

Working Women Scientists and Engineers

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Among the 200,000 scientists who reported their economic and professional characteristics to the *National Register of Scientific and Technical Personnel* in 1960, only 7 percent were women (1). By 1970, the last year that data were collected for the register, that proportion was 9 percent (2). No comparable data are available for later years, but the present proportion is about 14 percent.

Women were 9 percent of the 21,300 doctoral scientists and engineers in the United States in 1973 and in 1975 (3, 4) and 10 percent in 1977 (5).

tists. Further, the NSF finding raised the question of why only slightly more than half of the women scientists and engineers were in the labor force compared to 88 percent of the men and 64 percent of all the women with four or more years of college education (8). The labor force is defined as the total number of persons working or seeking work.

The NSF has since reviewed its findings, changed some of its analytical procedures, and revised its data for that year. The revised data, published in 1979, show that 84.5 percent of women

Summary. About 80 percent of women trained in science or engineering are in the labor force, but many are employed outside of their fields. Most who withdraw from the labor force do so temporarily, and about half do not take a career break even when they have small children. Factors affecting labor force participation are student status, highest degree level, parental status and age of children, and field of degree. Employment opportunities are restricted in some fields, and women have higher unemployment rates and lower earnings than men. Some policy changes would improve opportunities for women, and better data are needed to monitor their participation in science and technology.

Despite the slow growth in the proportion of women among scientists and engineers, women have doubled their share of bachelor's degrees and almost tripled their proportion of Ph.D.'s since 1960 (Fig. 1) (6). The increase in some fields has been greater than others, with psychology showing the greatest increases both numerically and proportionately. In 1977, women earned 32.8 percent of the bachelor's degrees, 22.9 percent of the master's degrees, and 18 percent of the Ph.D.'s in science and engineering. In 1978, women's share of science and engineering Ph.D.'s increased to 19.6 percent. In 1976, however, a finding by the National Science Foundation (NSF) that only 53 percent of women trained in science and engineering were in the labor force in 1974 (7) raised the question of whether the increase in degrees would have any substantial effect on the proportion of women among working scien-

tists and engineers were in the labor force in 1974 (9). This revision is of interest, since it corroborates the findings of the Scientific Manpower Commission (SMC) (10) reported here. The SMC found that women trained in science and engineering are more likely than other women with similar amounts of education to be in the labor force and recommended that "in planning the methodology for collecting, analyzing and reporting data on scientists and engineers during the coming decade, greater emphasis should be placed on obtaining accurate and reliable statistics about women, even if this requires less emphasis on other data needs" (10, p. 86).

In 1977 the SMC began an 18-month study of the labor force participation of women scientists and engineers and the factors affecting their participation (10). We determined labor force participation in a number of unrelated samples of data and compared these findings with other studies then in progress. To examine patterns of career development among

women scientists and engineers, we contacted about 600 women graduates of the past 15 years in chemistry and engineering from ten schools which, although not representative of all graduates in those fields, provided information on graduates in two fields over a 15-year period (11). We examined the factors that affected their retention or withdrawal from the labor force, as well as their patterns of career development including attainment of advanced degrees; the effect of their marital and parental status on their career advancement, and their utilization in science and engineering. In this group of women and in one other sample (12) it was also possible to determine plans to return to work of women who were then out of the labor force and some of the problems they foresaw or were experiencing in reentry following a career break.

The data sets analyzed included two NSF surveys, done in 1976 (13) and 1978 (14), of recent bachelor's and master's graduates in science and engineering; and data from a 1975 survey by Solmon *et al.* (12) of graduates from the 1961 freshman class who, by 1971, had received a bachelor's but no higher degree in a science or engineering field.

Labor Force Participation

Between 80 and 85 percent of women with degrees in science or engineering are in the labor force, with the participation ranging from about 50 percent of women with bachelor's degrees who are mothers of preschool age children to more than 95 percent of a group of women with doctorate or first professional degrees. Table 1, which summarizes, by highest degree level, the labor force participation of the women in the samples we examined and the samples in other recent studies (15), shows that the higher the educational credentials, the more likely women are to be in the labor force. Comparing these rates with the data in Table 2 from the U.S. Department of Labor (16), one finds that the proportions of women with science and engineering degrees in the labor force exceed those of women college graduates in all fields combined.

Since the SMC study indicated that women who have majored in science or engineering are more likely rather than less likely to be in the labor force than are all women college graduates, we examined all the data available to determine the factors that affect labor force participation, both negatively and positively, and the interrelations among these factors.

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Factors Affecting Labor Force

Participation

A number of sometimes conflicting characteristics were found to relate directly to whether women are in the labor force, and some of these characteristics take precedence over the others. Graduate student status, highest degree level, presence and age of children, and field of degree all affect labor force participation. Marriage by itself appears to have little effect on labor force participation, but does appear to affect somewhat the utilization of women in science and engineering employment when the spouse also is a scientist or engineer.

Women may leave the labor force in order to earn a graduate degree, have and raise children, or devote more time to a husband's career or to other family responsibilities. A majority return to the labor force when the degree is completed or the children are in school. A few remain out of the labor force even after these family responsibilities lessen, because job opportunities and available salaries are insufficient to draw them back; and others hesitate to reenter the labor force after a career break because their skills are rusty, their professional knowledge out-of-date, or their career direction is uncertain. Some stay out of the labor force because they prefer volunteer work.

The greatest incentive to leave the labor force is the presence of preschool children in the home. The desire to combine labor force participation and child rearing, expressed by many women in this study, is sometimes frustrated by conflicting demands on time, lack of part-time employment opportunities in science or engineering and, for some women, lack of employment opportunities for women without an advanced degree.

For women with children, the incentives to stay in or return to the labor force are stronger among women with advanced degrees, and among those whose chosen fields offer good employment opportunities at better-than-average salaries.

Despite the inherent conflicts involved in combining these various activities, many women, and particularly women trained in science and engineering, remain in the labor force while also pursuing a graduate degree, having and raising children, or handling other home responsibilities. More than half of the women with children whose work histories were examined for this study had never taken a career break of 6 months or more. Others had taken short or long breaks in their careers but had returned

to the labor force as soon as their other responsibilities lessened. Among the 140 women in the sample of chemistry and engineering majors who were out of the labor force in 1978 for school or family reasons, four out of five indicated definite plans to return.

We will examine the effect of each of the significant factors affecting labor force participation.

Graduate study. As part of its regular surveys of scientists and engineers, the NSF conducts a biennial survey of recent graduates in science and engineering. In 1976, the bachelor's and master's

graduates of 1974 and 1975 were surveyed (13); and in 1978, the bachelor's and master's graduates of 1972 and 1976 were surveyed (14). Among graduates who had completed a degree 1 or 2 years earlier at the time of the surveys, the proportions of both men and women who were out of the labor force were similar (Table 3).

Although the survey questions did not ask directly why graduates were out of the labor force, they did determine student status. As shown in Table 3, except for the 1972 graduates surveyed in 1978, the principal reason for being out of the

Table 1. Percentage of women scientists and engineers in the labor force in various populations, 1975 to 1978, by degree level.

Data source	Degree year of sample	Year of survey	Number in sample	Degree (%)		
				Bachelor's	Master's	Ph.D.
(13)	1974, 1975	1976	191,215*	83.6	87.5	
(14)	1976	1978	116,602*	84.3	87.2	
(14)	1972	1978	100,623*	79.9	86.5	
(12)	1965	1975	1,881	63.1		
(11)	1962 to 1977	1978	607	71.0	78.1	96.1
(5)	All years	1977	30,470*			89.5
(15)	All years	1976	1,125	89.0	84.4	92.8

*Weighted number.

Table 2. Percentage of women college graduates in the labor force by age and years of college, 1977 (16).

Years of college	All ages	Age group				
		20-24	25-34	35-44	45-54	55-64
Four	62.3	86.2	69.8	62.3	66.2	46.2
Five or more	71.5	79.1	77.9	81.4	80.5	66.9

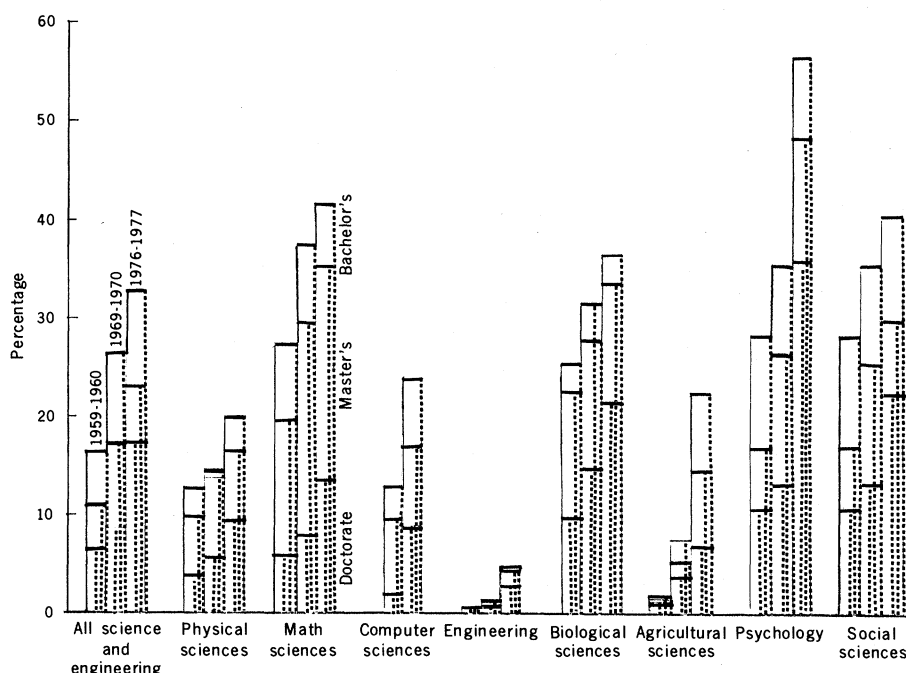


Fig. 1. Proportion of degrees in science and engineering earned by women in 1959 to 1960, 1969 to 1970, and 1976 to 1977 (6). Included in the social science degrees are anthropology, sociology, economics, and political science.

Table 3. Student status of recent science and engineering graduates who are out of the labor force, by sample population and sex (13, 14).

Sample population				Percentage out of the labor force			
Year of degree	Year of survey	Sex	Total number*	Total	Full-time student	Part-time student	Non-student
Graduates with bachelor's degree							
1974, 1975	1976	M	419,171	13.1	10.9	0.6	1.6
		F	189,640	16.4	9.6	1.2	5.6
1976	1978	M	215,054	12.5	11.4	0.1	1.0
		F	103,444	15.7	10.0	0.8	4.9
1972	1978	M	227,822	5.2	3.7	0.2	1.3
		F	90,025	20.1	2.6	1.5	16.0
Graduates with master's degree							
1974, 1975	1976	M	85,689	8.5	7.8	0.1	0.5
		F	20,868	12.5	5.5	2.5	4.5
1976	1978	M	45,670	9.0	7.7	0.2	1.1
		F	13,158	12.8	4.8	0.9	7.1
1972	1978	M	47,569	2.6	1.6		1.0
		F	10,569	13.5	3.3	1.1	9.1

*Excludes those whose employment status is not known.

labor force for both men and women among these recent graduates was full-time graduate study.

Field differences also reflect this pattern. Among engineering and computer science graduates of both sexes, higher proportions were in the labor force and smaller proportions were outside the labor force but involved in full-time graduate study; whereas among physical and biological science graduates, smaller proportions were in the labor force and larger proportions of the total group were out of the labor force and were full-time graduate students. Although many graduate students remained in the labor force while pursuing a graduate degree either full or part time, student status in Table 3 refers only to students who were neither employed nor seeking employment.

In both survey years, 5.6 percent of the women bachelor's recipients of 1 or 2 years earlier were nonstudents out of the labor force, compared to 1.3 percent of men. Among master's graduates surveyed 1 to 2 years after receipt of that degree, between 4.5 and 8 percent of the women were nonstudents out of the labor force compared to 0.5 and 1.3 percent of the men. Thus, full-time student status accounted for more than half of the recent bachelor's graduates out of the labor force and for about 40 percent of the recent master's graduates.

Among the 1972 degree recipients, only 13 percent of the women bachelor's graduates of that year were out of the labor force in 1978 because they were full-time students, but a surprising 24 percent of the 1972 master's graduates who were out of the labor force in 1978 were full-time students, with an additional 8 percent indicating part-time student status.

An important factor in projecting the future makeup of the scientific labor force in terms of increased proportions of women is whether similar proportions of men and women from recent baccalaureate classes are pursuing graduate degrees; and whether master's graduates are continuing toward doctorates. Table 4 shows the proportion of graduates from each of these samples who were full-time or part-time graduate students 1, 2, or 6 years after receipt of the bachelor's or master's degree, whether or not they were in the labor force. In the most recent classes, similar proportions of both men and women were continuing graduate study after attaining either degree level. Among the 1972 graduates, however, higher proportions of women than of men were graduate students in 1978, even though many of the women were attending school part time. Among the master's graduates of 1972, about 10 per-

Table 4. Student status of recent graduates, by sample population and sex (13, 14).

Sample population			Students (%)	
Year of degree	Year of survey	Sex	Full time	Part time
<i>Graduates with bachelor's degree</i>				
1974, 1975	1976	M	25.2	14.5
		F	20.6	13.4
1976	1978	M	21.8	8.9
		F	19.5	13.7
1972	1978	M	7.4	9.0
		F	5.2	12.4
<i>Graduates with master's degree</i>				
1974, 1975	1976	M	19.7	10.9
		F	17.9	14.1
1976	1978	M	19.9	9.2
		F	12.8	10.3
1972	1978	M	3.3	7.2
		F	9.2	6.5

cent of the men were graduate students compared to 16 percent of the women.

The fact that similar proportions of men and women from these classes were pursuing graduate degrees at the time of each survey indicates continuing growth in the proportion of advanced degrees in science and engineering earned by women, and significant growth in the number of women who are improving their educational credentials several years after graduation.

Highest degree level. Among the women in all these samples, the higher the earned degree level, the higher the labor force participation rate, regardless of any other factors. Participation rates among women in the various samples whose highest degree at the time of the particular survey was a bachelor's degree ranged from 63 percent of the women who were freshmen in 1961 to 84 percent of the recent graduates. Among women with master's degrees, labor force participation averaged about 85 percent, but ranged from 78 percent of the sample of 15 years of graduates in chemistry and engineering to 88 percent of more recent master's graduates. Among women with Ph.D.'s or first professional degrees attained following a science undergraduate degree, however, 90 to 96 percent were in the labor force (Table 1).

The dominance of higher degree level over other factors related to labor force participation shows more clearly when it is examined in relation to parental status.

Presence and age of children. For older women, the most important factor related to being out of the labor force is the presence of children. However, the effect of this factor is mitigated when the mother has earned one or more advanced degrees, and when her children are of school age.

Among the 600 women graduates in chemistry and engineering who were surveyed for this study, 36 percent had children and 64 percent of the mothers were in the labor force. However, labor force participation ranged from 51 percent of the mothers whose highest degree was the bachelor's to 74 percent of mothers with a master's degree and 91 percent of mothers with a Ph.D. (Table 5, column 4).

Twenty-one percent of the total sample had children under school age, and 59 percent of these mothers were in the labor force. Again, the range was wide (from 34 percent of baccalaureate level mothers in chemistry to 86 percent of mothers with a Ph.D. or M.D. degree).

Among mothers with no preschool age

children in this sample, 70.8 percent were in the labor force; the participation ranged from 60 percent of women whose highest degree was a bachelor's to 100 percent of the women with doctorates.

The field difference in labor force participation at the bachelor's level appears to be related to the better job market for engineers than for chemists at this degree level. Field differences in labor force participation are discussed below.

In the only national sample available that included information on parental status (14), we found that among women with children under 6 years who earned their degree in 1972 or 1976 and whose highest degree in 1978 was a bachelor's degree, more than half (54.6 percent) were out of the labor force in 1978. If

their highest degree in 1978 was a master's, 46 percent were out of the labor force, but when the highest earned degree was a doctorate, only 14 percent were out of the labor force even though their children were preschoolers (Table 6).

Although slightly more than half of all the mothers from these classes who had children under 6 years were out of the labor force in 1978, only 14 percent of mothers with children aged 6 or over were out of the labor force. (In this sample, mothers who had children in both age groups were counted in both groups.)

There is also a distinct difference in the labor force participation of mothers of preschoolers depending on whether the

mothers graduated in 1972 or in 1976; 63 percent of those from the 1976 class and only 44 percent from the 1972 class were in the labor force. This difference exists regardless of the degree level of the mother, perhaps indicating the rapid change in attitudes that has taken place in recent years in regard to labor force participation of mothers during their children's preschool years.

The 80 percent labor force participation of baccalaureate level mothers of children aged 6 or over, when compared to the 45 percent participation rate of mothers at the same degree level who have preschool children, reinforces the validity of many women's stated plans to return to work. Women in other segments of this study who were out of the labor force when surveyed indicated overwhelmingly that they planned to re-enter the labor force when their children were in school.

The data also indicate that women with degrees in science and engineering are more likely than other women college graduates to be in the labor force even when they have children. In March 1974, 43 percent of women who had completed four or more years of college and who had children under age 6 were in the labor force, as were 62 percent of mothers at that educational level whose children were between 6 and 17 years (17). These proportions are undoubtedly somewhat higher in 1978 than in 1974, but later data by educational level are not available. In 1978, 42 percent of all mothers of preschool children and 57 percent of all mothers of school-age children were in the labor force, regardless

Table 5. Labor force participation of mothers in a sample of chemistry and engineering graduates, by field, highest degree, and age group of children, 1978 (11).

Field and highest degree	Total number of graduates	Mothers					
		Total	Percentage in labor force	With children under 7 years		With children over 6 years	
				Number	Percentage in labor force	Number	Percentage in labor force
Chemistry	358	146	61.6	90	61.6	56	62.5
B.A. or B.S.	180	73	38.4	35	34.3	38	42.1
M.A. or M.S.	79	31	77.4	20	65.0	11	100.0
Ph.D. or M.D.	99	42	90.5	35	85.7	7	100.0
Engineering	249	71	70.0	38	55.3	33	84.8
B.S.	186	47	70.0	23	52.2	24	87.5
M.S.	58	23	70.2	14	57.1	9	89.0
Ph.D.	5	1	69.6	1	100.0		
Total	607	217	64.4	128	59.4	89	70.8
B.A. or B.S.	366	120	50.8	58	41.4	62	59.7
M.A. or M.S.	137	54	74.1	34	61.8	20	95.0
Ph.D. or M.D.	104	43	90.5	36	86.1	7	100.0

Table 6. Employment status in 1978 of mothers from 1972 and 1976 bachelor's and master's graduates by highest degree in 1978, graduating class, and age group of children (14).

Highest degree in 1978 and class	Children under 6 years					Children aged 6 years and over				
	Num-ber	Percentage				Num-ber	Percentage			
		Employed		Seek-ing	Out of labor force		Employed		Seek-ing	Out of labor force
		Full time	Part time				Full time	Part time		
Bachelor's										
1976 Graduates	4,210	38.9	12.5	8.0	40.6	7,040	59.2	7.4	9.4	24.1
1972 Graduates	13,594	25.6	11.6	3.9	58.9	3,702	46.8	29.5	13.3	10.4
Combined	17,804	28.8	11.8	4.9	54.6	10,742	54.9	15.0	10.8	19.4
Master's										
1976 Graduates	1,906	38.3	21.0	9.7	31.0	3,675	72.7	10.8	9.1	7.4
1972 Graduates	4,375	33.4	13.5		52.9	3,494	63.4	13.1	16.7	6.8
Combined	6,281	34.9	15.8	2.9	46.2	7,169	68.2	11.9	12.8	7.1
Doctorate										
1976 Graduates	86	66.3	33.7			57	50.9	49.1		
1972 Graduates	499	60.9	22.4		16.6	368	74.7	12.5		12.5
Combined	585	61.7	24.1		14.2	425	71.5	17.6		10.8
All degrees										
1976 Graduates	6,202	39.1	15.4	8.4	37.1	10,772	63.7	8.7	9.3	18.3
1972 Graduates	18,468	28.4	12.3	2.8	56.4	7,564	55.8	21.1	14.2	8.9
Combined	24,670	31.1	13.1	4.2	51.5	18,336	60.4	13.8	11.3	14.4

of educational level of the mothers (18).

In the two samples of women scientists and engineers in the present study whose parental status was known, the labor force participation of mothers with preschool children was somewhat higher than the 1974 national rate for college graduates, whereas the participation of those with children 6 years and over was significantly higher than for all college graduate mothers.

One surprising finding in the 1978 survey of science and engineering graduates (14) is that a higher number and proportion of the women who earned a bachelor's or master's degree in 1976 than of those from either of the 1972 classes reported having children aged 6 and over. Among the graduates of 1972, a higher proportion reported having preschool children, as would be expected, but a lower proportion reported children 6 and over (Table 7).

The data suggest a significant increase in the number of women reentering the work force who were among the bach-

elor's or master's graduates in 1976 following an earlier school or career interruption while their children were small. Among the women bachelor's graduates of 1976 reporting in 1978, 60 percent were 24 or under, 28 percent were aged 25 to 29 years; and 7 percent were aged 35 or over compared to only 3.3 percent of the men in this older age range (14).

Field of degree. The field of the degree in science or engineering is related to labor force participation of women. In general, fields showing strong labor market demand as indicated by lower unemployment rates, higher salary levels, and higher proportions of graduates employed in science or engineering also show higher labor force participation rates for women. Fields showing higher labor market demand by these indicators also are the fields with a smaller concentration of women among the graduates. Table 8 shows some of these relationships for the 1976 bachelor's graduates surveyed in 1978 (14).

In this sample, as in all other samples

studied, the unemployment rates (Table 8, column 6) are higher for women than for men in most fields. The unemployment rate is the percentage of the labor force that is unemployed and seeking work. Except in mathematics, the fields showing higher unemployment rates for women in this sample generally coincide with higher proportions of women among the graduates (column 4) and higher proportions of women out of the labor force who are not students (column 5).

Another way of looking at employment opportunities in various fields of science and engineering is to examine the ratio of graduates in each field to the number of persons from this class who were employed in that field in 1978 (Table 8, column 7). Almost four times as many women from this class were employed in the field of computer science as there were women graduates in this degree field. For men, also, the number employed in computer science was more than twice as large as the number of graduates, indicating an excess of demand over supply. More women graduates were employed in engineering than the total number whose degree was in engineering. No other fields show employment levels as high as 50 percent of the number of graduates, although the physical and environmental sciences were just under 50 percent. Except in the environmental sciences, the unemployment rates in these fields were below average and the labor force participation was above average among women who are not full-time graduate students. Salaries in computer science and engineering were well above average.

Salaries paid to these baccalaureate graduates employed in science and engineering are shown in Table 8, column 8. At the bottom of the salary averages are biological sciences and psychology, these being fields that include a high proportion of women, show a high unemployment rate among women, and a higher than average proportion of women out of the labor force for reasons other than that they are students.

Other samples in this study support these relationships. Among 1961 freshmen who had achieved a bachelor's but no higher degree in 1971 and who were surveyed in 1975 (12), 95 percent of the women engineering graduates were in the labor force compared to 54 percent of the graduates in sociology, 59 percent in mathematics, 67 percent in the physical sciences, and 69 percent of those with a degree in economics. Women with degrees in engineering and economics also showed significantly higher salaries than the graduates in other fields.

Table 7. Proportion of women science and engineering graduates of 1972 and 1976 who reported having children in 1978, by age group of children (14).

Year and level of degree	Total women	Women with children under 6 years		Women with children aged 6 years or over	
		Number	Percentage	Number	Percentage
1976 (All)	116,502	6,202	5.3	10,772	9.2
B.A. or B.S.	103,444	4,310	4.2	8,119	7.8
M.A. or M.S.	13,158	1,892	14.4	2,653	20.2
1972 (All)	101,623	18,469	18.2	7,564	7.4
B.A. or B.S.	90,025	16,815	18.7	5,484	6.1
M.A. or M.S.	10,598	1,654	15.6	2,080	19.6

Table 8. Some 1978 employment indicators among 1976 bachelor's graduates in science and engineering (S/E), by field and sex.

Field	Sex	Number	Percentage women	Percentage of non-students out of labor force	Unemployment rate	Percentage employed in S/E	Median salary for S/E employed
Total for all fields	M	215,054		1.1	3.0	42.4	15,598
	F	103,444	32.5	5.6	5.8	27.0	12,092
Physical sciences	M	13,192		5.3	3.0	48.1	14,077
	F	3,137	19.2	3.5	6.0	47.9	13,111
Mathematics	M	9,531		1.6	3.6	19.7	14,794
	F	6,554	40.7	4.9	2.0	10.2	13,000
Computer sciences	M	4,540			1.3	213.4	16,383
	F	1,124	19.8		0.0	395.8	16,013
Environmental sciences	M	7,072		1.2	6.6	46.9	13,725
	F	1,912	21.3	12.9	7.3	49.5	13,571
Engineering	M	45,223		0.2	0.5	96.5	17,210
	F	1,835	3.9	0.0	4.9	183.5	16,171
Biology	M	38,714		0.9	3.8	20.1	10,291
	F	20,298	34.4	6.7	7.2	33.0	10,294
Agriculture	M	15,890		1.2	1.9	50.4	12,140
	F	3,570	18.3	2.3	4.2	40.4	10,157
Psychology	M	22,987		0.8	3.3	18.4	10,144
	F	27,376	54.4	8.0	6.7	14.4	10,972
Social sciences	M	57,907		1.9	4.6	10.8	12,922
	F	37,638	39.4	4.0	5.5	13.0	11,044

In the sample of 600 women graduates of the past 15 years in chemistry and engineering (11), the engineering graduates at the bachelor's level who were not out of the labor force because they were in graduate school were considerably more likely to be employed (93 percent), and to be employed full time in engineering (91 percent) than were bachelor's graduates in chemistry, of whom 74 percent were employed but only 50 percent employed full time in science.

Employment in science and engineering. Based on the samples studied, women are less likely than comparable men to find employment opportunities in science and engineering. Among 1974 and 1975 bachelor's graduates employed full-time in 1976, for example, 52 percent of the women in the labor force reported being employed outside of science and engineering compared to 38 percent of the men. Most of this difference is accounted for by the fact that more women

majoried in fields having fewer employment opportunities for graduates without an advanced degree; higher proportions of men were in engineering and computer sciences, where field-related employment at the bachelor's level is high. However, that is not the complete answer. As shown in Table 9, in most degree fields, higher proportions of women graduates than of men were employed outside of science or engineering. Among these graduates, 69 percent of the women but only 47 percent of the men who were employed full time in non-science or engineering jobs said that this was because no science or engineering jobs were available (13). A similar pattern exists among the 1972 and 1976 graduates surveyed in 1978, although the reasons for non-science employment were not available for these classes.

Women graduates were somewhat more likely than men to be employed part time, but similar proportions of men

(26 percent) and women (28 percent) who were employed part time were seeking full-time employment.

Even when science and engineering employment is available, salaries paid to women are below those paid to men with similar credentials in almost every instance, and the salary gap widens with age. A number of other studies confirm these salary differentials for every field, degree level, and level of experience (19). Table 10 shows median annual salaries in 1978 of persons employed full time in science and engineering by field of employment, among the bachelor's and master's graduates of 1972 and 1976 (14). The salary gap between men and women is less in 1978 for the more recent bachelor's graduates of 1976 than for the 1972 graduates, but the difference persists in almost every field. Among 1976 master's graduates, however, the salary differential already was substantial by 1978.

For women, as for men, salaries in some fields are significantly higher than in others. Fields reporting the lowest salaries (the life sciences, social sciences, and psychology) also are the fields with the highest concentration of women. Conversely, salaries in engineering exceed the averages, but the proportion of women in this field is small. Among the recent graduates in engineering, average salaries paid to women exceed those paid to men in some of the subfields of engineering, but as a group, even the women engineers from these classes were earning less on the average than the men with whom they graduated.

Conclusions and Recommendations

In this 18-month study of a number of unrelated statistical samples of women it was found that, despite the problems and discouragements faced by women who seek to develop a career in science or engineering, more women than ever before are preparing themselves for careers in

Table 9. Type of employment of 1974 and 1975 bachelor's graduates who were in the labor force in 1976 (13).

Field	Sex	Numbers in labor force	Percentage				Unem- ployed and seeking
			Employed full time		Employed part time		
			S/E	Other	S/E	Other	
Total for	M	364,398	42.4	37.9	5.6	6.0	8.1
all fields	F	158,490	23.5	51.6	5.0	9.3	10.6
Physical	M	29,882	35.6	19.6	10.9	3.9	6.3
sciences	F	5,416	40.1	20.4	10.1	5.5	4.8
Mathematics	M	22,706	39.4	41.1	5.8	4.8	9.0
	F	13,311	35.9	47.0	3.7	6.6	6.8
Computer	M	7,110	85.1	9.6	2.0	1.3	2.0
sciences	F	2,307	85.1	6.3	4.3	4.3	
Environmental	M	4,980	47.2	29.2	14.5	4.6	4.6
sciences	F	890	42.0	27.9	18.5	6.9	4.7
Engineering	M	91,245	76.7	14.5	3.6	1.7	3.5
	F	2,084	80.0	9.9			10.1
Biology	M	52,426	36.4	33.7	9.9	10.4	9.7
	F	28,298	37.4	35.7	8.1	9.3	9.8
Agriculture	M	26,161	47.1	38.6	7.2	2.3	5.0
	F	2,874	42.6	23.3	10.1	9.5	14.5
Psychology	M	41,868	24.3	48.6	4.6	10.2	12.3
	F	45,192	14.6	57.7	4.9	10.7	12.1
Social	M	95,142	15.6	62.7	2.7	7.8	11.2
sciences	F	59,156	13.3	62.5	3.1	9.7	11.5

Table 10. Median annual salaries of bachelor's and master's graduates of 1972 and 1976 who are employed full time in science or engineering in 1978, by field of work and sex (14).

Field of work	Bachelor's graduates of 1972		Master's graduates of 1972		Bachelor's graduates of 1976		Master's graduates of 1976	
	Men	Women	Men	Women	Men	Women	Men	Women
All fields	19,644	15,225	22,865	18,115	15,598	12,092	19,074	15,010
Physical sciences	16,917	18,200	20,315	17,324	14,077	13,111	18,343	13,776
Mathematical sciences	15,141	14,297	18,301	19,000	14,794	13,000	14,967	16,151
Computer specialties	20,001	16,208	22,290	20,410	16,383	16,013	20,013	17,805
Environmental sciences	20,116	18,043	23,788	15,865	13,725	13,571	20,392	15,060
Engineering	20,348	18,206	25,044	22,468	17,210	16,171	21,094	19,902
Life sciences	15,453	12,666	17,873	14,922	11,217	10,265	14,642	13,180
Psychology	16,319	14,108	18,625	18,038	10,144	10,972	13,499	14,402
Social sciences	18,007	16,262	19,494	16,342	12,922	11,044	16,174	14,803

these fields, this increase is likely to continue, and women are strongly dedicated to participation in the labor force.

We used these unrelated samples to draw conclusions that in some instances might not be validated by analyses of other samples. A valid, current statistical base is a prerequisite for monitoring the progress and participation of women scientists and engineers, and for a number of reasons such a data base does not now exist. Most of the statistical information about women in science and engineering that is used by government agencies and others is in fragmented pieces which, when assembled to form a statistical portrait, does not necessarily provide an accurate picture. The different results obtained by the NSF regarding labor force participation and other characteristics of women scientists and engineers in 1974, which were based on different analyses of the same data from the same surveys, indicate that the survey methods, the sampling techniques, and the analytical procedures used to form the portrait must be strengthened over the next decade to place more emphasis on accurate differentiation of the numbers and characteristics of men and women in the scientific and technological labor force.

In addition to the need for better data, this study revealed that a number of practices and policies of educational institutions, employers, and government agencies continue to act as barriers to women. The traditional societal assignment of sex roles provides problems for women that go beyond those typically associated with combining career development and a family. Among the 600 women contacted individually for this study, many who have entered male-dominated fields report particular difficulty in being accepted on their merit. The overwhelming evidence of salary differentials between comparable men and women indicates continuing discrimination which, though lessening among new entrants, is widening among experienced professionals (3-5, 15, 19).

A number of changes in policy would make it easier for women to manage many of the problems associated with combining career development and family responsibilities. Many women wish to take career breaks during their children's early years, but few programs geared to women reentering science and technology are available. Most financial aid for graduate study is restricted to full-time students, although full-time commitment is not always possible for women who would otherwise be fully quali-

fied to compete for prestigious fellowships and traineeships.

Opportunities for part-time employment in science and engineering are rare outside of academic institutions. The availability of more part-time jobs would allow more women to continue their work while their children are young, and would hasten the reentry of others to the labor force after a career break for child rearing. More part-time job opportunities in science and engineering also would reduce some of the need for retraining or updating these women.

Many overt barriers have been removed or reduced in the past few years by changes in the law and by an increasing perception on the part of employers that such barriers were not only discriminatory but were also contrary to the best interests of the employer. However, many of the barriers that remain are not easily remedied because they are subtle. Some were well described by women contacted for this study.

"For a woman, proving herself equally capable isn't good enough. She has to prove herself better in order to be accepted in a man's world."

"Women are required to prove their worth, while men only have to prove their lack of worth."

"My growth and career development have been hampered most by the prevailing attitude of my supervisors and peers. They are less willing to trust, support, and assume risks with a woman than with a man."

Commenting on the passive and dependent role assigned to women by societal values, one woman pointed out that "This self-limiting expectation is a negative factor that must be overcome by constant internal struggle."

Despite the barriers to participation in science and engineering, particularly those that characterize fields strongly dominated by men, increasing numbers of women are demonstrating their commitment to careers in these fields. Continued and enhanced efforts will be required to remove the remaining barriers to the full participation of these women in the scientific enterprise.

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