 4, CONTINUED: QUESTIONS FOR THOSE WHO ARE **CURRENTLY EMPLOYED:**

Q. Rate your satisfaction with each of the following aspects of your work. *(check ONE in each ROW):*

	Very Satisfied (5)	Satisfied (4)	Neutral (3)	Dissatisfied (2)	Very Dissatisfied (1)
Job Content	[ ]	[ ]	[ ]	[ ]	[ ]
Personal Challenge	[ ]	[ ]	[ ]	[ ]	[ ]
Equitable Treatment of People	[ ]	[ ]	[ ]	[ ]	[ ]
Immediate Management	[ ]	[ ]	[ ]	[ ]	[ ]
Overall Management	[ ]	[ ]	[ ]	[ ]	[ ]
Salary Compensation	[ ]	[ ]	[ ]	[ ]	[ ]
Employee Benefits	[ ]	[ ]	[ ]	[ ]	[ ]
Support Facilities	[ ]	[ ]	[ ]	[ ]	[ ]
Advancement Opportunities	[ ]	[ ]	[ ]	[ ]	[ ]
Training Opportunities	[ ]	[ ]	[ ]	[ ]	[ ]
Support for Professional/Technical Activities	[ ]	[ ]	[ ]	[ ]	[ ]

R. Do you believe that female and male employees performing the same job are treated equally where you work? *(check one):*
No—consistent inequities in treatment of men and women [ ]
Depends—sometimes equitable, sometimes not [ ]
Yes—always equitable [ ]

Do you believe that employees performing the same job are treated equally where you work, regardless of ethnicity, nationality, race, or religion? *(check one)*
No—consistent inequities in treatment of people [ ]
Depends—sometimes equitable, sometimes not [ ]
Yes—always equitable [ ]

IF YOU CHECKED "NO" OR "DEPENDS" FOR *EITHER* OF THESE TWO QUESTIONS:
Are these problems "corporate" in nature, "departmental," or both? *(check one):*
They're corporate [ ]
They're departmental [ ]
They're both corporate and departmental [ ]
Can't say; don't know [ ]

S. Please RANK the top THREE factors which would influence your decision to change jobs. Mark the strongest factor with a "1", the next with a "2", etc. Assume that the new job is otherwise similar to the one you have now:

Better employee benefits [ ]
Change in type of work [ ]
Higher management level [ ]
More technical challenge [ ]
Transfer of spouse [ ]
Broader work responsibilities [ ]
Change of company size [ ]
Other factors [ ]
Closer to relatives [ ]
Increased salary [ ]
More free time [ ]
SPECIFY: [ ]

PART 5. CAREER PROSPECTS (ALL RESPONDENTS PLEASE ANSWER):

A. Which of the following TECHNICAL specialties best describes you as an engineer? *(check one):*

Aerospace [ ]
Ceramic [ ]
Electrical/Electronic [ ]
General Engineering [ ]
Materials/Metallurgy [ ]
Petroleum [ ]
Systems [ ]
Agricultural [ ]
Chemical [ ]
Engineering Science [ ]
Industrial [ ]
Mechanical [ ]
Architectural [ ]
Civil [ ]
Engineering Management [ ]
Manufacturing [ ]
Mining/Minerals/Geological [ ]
Biomedical [ ]
Computer [ ]
Environmental [ ]
Marine/Naval Architecture [ ]
Nuclear [ ]
Others or mixed specialties [ ] SPECIFY: [ ]

B. What career path are you following NOW? What do you hope to be pursuing TEN YEARS FROM NOW? *(check ONE response in EACH COLUMN):*

	What I'm following NOW:	What I hope to be following IN TEN YEARS:
Consulting	[ ]	[ ]
Technical	[ ]	[ ]
Managerial	[ ]	[ ]
Other: SPECIFY: [ ]	[ ]	[ ]

C. If you feel that you have been able to achieve significant accomplishments in your work as an engineer, please provide a BRIEF example of such an accomplishment *(example: "Came up with key parts of a design for a people mover at a major international airport.")*

[ ]

PLEASE GO ON TO THE NEXT PAGE OF THE QUESTIONNAIRE...

D. Identify the biggest obstacle/problem that you face TODAY in your career *(if none, enter "None")*:

E. Check ALL changes you are considering *(check AS MANY AS APPLICABLE)*: If NO changes are being considered, check here: [ ]

Change employer [ ] | Change type of work [ ] | Change career [ ]
More education [ ] | Leave of absence [ ] | Retirement [ ]
Other: [ ] SPECIFY:

F. Please rate your general satisfaction with EACH of the following *(check ONE in each ROW)*:

	Very Satisfied (5)	Satisfied (4)	Neutral (3)	Dissatisfied (2)	Very Dissatisfied (1)
Your engineering education	[ ]	[ ]	[ ]	[ ]	[ ]
Your engineering supervisors	[ ]	[ ]	[ ]	[ ]	[ ]
Your engineering employers	[ ]	[ ]	[ ]	[ ]	[ ]
Your accomplishments to date	[ ]	[ ]	[ ]	[ ]	[ ]
Your career prospects	[ ]	[ ]	[ ]	[ ]	[ ]

G. In what areas was your training as an engineer deficient? *(if none, enter "None")*:

H. On or after January 1, 1990, were you laid off or otherwise involuntarily separated from a job? *(check one)*: No [ ] Yes [ ]

IF YES: When did the separation occur? *(if more than once, give the FIRST time; enter month and year—e.g., "12/91")*:

IF YES: From what sort of job? *(check one)*: Technical/Engineering [ ] Engineering Management [ ]
Other : SPECIFY: [ ]

IF YES: How many WEEKS were you without work of ANY KIND? *(enter number of weeks)*

IF YES: How many WEEKS were you without acceptable PROFESSIONAL employment? *(enter number of weeks)*

IF YES: Please estimate the extent of income you have LOST to date as a result of being laid off. Do NOT adjust for any unemployment or other benefits you received. DO include all reductions in your income, even if you've been rehired: *(enter dollar amount)* $

I. Here are some statements about the transferability or flexibility of engineering training. In EACH case, please indicate your degree of agreement or disagreement: *(check ONE in each ROW)*

	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
My training has been relatively flexible--I can deal with new areas of specialization without much additional formal preparation	[ ]	[ ]	[ ]	[ ]	[ ]
On-job training or other employer-provided education has been sufficient to keep me up to date in my career	[ ]	[ ]	[ ]	[ ]	[ ]
My professional skills are too narrow or may become dated too quickly; without formal retraining my career could be at risk	[ ]	[ ]	[ ]	[ ]	[ ]

J. Are you personally aware of instances where women or members of minority groups have been overlooked with regard to career opportunities? *(check one)*:
No [ ]
Yes—in the case of women [ ]
Yes—in the case of minority groups [ ]
Yes—both women and minorities [ ]

K. In the last five years, did any of the following things happen to an organization that you worked for? *(check AS MANY AS APPLY)*:
There was a major reorganization [ ]
There were major layoffs [ ]
The organization went out of business or closed down [ ]
The organization was merged, taken over, or changed ownership [ ]

IF ANY OF THESE EVENTS TOOK PLACE WHERE YOU WORKED: Were you personally affected by these developments? *(check one)*:
No [ ]
Yes, favorably [ ]
Yes, unfavorably [ ]
Yes—both favorably and unfavorably [ ]

PLEASE GO ON TO THE NEXT PAGE OF THE QUESTIONNAIRE...

L. To what technical or professional societies do you currently belong? *(check AS MANY AS APPLY)*:

AAEE (environmental) [ ]	AIAA (aerospace) [ ]	AIChE (chemical) [ ]	AIPE (plant) [ ]
ANS (nuclear) [ ]	ASAE (agricultural) [ ]	ASCE (civil) [ ]	ASEE (education) [ ]
ASHRAE (HVAC) [ ]	ASME (mechanical) [ ]	ASSE (safety) [ ]	AWS (welding) [ ]
IEEE (electrical/electronic) [ ]	IIE (industrial) [ ]	NICE (ceramic) [ ]	NSPE (PE's) [ ]
OSA (optical) [ ]	SFPE (fire protection) [ ]	SME (manufacturing) [ ]	SMME (mining/metallurgy) [ ]
SPE (petroleum) [ ]			
SWE (women) [ ]	Others—SPECIFY:		

M. Have you ever held office and/or committee positions as a member of a professional or technical society? *(check one)*: No [ ] Yes [ ]

N. If you have any comments or further observations that you would like to pass along about either the state of the engineering profession today or your own experiences as an engineer, please enter them here:

O. Use this space to add any comments or additional information on specific questions in this form. Be sure to fill in the Part/Item Number references to identify the item you are expanding:

PART: (1-5)	ITEM: (A-S)	COMMENTS/ADDED INFORMATION:

This completes the survey. Please mail your response NOW to:

Engineers' Survey
American Association of Engineering Societies
1111 19th Street, N.W.
Washington, D.C. 20036

A postage-paid return envelope is provided for your convenience (it uses a different ZIP code because it's business reply).

Thank you for your help!

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