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ABSTRACT

This issue of "Engineering Manpower Bulletin" reviews some of the statistics and other information concerning the status of women in engineering. These major topics are considered: dispelling some common misconceptions; women in the current engineering picture; why does engineering need women; what keeps women out of engineering; problems facing women in engineering; and future opportunities. Women presently constitute less than one percent of the active engineering profession and a little more than one percent of the current engineering student enrollment and new graduates. The average starting salary offered to women in engineering at the bachelor's degree level was $885 per month in 1971, which was a little higher than the average starting salary of male engineers, and is superior to the average salary in other fields generally occupied by women. (PR)

ENGINEERING MANPOWER BULLETIN

This is the twenty-first in a series of Bulletins designed for leaders in industry, government, and education whose responsibilities include an awareness of engineering and technical manpower. In this issue we pull together some of the statistics and other information on the status of women in engineering, in hopes that better knowledge of the facts will help to counteract some of the misconceptions about the opportunities available to women engineers.

JOHN D. ALDEN, *Executive Secretary*
Engineering Manpower Commission
of Engineers Joint Council

WOMEN IN ENGINEERING

Photo courtesy of Newark College of Engineering.

DISPELLING SOME COMMON MISCONCEPTIONS

Misconceptions about women engineers are all too common and, unfortunately, widely accepted. The facts are less easy to come by and are not generally known among women at the ages where career choices are made. The true situation, as seen by most women and men who are familiar with the real world of engineering, can be summed up in these general conclusions:

- Women students are welcomed in most U.S. engineering schools and are already well represented in many.
- Engineering jobs are widely available for women in many areas of industry, government, and education. Opportunities are becoming more available every year.
- Women engineering graduates are being offered salaries fully equal to those of their male contemporaries and far superior to the average pay levels available in other career fields typically occupied by women.
- In spite of the demonstrable advantages of an engineering career, young women from an early age are still being led to view engineering as an unfeminine occupation. Consequently too few of them are receiving the educational preparation and motivation needed for entry into the engineering profession.

WOMEN ENGINEERING GRADUATES, 1952 - 1971

Year Ending In June	Bachelor's	Master's*	Doctor's	Percent of Total Eng. BS
1952	52	17	2	0.17
1953	33	15	4	0.14
1954	62	13	1	0.28
1955	62	13	0	0.27
1956	76	20	0	0.29
1957	81	15	1	0.26
1958	109	20	4	0.31
1959	121	24	1	0.32
1960	145	26	3	0.38
1961	135	27	6	0.38
1962	125	40	4	0.36
1963	130	32	11	0.39
1964	146	34	7	0.41
1965	139	44	10	0.38
1966	146	76	9	0.41
1967	184	78	11	0.51
1968	177	58	5	0.47
1969	328	107	23	0.82
1970	358	170	16	0.83
1971	353	158	25	0.82

*Includes "engineer" degrees.

Source: U.S. Office of Education annual statistics 1952-1966. Engineering Manpower Commission surveys 1967-1971.

The numbers reported by EMC do not include estimates for those schools that did not provide data broken down by sex. The actual totals are therefore probably somewhat higher than the numbers reported in this table.

TABLE I

The problem of bridging the gap between the realities of engineering careers for women and the objections to such careers as perceived by many women of all ages was the subject of two major conferences in recent years. The first was the M.I.T. Symposium on American Women in Science and Engineering, held in 1965.[1] This was followed in the summer of 1971 by the Conference on Women in Engineering sponsored by the Engineering Foundation at New England College in Henniker, New Hampshire, where some 60 women and men spent a week discussing the problem and seeking possible solutions. The rest of this Bulletin is devoted to presenting factual data on women in engineering and expert opinion on reasons why more of them should be encouraged to enter the profession.

WOMEN IN THE CURRENT ENGINEERING PICTURE

Available statistics show that women constitute less than one percent of the active engineering profession and only a little more of the current engineering student and new graduate population. Table 1 gives the number

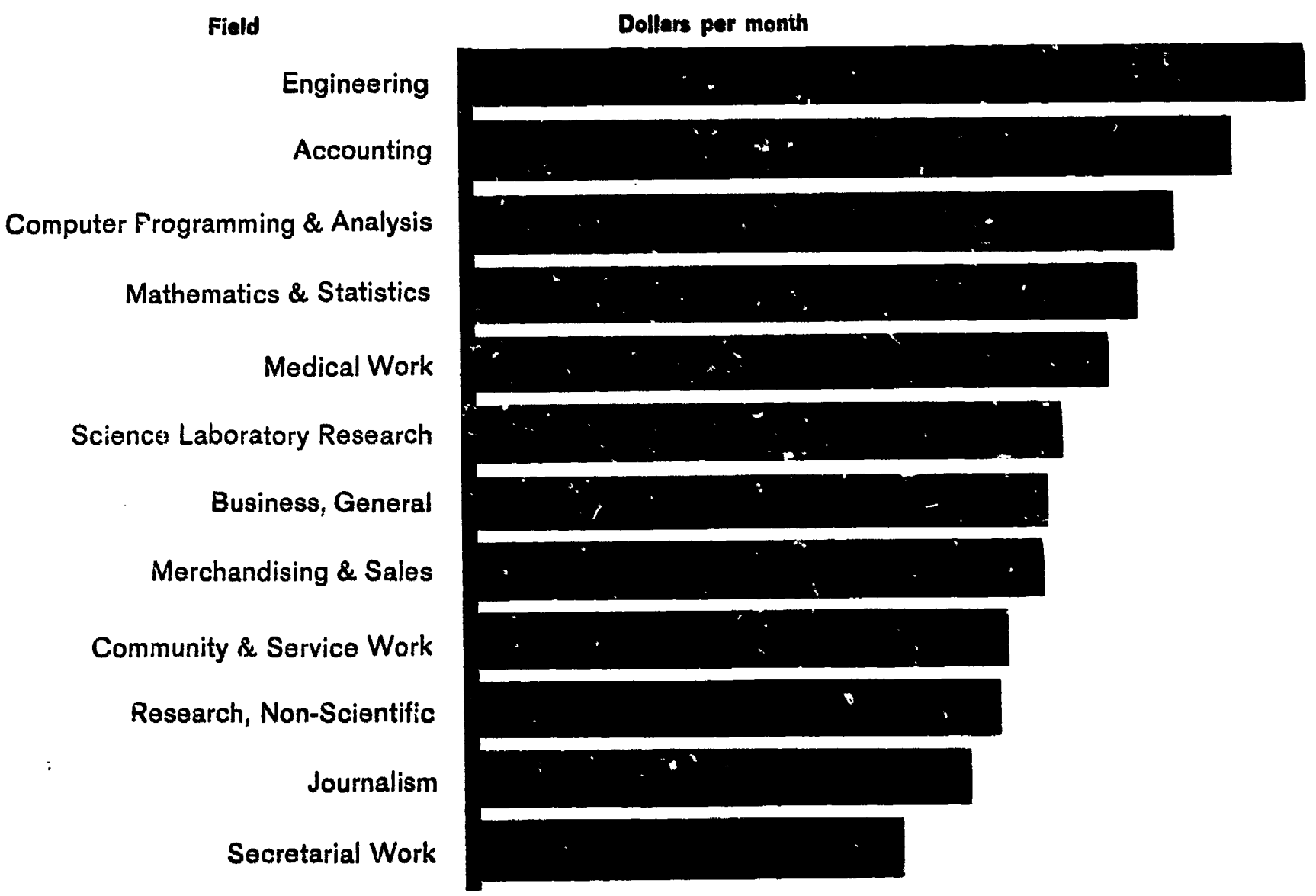
[1] *Women and the Scientific Professions,* edited by Jacquelyn A. Mattfeld and Carol G. Van Aken. 272 pp. The M.I.T. Press, Cambridge, Mass. 1965

of engineering degrees earned by women in the last 20 years. These statistics show that the proportion of women engineering graduates has increased steadily until it is now five or six times greater than in the 1950's, although the ratio of women to men is still well below 1:100. In recent years, however, there seems to have been a gradual increase in the percentage of women enrolling as students in the nation's engineering schools. Thus in fall 1971 women constituted about two and one-half percent of the entering freshman class as compared to just over one percent of the seniors. Many schools have substantial numbers of women undergraduate engineering students. The ten largest in 1971 were M.I.T. with 183, University of Puerto Rico--181, Pennsylvania State University—134, Lamar State University (Texas) —123, Vanderbilt University—94, Purdue University—84, University of Michigan—84, Michigan State University—82, Newark College of Engineering—76, and the University of Illinois at Urbana with 68.

The demand for women engineers is perhaps best documented in terms of salaries employers are willing to pay. In 1971, the average salary offered to women engineering graduates at the bachelor's degree level was $885 per month. This must be placed in proper context by comparing it not only to the average salary of $877 offered to male engineers but also to salaries of women graduates in other career fields. Such a comparison, shown graphically in Figure 1, reveals women engineers as virtually the aristocrats of their graduating class.

It should not be assumed, however, that women and men engineers follow identical educational and employment patterns. Figure 2 shows that the distribution of men and women engineers according to curriculum is quite different, with the women tending to concentrate more heavily in chemical engineering and less so in mechanical and electrical engineering. The employment pattern of women engineers is shown by Figure 3. In comparison with men, women engineers are more heavily

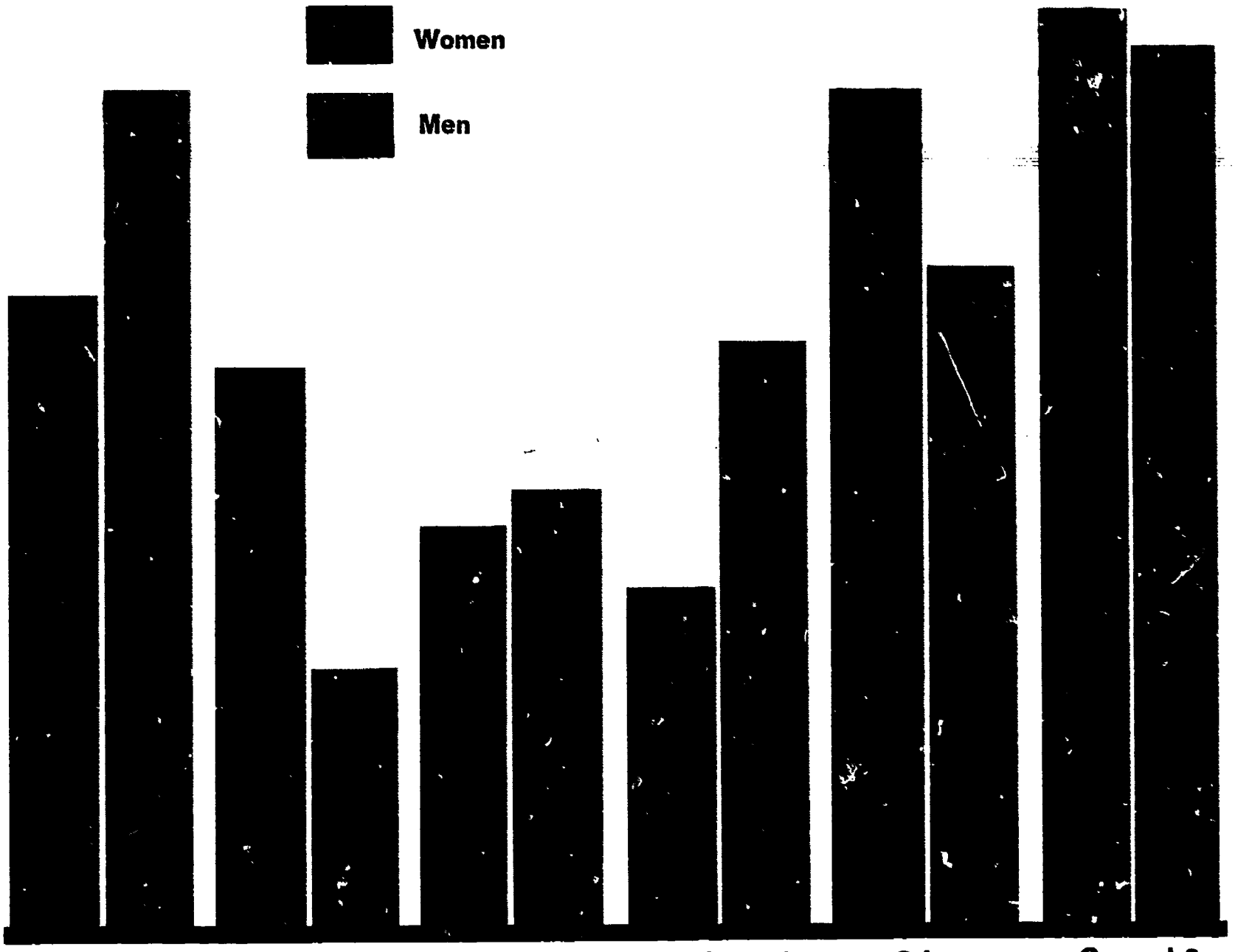
STARTING SALARIES OF WOMEN BACHELOR'S DEGREE GRADUATES IN 1971, ENGINEERING COMPARED WITH OTHER FIELDS



Source: Adapted from reports of the College Placement Council, Inc., 1971

FIGURE 1

DISTRIBUTION OF ENGINEERING STUDENTS BY CURRICULUM



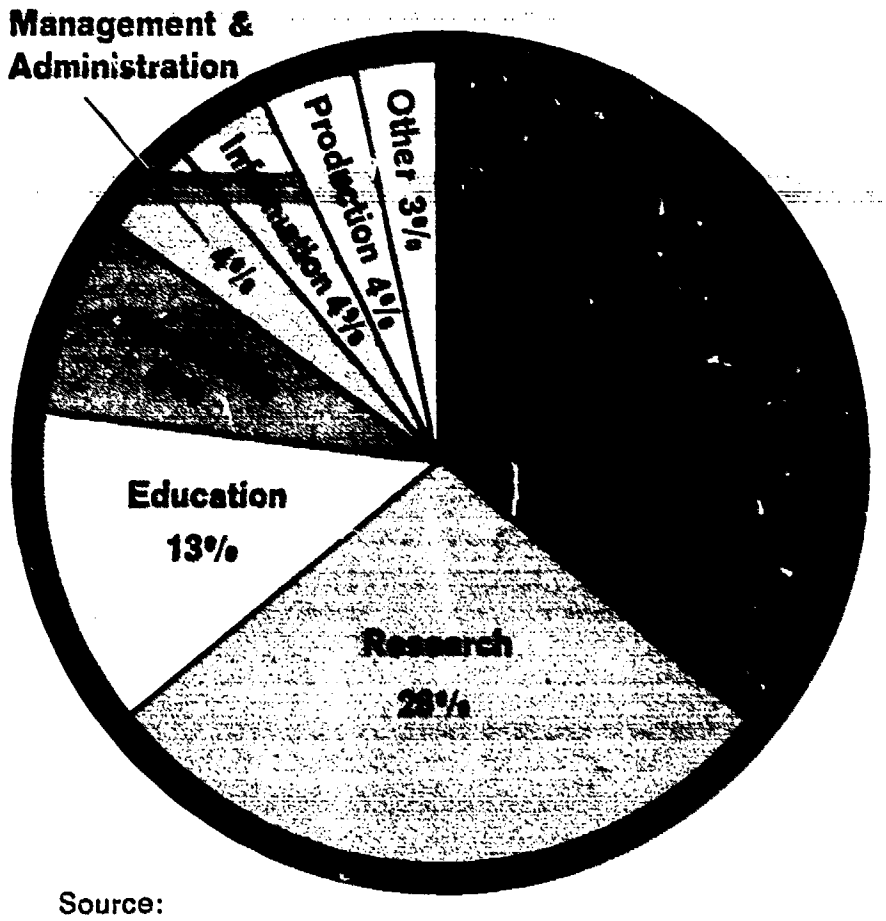
Source: Women—Society of Women Engineers survey 1969-70
Men—Engineering Manpower Commission survey Fall 1969

FIGURE 2

concentrated in research, development, and design and less in production, construction, administration, and management. The reported tendency of women to favor such areas as systems analysis and computer applications is in part a natural consequence of their choice of curriculum; in part due to a preference for jobs not involving the physical demands of fields like construction or mining; and no doubt in part the result of longstanding tradition, "conditioning," or even prejudice on the part of U.S. society in general. There are, however, virtually no engineering fields into which women have not entered. Women who are working in engineering generally seem to feel that employment patterns appropriate to the special interests and abilities of women should be somewhat different from those for men, as long as equality of opportunity and equal pay for equal work are in fact offered.

Within the engineering profession women are to be found, of course, in all of the professional societies appropriate to their discipline or technical specialty. In addition they have an organization of their own, the Society of Women Engineers, which currently numbers a membership of about 1,100 and is dedicated to making known the need for women engineers and encouraging young women to consider an engineering education. Information on the program of this group, and on the role of women engineers in general, may be obtained from Mrs. Winifred D. White, Executive Secretary, Society of Women Engineers, 345 East 47th Street, New York, N.Y. 10017.

DISTRIBUTION OF WOMEN ENGINEERS BY KIND OF WORK



Source:
Adapted from Society of Women Engineers survey, 1967

FIGURE 3

WHY DOES ENGINEERING NEED WOMEN?

This question is frequently asked by people to whom the concept of engineering as a woman's occupation may appear novel. It is also asked nowadays by those who believe there is a surplus of engineers and therefore no reason to encourage women to enter an already overcrowded field. To answer the last objection first, all available evidence indicates that the employment problem of 1970-1972 stems not so much from an overall surplus of engineers as from a maldistribution of the supply in terms of specialized competence and geographical location, and the danger of technological obsolescence overtaking older engineers. These problems cannot be minimized, but neither can they be solved simply by cutting down the input of college graduates into the profession. The strong demand for new engineering graduates as exemplified in the salary offers cited earlier is perhaps the most convincing argument against those who believe engineers to be in surplus supply as compared to other professional fields.

More basically, the engineering profession needs women because no profession or occupation can exclude, or afford to have the public think that it excludes, half of the population because of sex discrimination. Engineering is indeed a profession open to all, but it needs more women and more minority group members to make its case convincing. The fact that women may have stayed away from engineering on their own volition is no longer an adequate defense for not attempting to attract them. Women can add strength and breadth to the profession by virtue of their individual talents and interests. The impact of technology on society is felt by men and women alike, and it is only reasonable that women should contribute a strong input here as in other areas of life.

Additionally, engineering and technology need to be better understood by the public at large because our entire society is intimately involved with the products, processes, by-products, and effects of technology. Whether or not people actively practice the profession of engineering, they can benefit in many ways from a knowledge and understanding of engineering. The fact that one-half of the population—the female half—is largely unacquainted with the principles and methods of technology is clearly a detriment to the engineering profession.

Engineering schools too, faced with a general decline in male enrollments, need to broaden the base from which they draw their students. Women, constituting the largest single underutilized group, are an obvious potential source of new recruits to engineering education.

WHAT KEEPS WOMEN OUT OF ENGINEERING?

Investigators are generally in agreement that the main factor tending to deter women from entering engineering is the male image of the profession. Because of this, girls from an early age are discouraged from seeing themselves as engineers. The tragedy of this early conditioning is that it is very difficult to overcome later. If a young woman approaching college entrance decides that she might like to seek a career in engineering, she is unfortunately likely to find that she is lacking in exposure to some of the desirable prerequisites, such as mathematics or science courses and a general familiarity with technological "hardware." This often puts her at such a disadvantage in competition with other candidates for admission to engineering schools that she may elect to enter some other field where a rigorous science and mathematics background is of less importance.

There is less agreement as to the reasons underlying the unsuitable image that engineering presents for women. Some think that the profession, or strong elements of it, deliberately cultivates a male image and therefore discourages women from entering engineering. Such attitudes unquestionably exist among individuals and may have been quite pronounced in the past. The mere fact that the profession is 99 percent male reinforces the view that this is how it will remain. Women can easily cite instances of "male chauvinism" among engineers of their acquaintance, even though these may seldom represent real prejudice. Nevertheless, only one or two such incidents may be enough to discourage a young woman who has had to overcome many other prejudices before even considering engineering as a career.

On the other hand, it is difficult to find cases of outright discrimination against women on the part of engineering schools. There is no evidence that qualified applicants are being denied admission because of their sex, or that women students are treated unfairly by engi-

neering educators. Those engineering schools that are part of all-male colleges provide only a small percentage of U.S. engineering enrollments. At worst, engineering schools in general can only be accused of not seeking women students aggressively enough, and many schools cannot even be charged with this.

Among employers, policies and practices that discriminate against women are rapidly becoming a thing of the past, although some prejudice will always exist because of individual attitudes. It is sometimes pointed out that women are conspicuously absent in top managerial positions, but as long as women constitute less than one percent of the engineering population it is unrealistic to expect to find many of them at the top. In fact, such examples as Grace Hopper in computer engineering, Olive Salembier in the packaging field, Betty Yost in electrical engineering, and Naomi McAfee in quality control can be cited to prove that women have succeeded in reaching highly responsible engineering positions.

The negative image of engineering among women cannot be attributed to any single cause. It is apparently fostered by women themselves as much as by men, and is the result of deep-seated misunderstandings and prejudices among large segments of the U.S. population. Because engineering in this country has been and still is predominantly a male occupation, too many people assume that it must be and should remain an unsuitable field for women. It is the aim of this Bulletin, in a small way, to help dispel the notion that women are unneeded and unwanted in the profession of engineering.

PROBLEMS FACING WOMEN IN ENGINEERING

In addition to the problems women face in overcoming the male image of engineering, there are serious difficulties that confront the woman who seeks an engineering career. These particular problems are not peculiar to engineering, but are common to other professional pursuits followed by women. However, certain aspects of engineering work may well accentuate difficulties that are more easily manageable in other occupations.

Advocates of "Women's Liberation" have amply spelled out the problems involved in combining marriage and motherhood with a career of one's own. These problems certainly exist in engineering. If a person's mobility is limited, he or she will obviously have less flexibility in pursuing opportunities toward advancement. If a person's responsibilities toward home and family must take priority over the demands of a job, it is evident that some aspects of job performance will have to suffer. The special problems in engineering, however, stem from the inexorable pace of technological change. So rapidly is new knowledge developed and so quickly does new technology displace the old that premature obsolescence is a constant threat to any engineer, male or female. Some women may still want a career from which they can take a few years off in order to raise a family. Such careers are possible in engineering but not as widely available as in some other occupations. A woman engineer should recognize that prolonged absence from the profession will limit her opportunities for returning to engineering work at a later date and may be a handicap in advancing both technically and managerially. The same problem, of course, is faced by men who leave the field temporarily because of military service, illness, or other reason. Technological obsolescence makes no distinction between the sexes.

WHAT ABOUT THE FUTURE?

Powerful social forces are at work that will make it increasingly easier for women to avoid many of the problems of the past in pursuing careers in engineering or science. It has become eminently respectable for a woman to seek a career independent of husband and family. Federal legislation now mandates equal opportunity for women in seeking both employment and promotion. Employers are now required to have affirmative action plans to demonstrate their compliance with the law. Consequently the demand for women engineers is currently very strong despite the relatively higher level of engineering unemployment compared to past years. There is every indication that the doors will be wide open for many years, until the proportion of women in engineering becomes more nearly equal to their proportion in the total population. At the same time, women newly entering engineering will find that they are not strangers in an alien world. The path has already been broken by thousands of women who have demonstrated that women can be successful as engineers.

The range of interests and talents among both sexes is such that large numbers of women are potentially qualified to enter engineering without in any way sacrificing their femininity. In the words of Bruno Bettelheim, Professor of Education at the University of Chicago and keynote speaker at the M.I T. Symposium on American Women in Science and Engineering, "we deeply need women scientists and engineers who are committed, as human beings and as good workers, to their profession, and who are committed to it in line with their female genius." Once the blinders of ignorance and preconceived false image are removed, women who undertake the commitment to engineering will find ample opportunity and satisfaction in applying a knowledge of the mathematical and natural sciences "to utilize, economically, the materials and forces of nature for the benefit of mankind."