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WOMEN CAN BE ENGINEERS

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INTRODUCTION

I have come to speak on, "Women Can Be Engineers," and I'm undoubtedly supposed to be live evidence that this is indeed true. I was graduated from the University of Illinois in 1950 with a B.S. in Mechanical Engineering. Since then, I have been employed by the General Electric Company on a variety of stimulating and responsible jobs. The biggest portion of this experience is represented by eight and a half years working on the design of jet engines. Most recently, I have been working on space projects. My current responsibility is for the adapter and payload separation system which goes between the new Nimbus meteorological satellite and the booster. I am a registered professional engineer in the states of Ohio and New York.

Actually, I am quite pleased to talk to a group which is primarily high school guidance counsellors because I believe there are some special problems in counselling girls about engineering and that it is well worth understanding these problems.

One of my friends, who is also a woman engineer, has done a considerable amount of high school counselling. She refers to it as, "telling the girls we don't have two heads." In other words, high school students are often going through a phase where they fear to be different from others. This, coupled with a lack of

knowledge about engineering, means that the majority of girls who would make good engineers probably don't even give it a thought.

PERSONAL HISTORY

Fortunately, my oldest sister and her husband counselled me about taking engineering during the summer between my junior and senior years of high school. That same summer, I was working at the Chicago Bridge and Iron Company as a combination file clerk, mail clerk, and general flunkie. Although I didn't work in engineering, I saw enough of that plant to realize that engineering work would have less routine in the daily work than most of the other jobs. I did like mathematics and science, especially physics, in high school. I was fairly sure that I didn't want to teach or do pure scientific research, so that fall I decided I would take engineering in college. I had never known any women engineers directly or even through a mutual friend. Once I had seen a picture of some women engineering students in a magazine. In other words, this wasn't an altogether convincing background on which to base a decision to take engineering. I certainly wasn't at all sure that it would work out all right. This, combined with a fear of not wanting to be different, meant that for the first two years of college, I was quite careful not to "let it slip" that I was an engineering student. During my third year, I didn't mind if people found out I was in engineering college, and by my fourth year, I would talk about it openly. This was after I had worked the summer between my junior and senior years at Holley Carburetor in their engineering laboratory. This job gave me confidence that my lack of practical background would not seriously interfere with being an engineer. Like most girls, I had been supplied with dolls instead of erector sets and had never been exposed to tinkering on a car.

By the end of my four years here, I had been successfully converted from a high school girl into an engineer. Frankly, I found my college homework more to my liking than that in high school. In addition to completing the formal course of study, I had learned to become "one of the boys." The faculty here had never paid

any special attention to me and that is the way it should be. In other words, when a properly qualified girl gets headed into engineering, she should be left alone. After she graduates, she has to perform to the same standards as anyone else and it wouldn't be fair to the girl to give her special attention in college.

JOB SATISFACTIONS

What does await the new engineer when he or she graduates from college? As I see it, one of the greatest satisfactions of engineering work is the mental stimulation it provides. Over and over again, you are asking yourself such questions as, "How can we get such-and-such done? Suppose this and so happens. How will we manage to get things going again? Since we can't get item X in time, what can be used in its place? Something looks fishy here -- just what is going on?" Over and over again you are stretching mentally, reaching for answers. It's not just a matter of asking questions of someone else who already knows the answer. Sometimes that can be done, but mainly there is a need for answers to new questions that haven't been asked before. Since engineering jobs deal with practical problems and projects, these questions must be answered within a time limit. Consequently engineering is characterized by finding a workable but not necessarily perfect solution to a given problem and then rushing on to tackle the next quandary.

Another primary satisfaction of an engineering career is the sense of physical accomplishment you can get from your work. It doesn't matter whether it is a new power station, a new airplane, or another space satellite. It is something which is real, and part of it seems to be yours. I've never designed and patented a device which is sold commercially, but many engineers do; and I'm sure it's a great satisfaction to them.

Besides these direct feelings of satisfaction, an engineer also feels that he or she is in on the forefront of the scientific revolution. By the scientific revolution I mean a change comparable to the industrial revolution of the past. The scientific

revolution is characterized by such things as automation, large budgets for research computers, and, hopefully, the supplanting of space exploration for warfare as a means of international rivalry. Because of this scientific revolution, we have now reached the point where the so-called liberal education is incomplete if it does not include courses in both the biological and the physical sciences. A person without any scientific background is basically stunted in his comprehension of the modern world. Some of these people may even fear science simply because they do not understand it. On the other hand, people with engineering or science backgrounds have the satisfaction of being the most active participants in the scientific revolution. Unfortunately, we may as a country tend to lag in this scientific revolution simply because we are not able to staff it with the large numbers of trained people it requires. The selection of college majors by high school students is largely based on tradition in this country. This generation tends to take what the last generation took in about the same proportions because that is what they hear about from the generation before them. In America, our engineering enrollment was 12% of our college students in 1950 and 9% in 1959. How are we to tackle the vast job of working out the practical applications of a steadily growing body of scientific knowledge if our engineering enrollment is actually falling off slightly? I'm sure everyone knows that Russia graduates more engineers than we do, but it is also interesting to note that in this same period of 1950 to 1959, their percentage of college students in engineering rose from 20 to 32%. Through direct cognizance of the scientific revolution, Russia is taking steps to meet its requirements. We in this country are dependent on the advice of counsellors like yourselves who can recognize that we are in a scientific revolution and can tell the high school students that it behooves those who are qualified to participate fully by becoming engineers or scientists. Let me hasten to add that ability is needed and not sheer numbers. An obvious comment here is that girls should be just as thoroughly screened for talent as boys if we are to find a substantial means of increasing our engineers and scientists without sacrificing quality.

JOB POSSIBILITIES FOR WOMEN

If I tell you that high school girls should be screened for engineering talent, it is only appropriate that I discuss the job possibilities for women engineers as frankly as possible. The best investigation that I know of is a 1951 survey conducted by the National Society of Professional Engineers. Since this was taken eleven years ago, the results are probable conservative. Nevertheless, the survey results are probably of good basic quality since the survey was based on replies from 500 employers operating 4000 plants. The tabulated replies showed the following:

- 65% would hire women engineers if available
- 45% had found it "feasible" to use women engineers
- 23% had women engineers on their staff.

In other words, the majority of employers contacted would hire women engineers if they were available.

There is a sizeable minority of employers who will not hire women engineers, but I don't think this should discourage a high school girl. After all, the number of engineers in this country is well over 500,000. Why should a young woman be concerned that only 300 to 400,000 jobs are open to her when many of her college classmates will have majored in some specialized field where the entire job potential in the country is only 20,000 or so? Engineering simply is such a large field that you don't need to have all the jobs open to you in order to have good job offers.

As for availability, the NSPE survey certainly is correct in indicating that women engineers aren't available in any great quantity. A current estimate would be about 3000 for the entire country, which is less than one per cent of American engineers.

A pertinent estimate on the classifications of engineering jobs shows that roughly 75% are in design, administration, research, and development, while 25% are in manufacturing, production, construction, and operation. In other words, the first and larger group of jobs are primarily office or laboratory jobs, while the smaller group are primarily shop and field work. It is only natural that employers would be more receptive to hiring women for office and laboratory jobs. Let me also point out that the jobs which are primarily shop and field work have sometimes been filled by women. By now I have heard of enough women engineers in such jobs that I would not consider any engineering job impossible for a woman. To give an example -- an engineer on a construction job is there to see that it is done right, not to personally wield a sledge hammer.

Another hopeful sign on the broadening of job opportunities for women in engineering is the change in attitudes which are expressed in articles on women engineers today compared with when I started my first real engineering job twelve years ago. In the early 1950's, if a popular magazine or Sunday newspaper supplement would run a biography on a woman engineer, they often would present her as a freak or a peculiar curiosity. I started a scrapbook for counselling purposes at that time, and quite a few of the articles on women engineers I found then simply weren't suitable for counselling purposes and didn't get put into the scrapbook. Lately, the non-technical publications have displayed an attitude of esteem and respect in their articles on women engineers. It has been several years since I have rejected an article for my scrapbook.

FAMOUS WOMEN ENGINEERS

Although women engineers receive some publicity because of their relative scarcity, it is certainly true that there are far too many today for them to be individually well-known. The famous women engineers belong to the past.

The first woman engineer who achieved conventional recognition as an engineer was Miss Edith Julia Griswold, who had some courses in civil, mechanical,

and electrical engineering, as well as law. In 1886, she opened her own office in New York City as a draftsman specializing in patent drawings. Her official recognition as an engineer came in 1925, when she was listed in Who's Who in Engineering as an engineer and patent law expert.

Perhaps better known is Miss Kate Gleason, who enrolled as a special student in Mechanical Arts at Cornell University in 1884. She received additional training from her father at the Gleason Gear works in Rochester. She became well known for her worm and gear designs and in 1914 became the first woman member of the American Society of Mechanical Engineers. Later, she represented ASME at several world conferences. That would have been enough for any ordinary woman, but Kate was also the first woman bank president in the United States, and was also noted for the design and manufacture of fireproof houses.

These women mentioned previously did not have engineering degrees. This was really not too uncommon back then, since engineering was still in the transition from apprenticeship to a formally educated profession. The first woman to obtain an engineering degree was Bertha Lamme, who was graduated from Ohio State University in 1893. She was employed by Westinghouse as an engineer for twelve years, then married and retired in 1905.

The most famous woman engineer today is Dr. Lillian Gilbreth, now in her 80's. She is known as an expert on time study and also has done many studies on fatigue and skills. The movie based on the book, "Cheaper by the Dozen," described her large family and her engineer career. She has received the Washington Award which is a joint award of several technical societies for her professional contributions. Incidentally, she is a classic example of a woman engineer who started out in another field. Her first two college degrees were in literature.

CAREER PROBLEMS - SUPPOSED AND OTHERWISE

These early women engineers undoubtedly did have some real problems because of their sex, but today the problems are actually much less than generally supposed. In fact, the real problems of being a woman engineer are often not the generally expected ones. For instance, men will generally remember the name of a woman engineer, but I often don't remember their names in return since I'm not very good at remembering names. The one thing that saves me is that we all have to wear badges where I work and I can sneak a look at the name on the badge of the person I'm talking to.

People often ask if I have trouble getting along with my supervisors. By now, I must have had a dozen or two different supervisors in my career, and I have gotten along well with all but two. These two men were having similar troubles with men engineers, so I don't think the basic problem of our difficulties was based on my being female.

Another question people ask is how I get along on trips. This also doesn't turn out to be any problem. Obviously, if you are going out alone, the trip doesn't present any more problems than if you were on a vacation. If you are travelling with men, a woman needs to be broad minded enough to accept the fact that she may end up playing bridge in some hotel room as a means of "killing the evening." Engineering being what it is, she is even more likely to be working in a room discussing what should be said in tomorrow's meeting or marking up blueprints with proposed changes in design.

Often, I am asked if men resent taking directions from a woman. This just doesn't turn out to be the problem people think it is. I remember getting into an informal discussion with several men on this subject. One of the men said. "Oh well, most of us are married." I might add that the rest probably had mothers.

One of the real problems that women engineers do sometimes have is keeping up-to-date technically if they temporarily retire to raise children. Generally

speaking, if a woman engineer has worked five or six years after completing college, she will not want to retire permanently. Quite a few don't retire at all, and these of course make salaries which are big enough that they do have a fair sized net income after they pay the baby sitter. One recently publicized example of an employed woman engineer with a family is Maryly Van Leer Peck. She was featured about a month ago in the issue of "Life," devoted to "The Take Over Generation." Incidentally, you should perhaps reassure the high school girls that not all women engineers have as crowded a schedule as she does. She might scare them off with her husband, four children, full time job, housework, and a Ph. D. thesis to complete. Some women engineers who quit their jobs when their children are small keep up with the engineering world by doing work in their homes. One of the most common sources of such work is from consultants who occasionally have more work than they can handle. Those consultants who maintain their office in their own home are particularly agreeable to having a woman engineer do work in her home. How does a woman get to know such consultants? The easiest way is by being active in technical societies. At any rate, this problem of keeping current in engineering is something each woman has to work out for herself if she chooses to retire temporarily.

PROBLEMS ON THE HIGH SCHOOL LEVEL

Although the career problems of women engineers are generally exaggerated, there are some real problems involved in counselling high school girls. First of all, high school students generally know very little about industrial and government jobs. This is particularly so of the girls, although it is a serious problem for boys too. A typical high school student knows something about the jobs held by his or her close relatives and that is about all. In the case of the girls, it can also be stated that engineering will be alien to their background if they have had a conventional upbringing. This will make it much harder to convince a girl that she may have talents suited for engineering.

The high school girls are especially apt to reject engineering as a career simply because they fear to be different. At high school age, the girls are more

eager to conform to the expected pattern of things than they are later on in life. Let me tell you a story that demonstrates this.

This last Engineers Week in Philadelphia, the engineers had a luncheon at the Engineers' Club for selected high school students. Some of the high school students present were girls and some of the technical society members present were women. After the program, one of the girls approached a woman and asked her, "Are you a woman engineer?". When she was told "Yes," the girl then stated, "But you look like other ladies." Actually, if you knew the woman involved, I'm sure you would agree that she looks "better than most other ladies" rather than "like other ladies."

Another stumbling block to the young girl considering engineering as a career is the matter of marriage. She wants to know if marriage can be combined with a career. Many women certainly do combine both, although engineering probably is somewhat harder to combine with marriage than some other careers. Roughly, 40 to 50% of the active women engineers are married. You may not see as much of the married ones at technical society meetings, but this is understandable because a job and a home put a considerable demand on their time.

PERSONS TO ENCOURAGE INTO ENGINEERING

Now that I've discussed the inherent problems in counselling high school girls about engineering, I should also discuss who should be told about engineering as a possible career.

First of all, they should be students who like mathematics and science. They should have a good intelligence although they do not have to be at the very top of their high school class to succeed. Their intelligence should be strong in the area of logical reasoning rather than rote memory, although it certainly doesn't hurt to be good in both. If an engineer can remember drawing numbers and specification numbers without looking them up, it is convenient, but it is not a fundamental requirement of his or her job performance. Judgment and ability to find logical solutions to engineering problems are far more important.

A reasonably good facility in English, both written and spoken, are necessary for success as an engineer. Clarity of expression is vital to an engineer although he can get along without being entertaining and "clever."

While it is desirable for a potential engineer to have shown an interest in the practical applications of science, it is not essential as long as the interest and aptitude is there. This is particularly important in the case of girls who may not have been encouraged to do such things as dismantling alarm clocks, tinkering on a car, or building electronic kits.

Actually, one of the basic traits which tends to differentiate between engineers and scientists is the matter of an economic bent. An engineer must provide a solution to a problem which is good enough to function satisfactorily in the required situation. It may not be a perfect solution and maybe the engineer isn't even certain exactly why it does work, but the solution does satisfy the needs of the particular problem without

costing more than the necessary funds. If a person would find it painful to adopt a less than perfect solution to a problem, he should be a scientist.

While on the subject of traits, it should be mentioned that an engineer needs to be both a good team member and a good leader. This is the age of large engineering efforts in which all must work together as effective members of a team. Nevertheless, when this large project has been subdivided, even a beginning engineer will find that he is called upon to exercise leadership in his relatively small portion of the overall job. He or she must assume the assigned responsibility and give adequate technical direction to the people in drafting, purchasing, manufacturing, data processing, etc. This matter of engineering leadership does not require an extrovert personality, but rather a willingness to assume responsibility and the ability to give directions clearly.

Another important trait for a potential engineer is that of a sustained interest in things. Engineering projects typically take a long time. There will be periods, generally in the middle of a job, when accomplishment is not readily apparent. The engineer must not be discouraged but keep on for the several years that it often takes to complete a particular project. In the long run, an engineer will get a feeling of satisfaction which bears a relationship to the size of the job as well as to its ultimate success.

The desirable traits which I have been discussing are needed by both boys and girls who are considering engineering as a career. What about those traits which are especially required of the girls? First of all, she should not expect that any special favors will be shown her simply because she is a woman. Since she is to receive a standard salary for a standard job, it is only fair that she supply a standard performance.

Another important trait for a woman in engineering is that she should think of

herself as "one of the gang" at work. What this means is that she should have an essentially neutral attitude toward being a woman engineer. She shouldn't have a "chip on her shoulder" or defensive attitude. What is more likely is a self-conscious attitude. Actually, this can be overcome with time by the age old method of becoming so interested in what you are doing that you forget about yourself. Both the overly self-conscious and the defensive attitude toward being a woman engineer are negative attitudes. On the positive side, a girl who wants to take engineering primarily because she desires to be with men would be taking engineering for a wrong reason. In other words, the best attitude for a woman engineer to have about being a woman is a neutral attitude of being unconcerned. Naturally, it would be easier on her as well as her fellow employees if she is not an ardent feminist. In summary, a girl going into engineering should be either unconcerned about going into a "man's field" or she should be capable of developing such an attitude after an initial period in which she can get rid of her self-consciousness.

NEED FOR BETTER COUNSELLING

Having discussed the various traits to look for when counselling girls about engineering, I would like to emphasize the importance of proper counselling.

A surprising number of the active bona fide women engineers today did not start out to be engineers. They may have started out as liberal arts majors or teachers. Later on they became engineers by attending night school, taking special courses, and/or acquiring special training on the job. Special engineering training was taken by quite a few women during World War II. A typical example of such a person is Commander White, an electronics engineer who is the only woman in the U.S. Navy assigned to engineering duty. She began her working career as a teacher. During World War II, the Navy was making electronics experts out of anyone with proper aptitudes since persons already knowledgeable in this field were quite scarce. During Commander White's career in the

field of electronics has emerged from infancy to a well-developed technological speciality. Today, there is a considerable supply of electronics engineers available from the engineering colleges. In other words, if she were to prepare for her present job with this generation of young people, it would be necessary to take electrical engineering majoring in electronics. This is typical of engineering today. To get into the field, an engineering degree is required. About the only exceptions are the persons with science degrees who sometimes slip into engineering jobs after graduation.

Like many other professions who formerly trained young blood by a form of apprenticeship, engineering is now essentially a profession of formally educated college graduates. Today, the engineer whose training is partly by courses and partly by on the job experience is generally a man close to retirement age. The women engineers have perhaps a higher percentage of practitioners who entered the profession by what is now regarded as the back door. By coming into engineering after an attempt at another career, the women are showing that they were not adequately counselled at an appropriately early age. During their initial working years, they were dissatisfied and probably earned less money. However, for today's young people, it is practically impossible to correct an unfortunate career decision by going into engineering via the "back door." The young women of suitable abilities and traits need to be told about engineering as a career while they are still in high school. The "front door" is open for an engineering career, but the high school girls don't know it yet. It is up to you guidance counsellors to tell the girls that engineering can be a very satisfying career for a woman.