

# **ENGINEERING CAREERS WORKSHOP FOR HIGH SCHOOLS GIRLS AND THEIR MOTHERS**

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## **ABSTRACT**

This paper describes a six-week long Saturday Academy Workshops for Mother and Daughters conducted at California State University Los Angeles (CSLA), with the goal to inform and excite female high school students about career opportunities in engineering. The workshops consisted of lectures, career exploration sessions, hands-on experiments and contests. The mothers were invited to be informed and to provide moral support to daughters in the hard decision of choosing a career. This paper describes the effort and the results obtained.

## **INTRODUCTION**

Recent statistics have shown that engineers are the best paid professionals entering the work force with four years of college education. In the past year the number of engineers employed in the U. S. has increased from about 1.7 million to almost 2 million.<sup>1</sup> According to US Department of Labor statistics, nearly two-thirds of the new entrants into the work force in general are women and by the year 2000, nearly two-thirds of working age women will have jobs.<sup>2</sup> However, current low level of female engineering students will preclude women in achieving equity in employment and in pay scale of entering engineering graduates.

Different studies have traced the low female participation of math and science based careers to the math anxiety and science avoidance of girls in middle schools. Although agreeing with these findings, I have found from my own experience as a mother and educator that even female high school students who excel in mathematics, like those who take calculus in high school, rarely consider engineering as a valuable career. This can be observed from a number of female honor students and the number of women entering engineering. As an

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<sup>1</sup> Edward Wenk, Jr. "Teaching Engineering as a Social Science", PRISM, American Society for Engineering Education Publication, Volume 6, No. 4, December 1996.

<sup>2</sup> US Department of Labor, June 1987. "Workforce 2000". Washington, DC: US Government Printing Office.

example, I noticed this in the 1995 graduating high school class of Glendale (California): from about 50 female honor students only two showed interest in studying engineering. According to National Science Foundation (NSF) statistics only 11% of engineering students are female.<sup>3</sup>

One of the most important reasons for that, according to my experience is the influence of mothers on the career choice of the girls. When asked what they would like to study, most high school girls answer, "I do not know." When asked who is the biggest influence in their careers the answer is usually the parents; for girls, the mother is the main influence. Mothers are intentionally or unintentionally molding the career path of teenage girls. Unfortunately, most mothers, due to previous and existing bias, have very limited formal mathematical and physical science background. Questions asked in math and science areas are referred to fathers, proving the stereotype that these problems can be solved only by men; therefore, math and physical science should be avoided by girls. Most math and science teachers are also male, so it is no wonder girls feel lost in "a man's world" of science and mathematics. While boys getting C's and B's in math in junior high school consider science and engineering for their careers, only girls with A's in math might do so. Others are "scared to death," they "hate math," and they try to avoid these classes as much as possible. Mothers are not a big help in these cases, having had identical experiences when they were in school.

However, I have found from my own experience that many mothers are very enthusiastic when properly introduced to experimental aspects of science and engineering. In the past at our school, we have organized special experimental presentations to the students involved in Gifted and Talented Education programs in high schools and junior high schools. I often worked as a volunteer in the Strength of Materials Laboratory. Although approximately 50% of participants were girls, boys tried to participate most actively in experimental activities. Being sensitive about these issues, I tried very hard to get girls involved. To my surprise, I have discovered that mothers who accompany children to our school have often shown more interest in experiments than students. Comments like: "I never knew that this works this way," "this is so interesting," "they (students) do not know what they are getting; I wish we had learned this when we were in school" are common.

Also, as a mother of two children and former member of the Parent-Teacher Association (PTA), I have seen that mothers often show interest in my career. Several middle-aged women told me, often with a touch of sadness, how they wished to have studied some science or engineering but were discouraged by their mothers, counselors, and teachers. They are especially surprised when I tell them that I was strongly encouraged by my mother (who was a foreign language and literature teacher in high school) to study engineering. My mother, due to her experience in WWII in Europe, believed that the best way to succeed in life is to have a profession. In my home country of Bosnia, engineering was a profession that had a future.

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<sup>3</sup> NSF Directorate For Education and Human Resources: "EHR Activities for Women and Girls in Science, Engineering and Mathematics, Program Sol., Infor. and Guidelines" NSF, 93-126.

*Based on my own experience and discussion with other women, I feel that a necessary component in motivating girls to take more "hard" science and math classes in junior high school and senior high school and eventually enter science and engineering careers, is to involve mothers more actively in the process.*

### **MOTHER-DAUGHTER WORKSHOPS AT CSULA**

With the above thought in mind, I have applied and been successful in receiving two grants from California lottery funding to prepare and conduct in Spring of 1995 and 1996 a set of introduction to engineering workshops for MOTHERS AND DAUGHTERS (or any other female member of the family interested in girls' development).

The MOTHER-DAUGHTER workshops in 1995 and 1996 consisted of six Saturday half-day sessions with lectures, demonstrations, hands-on experiments, contests, factory tours and career exploration and were conducted in Spring 1995 and Spring 1996 at California State University, Los Angeles. The goal of the project was to:

- a) encourage girls to consider engineering as valuable option for their future careers,
- b) to dispel a myth that engineering is physically difficult and "non-feminine",
- c) to raise the level of scientific knowledge of the general population (especially female),
- d) to foster appreciation of the general public for engineering professions

The workshop concentrated on the four most common engineering branches: mechanical, civil, electrical and manufacturing. All demonstrations and lectures were performed by women (students and faculty) to reinforce the notion that women can do engineering experiments and do them well. Two hours of each workshop consisted of lectures, technical videos and demonstrations, and two hours were "hands-on experience" experiments and contests. The contests that the participants competed in were chosen so that the students succeeded in participating in them. According to Bandura's theory of self-efficacy, perceived outcome expectancies need to be sufficiently positive to motivate the person to perform a given task.<sup>4</sup> Self-efficacy is defined as one's belief how well she or he can perform a given task or behavior.<sup>4</sup>

The contests were: bridge-tower building contests (related to civil engineering), egg-drop contests (related to materials, and mechanical engineering), solar car race (related to electrical and power engineering) and CAD-CAM contest (related to manufacturing engineering). Winners of the contests were rewarded with scientific calculators during the last session of the workshops. Awards were also given for the best attendance and most enthusiastic participants, so that eventually scientific calculators are given to each high school student. Several special handouts, describing the material covered, were developed and given to participants.

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<sup>4</sup> Bandura, A. "Self-efficacy Theory in Contemporary Psychology", Journal of Social and Clinical Psychology, Volume 4, No. 3, 1986, 359-373.

The first session of the workshop was career exploration conducted with the help of members of Los Angeles Chapter of Society of Women Engineers (SWE) and CSULA female engineering students. At that session, several CSULA Engineering, Technology and Manufacturing Coalition recruitment tapes were shown to the audience (after all this was supported by CSULA and some public relation effort was in order).

The last session of the workshop each year was a very successful visit to Hughes Space and Communication group of Hughes Electronics Company in El Segundo, California. Participants spent a day listening to the presentations about the company and the engineering profession, touring the company, meeting Hughes employees (mostly women engineers), and enjoying Hughes hospitality (delicious breakfast and lunch). Also, at that session, the certificates of participation were awarded and a survey evaluating the workshop was distributed. Hughes provided the newspaper reporter and photographer for the awards ceremony. These visits were organized with the help of Mechanical Engineering Department Industry Advisory Board members from Hughes Space and Communication Division. "Mother-Daughter" visits to Hughes were publicized with articles published in the "Journal, Hughes' Space & Communication Group publication." Hughes' has also provided funds to purchase calculators for the contest winners.

### **RECRUITMENT OF THE PARTICIPANTS**

In order to recruit participants for the first set of workshops, I have visited the math and science classes and met numerous times with teachers at two high schools in Glendale, the city where I live. I have also advertised the project at PTA meetings, and organized special meetings in my house.

The number of participants was limited to twenty in order to provide the appropriate "hands-on" experience. Although twenty participants signed up for the project, only a disappointing ten showed-up. The main problem was to find six Saturdays when the students did not have Advanced Placement exams, driver education exams, or other commitments. I have targeted high school students believing that they will be more interested in a choice of careers and more able to understand the presentations rather than junior high-school students. Although the group was small it proved to be enthusiastic and dedicated. All five high school students, sophomores and juniors, attended all sessions while one mother was replaced by one father for one session. Three mothers were teachers, one was a school secretary and one a registered nurse. All of them were very enthusiastic, offering their help for future recruitment and keeping in touch. One participant decided to quit her job and continue her education on a full-time basis, one donated a modest amount of money to the Department of Mechanical Engineering at CSULA for this program.

For the workshop in 1996, in addition to the presentations at local high schools I have distributed material to different schools in the Los Angeles area. Several previous participants have helped in publicizing and recommending the program. In 1996, 24 participants registered and 14 completed the program. All daughters attended all workshops, while mothers were sometimes replaced by aunts or grandmothers.

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## PARTICIPANTS' EVALUATION OF MOTHER-DAUGHTER WORKSHOPS

From an anonymous evaluation form distributed to the participants at the last meeting, it is obvious that the project was very well received. The survey was expanded in 1996 and its results are described below:

Roughly half of the participants (predominantly mothers) state that the project had exceeded their expectation, while the rest of them (except one who put "somewhat") felt that the project had met their expectations. Answers to other questions were equally positive. "Do you think involving mothers and daughters in this activity is a good idea?" All participants answered "yes." Here are some excerpts from their answers:

*"Yes, because it will boost the moral of the children who are still undecided on what to take & mothers understanding of the subject could help the daughter."*

*"Yes. Mother provides a sense of support for the daughter! When they go home, they also have something to talk about, not like in school."*

*"Yes, it is not only a time for the mother and daughters to be a team in an activity. They also learn more about technology, and this makes them get involved more."*

*"Yes. It's a chance to bond with the daughter as she prepares for a career, and especially in a career as engineering. This field is complicated and daughters may need encouragement or help in what they are doing..."*

On the question, "Is there anything else that you would like to tell us?," all participants praise the program and suggest that schools should participate more in this kind of program. Due to the limitation of space, only two comments will be cited, one apparently from daughter and the other from one mother participant: *"I really enjoyed this workshop because it helped me to decide that I want to become an engineer. By having my mother here, she got to really understand what I like. I believe that the class size was also great, since there weren't many, a lot of interaction and communication was possible. Thank you for making this possible for us".*

*"Even though I have already chosen my career (illustrator), I also look forward to challenging and educational experiences. This course has broadened my vision into the engineering field. It has opened my daughter's eyes to see different fields available to her. Even though she is only 15, this course has enabled her to focus on a goal, that being her career in life. It is so much easier to attain goal when one sees that others have reached it already and they are WOMEN  
I hope to keep in touch with you,*

One mother, first year participant, wrote after the completion of the course in her letter: *...A change of attitude is critical to overcome stereotypes which bias women against entering the field of engineering. Your program is innovative and effective technique to motivate and encourage high school girls to consider non-traditional careers. The course content was instructive as well as entertaining. The women engineers who spoke to the class about their personal experiences and rewards in engineering served as successful role models. The projects and contests were fun and effective teaching tools. As a parent, I*

*appreciated the opportunity to participate in a program together with my daughter. Additionally, it was stimulating to be on a university campus and experience both lecture and lab classes ... It is an empowering and motivating program to encourage high school girls to consider engineering as a realistic career option... Thank you for sharing your enthusiasm and love for your work through this enriching series..."*

ALL DAUGHTERS, who participated in 1996, EXCEPT ONE, DECIDED TO STUDY ENGINEERING. Before the workshop only a few admitted they were considering engineering as future careers. All parts of the workshop were rated well although students gave preference to contests while mothers also liked theory and demonstrations. All of them rated the visit to the company highly. For most mothers this was the first time they had entered a high-tech company. Presentation of Hughes engineers, learning about communication satellites, and witnessing their building was an exciting experience for them. In addition, Hughes treated the participants very well, giving a Cross ball-point pen set to each and providing an excellent lunch and breakfast. Naturally, we have dispelled the impression that each day Hughes' treats its engineers to the same feast.

### **SUMMARY AND FUTURE PLANS**

This project is, to our knowledge, the first recruitment program in the nation targeting female high school female students and involving their mothers in that effort.

The best indication of the success of this project is the decision of all participants to support future workshops as volunteer consultants or recruiters. The extensive evaluation surveys project the enthusiasm of the participants for the project.

The problem of the previous projects is the relatively limited number of participants, due to the fact that 50% of the participants did not attend the program. It will be better if some fee could be charged as a deposit to ensure the participation; but this was against the rules of Lottery funding.

Also, a six-week program is quite extensive. The effort in the future will concentrate on the development of the modular approach: i.e. each participant would be able to sign up for two, three, four, five or six sessions. Although the visit to the company was a favored session, the goal of the workshop is also the education of the participants and increasing their understanding and appreciation of the engineering profession. After all, "overselling" of any profession does not yield results. We all know that engineering is a hard and serious profession. Neither students nor professional engineers spend their time making popsicle bridges and touring companies. However, activities should be on one side meaningful and on the other side attainable to participants so that they may benefit from the experience.

One of the important outcomes of this project is the realization that the serious type of engineering education (after all, the material covered in these workshops was similar to that covered in first engineering courses) can be made attractive and interesting to an audience with no engineering background at all.