A Taste of the Future: The Summer Engineering Program

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ABSTRACT

The problem of increasing engineering enrollment of female students to meet the national need has been of great concern to engineering educators. This paper presents the experience gained from the 1993 summer engineering program. Thirty female high school students in grade 11 participated. The program teaches engineering design through a product realization process and introduced engineering disciplines through laboratory work and field trips. With a stimulating first experience in engineering, the participating students built up their confidence. Evaluation results show that the program has been extremely successful in encouraging female students to consider choosing the path to an engineering career.

1. Introduction

The rapidly expanding work force of women who need engineering education is challenging engineering educators to develop effective strategies to increase recruitment and raise retention rates of women in engineering. The focus of these strategies is a strong education in science, engineering, and mathematics. However, few high school students, especially female students, are prepared for or even interested in these areas. The gap between high school education and college education has led to disproportionately low numbers of high school women entering undergraduate studies in science, engineering, and mathematics. National statistics show that women make up over 50% of the college age population, however, only 14% of the students in engineering are women. The retention rate is about 60%. In the professional world, only 6% of practicing engineers and 2% of engineering faculty members are women. The gender pipeline problem is evident.

During the past three years, the University of Maryland at College Park has developed a new engineering design course, which introduces basic engineering principles through a project approach. Students apply what they have learned in class to the design and fabrication of a real life product. They are highly motivated and, as a result, learn engineering fundamentals, develop critical thinking skills, learn to cooperate as team members, and gain practical hands-on experience. Statistics show that the program has been extremely successful in increasing interest in mathematics and science courses and encouraging them to pursue engineering study in college.

In the 1993 summer program, thirty students participated. With the support from the Maryland Space Grant Consortium, the students lived in dorms on campus while they were taking two academic courses during a six-week period. The design project selected was a glider rocker. Under the leadership of the Dean's Office, the summer program provided the participating students with a stimulating first

experience in engineering. Not only did they gain a clear understanding of what engineering is really about, but also they learned how to study, survive, and succeed in college.

2. Recruitment of Participating Students

Our study on attrition of women in the engineering education pipeline dictates that women students often fall between the cracks at the point of transition between high school and college. As an intervention strategy, our program targets students who just finished junior year in high school. Those students are naturally faced with the difficult decision of choosing a college major in their senior year at high school.

In our effort to recruiting students, one hundred and five students applied for the 1993 program. We selected thirty students based on the following criteria:

Student qualification:	Diversity considerations:
(a) academic performance in high school	(a) nationality distribution
(b) motivation and interest in math and sciences	(b) county distribution
(c) willingness to meet new challenges	(c) school distribution

Because of the offering of free housing, the 1993 program created a unique opportunity for students from financially disadvantaged families. Figure 1 illustrates the nationality distribution among the 30 selected students.

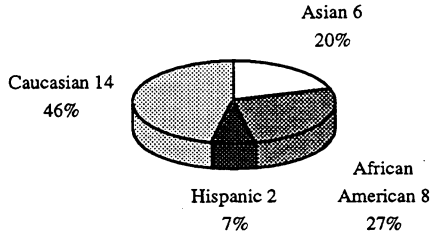


Figure 1 Nationality Distribution of the 1993 Participants

3. Program Structure and Major Activities

In order to attract young women students to the engineering field, we have developed an innovative engineering curriculum for the pre-college program. Figure 2 illustrates the structure of the 1993 program. It consisted of three parts, i.e., the student program, the parent program, and the social program.

3.1 The Student Program

The student program required the participating students to take two engineering courses. The first course is ENES 121W - The World of Engineering. This course is a laboratory demonstration course. It serves as an introduction to the disciplines of engineering offered at College Park, and emphasizes the diversity of engineering. In the 1993 program, the participating students performed seven exercises in aerospace, chemical, civil, electrical, fire protection, and mechanical laboratories. In the meantime, they visited the National Institute of Standards and

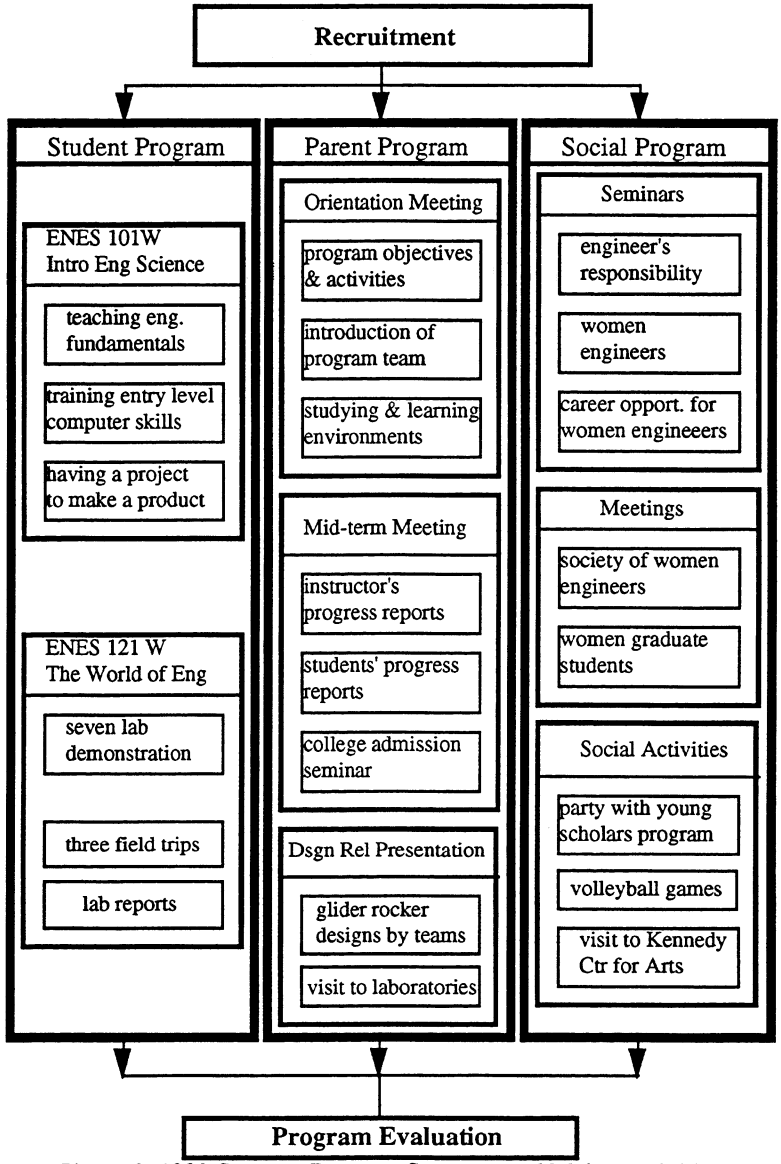
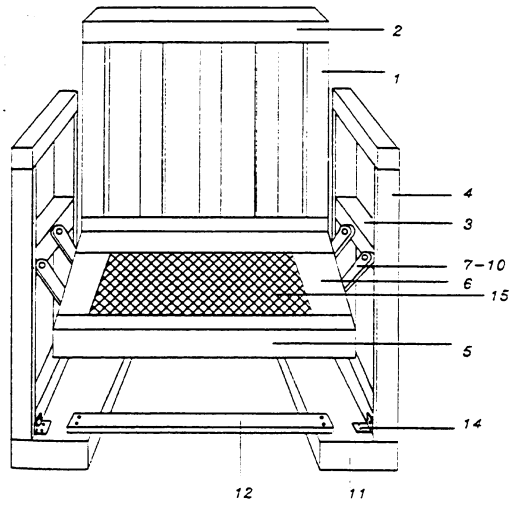


Figure 2 1993 Summer Program Structure and Major Activities

Technology (NIST), the John Hopkins Physics Laboratory and the GM Minivan Manufacturing Plant at Baltimore. They were exposed to a variety of engineering disciplines and gained a comprehensive understanding of engineering. The hands on experience through laboratory work stimulated their interest in engineering and broadened their career options. One student wrote in her report on visiting NIST:



(a) Assembly Drawing of a Design Glider Rocker

(b) Working Together as a Team

Figure 3 Design, Manufacturing, and Assembly of a Glider Rocker

"Before this program, I had no idea what the difference between a mechanical and structural engineering was. Now I not only can say that I want to be an engineer, I can say that I want to be a structural engineer."

The second course is ENES 101W - Introductory Engineering Science. It consists of basic engineering concepts, computer skills, and a design project. The course was taught using a product-driven approach. In the 1993 program, the selected product was glider rockers. The students were organized to four groups. Each group worked as a team to design a glider rocker by applying the engineering concepts learned in class, using computer to prepare the design documents, and fabricating the designed glider rocker. Figure 3a illustrates an assembly drawing of one of the designed glider rocker. Figure 3b presents a scene of team work during the glider rocker fabrication.

3.2 The Parent Program

It has been well known that parental influence in career development of their children can never be overlooked. The parent program invited parents not only to be actively involved in the student learning process, but also to provide them with information needed to assist their children during the decision making process of college education. When their children were moving to the dormitory just before the program started, we invited them to visit campus and provided them with a comprehensive picture of the program. During the program, we had a meeting with them in the evening every two weeks and asked the students to make presentations about their progress. At the end of the program, we invited parents to visit laboratories and let the students demonstrate what they had accomplished during the six-week program.

3.3 The Social Program

In the social program, we invited three woman scientists to present seminars. Serving as role models, their career experience depicted vivid pictures of what it would be like if they decide to actually take engineering in college and become an engineer. We also worked with the student section of the Society of Women Engineers and had student members to meet them. Their experience in college education provided valuable advice on how to select academic courses, how to choose a major, and how to manage time. To enrich the life living on campus and promote students interaction among themselves and with instructors, we organized sports games, visits to local theaters, and parties with the high school students in other programs.

4. Accomplishments, Responses and Evaluations

During the six-week program, the participating students successfully completed the two college level courses. The following paragraphs are taken from their summary reports demonstrating their accomplishments.

Pursuit of Engineering

"The program at the University of Maryland has taught me many things, including everything from specific engineering skills to how to survive independently. I have decide that I would like to pursue chemical engineering so that I may work to preserve our ecosystem. This decision is a very important one to make, and I feel that without the knowledge I have gained from the summer program, I would have a much more difficult time deciding what to do with my interests. This has given me a big step ahead most other people of my age, since it

is very difficult to make such a big decision without some experience at what you want to do."

Personal Development

"This has been the first time in my life that I have ever lived away from home. When my parents dropped me off in July, I was afraid that I would be homesick. However, the program did not give me the chance to feel homesick because I was so busy and I did not have time to. The first night, I thought my bed was hard and my room was cold. I felt like I was in an unfamiliar and strange place. For the past few weeks, however, I have come home from the computer lab so late at night that I am asleep before I realize I am even lying in my bed. Sleep has become such a precious thing to me. This program has certainly helped me appreciate it. This is one way this experience has prepared me for college."

Team Work

"Engineers work together to design a product or system that utilizes scientific principles to improve the quality of life. I learned this concept in Introductory Engineering Science class where we had to work in teams to design and build a glider rocker. We compromised on design, on how to divide the work, on the materials that would be used, and during the actual building process. At first, all of this compromise was difficult because I am used to being looked to as a leader. Usually, in a "team" situation, I can effect all of my ideas and take control. In this program, others were not afraid to speak their minds. And the more I listened, the more I learned. Gradually, I warmed to this teamwork concept. It felt good to admire the ingenuity of others."

5. Conclusions

Our experience with the 1993 summer program was extremely favorable. The innovative engineering curriculum focused on an interactive learning process and was effective in providing women students with a stimulating first experience in engineering. They had a taste of what engineering is really about and were grateful for the opportunity to prepare themselves for college.

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