"ENGINEERING AND SCIENCE FOR THE TWENTY-FIRST CENTURY WOMAN: A PRE-COLLEGE PROGRAM"

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Background

Upon arriving at GMI Engineering & Management Institute in 1991, President James E. A. John requested the then-informal organization of women faculty to meet as an official task force. He charged the Women Faculty Task Force (WFTF) to investigate and develop programs for three purposes: recruiting new women students to the fields of engineering and science, retaining existing female students, and recruiting new women faculty. Accepting this charge, the WFTF began to explore the possibility of collaborative efforts with the Genesee Area Mathematics, Science, and Technology Center (GAMSTC). In November of 1992, members of the WFTF met with the GAMSTC to discuss plans for a summer project aimed at encouraging young women to pursue careers in engineering and science. At this meeting, it was decided that the two groups would coordinate and fund a student forum to be held during the Christmas holiday. The goal of the forum was to gather student ideas and suggestions to incorporate into the development of a summer engineering and science program.

The Planning Forum

To finalize plans for the December forum, teacher representatives from GAMSTC and faculty and staff from GMI met in early December of 1992. The one and one-half day forum was held in late December. The 63 students who attended the forum ranged in age from 10 to 17 years. They were charged with the task of generating the perfect three-week program for young women in grades 8 through 10 to be held on GMI's campus during the upcoming summer. The students were told that the program should enable young women to better understand engineering as a career and should motivate them to consider engineering as a course of study.

In developing the summer program, the students met in groups and were asked to respond to five questions. Selected student responses are given below.

1. Generate the perfect three-week program.
   - Provide hands-on experiences, such as making nylon, designing structures with Legos, and building bridges. Offer tours to places like a recycling center, a sewage treatment plant, or General Motors. Invite engineering speakers. Link the hands-on activities, labs, speakers, and tours so they are all related.

- Offer hands-on activities such as a ping-pong ball or egg drop contest. Provide biology experiments, environmental projects, and computer dissection. Include field trips to see applications of computers in the medical field.
- Go to an amusement park and study the mechanics of the rides. Visit a crime lab or a university hospital.
- Offer experiments in water testing or a blue print drawing course. Take apart a small remote-control car.

2. Suggest activities in which parents can participate.
   - Offer tours for parents. Have parents recreate what the students have done. Provide a session to educate parents on methods to positively direct their children.
   - Have the students "lecture" to parents regarding what they did. Involve parents in a design competition with the students.
   - Allow students to undertake an engineering project with the kids. Incorporate a parent-child research presentation.
   - Offer financial aid classes. Discuss the parental role for education.
3. Identify specific people that young women might like to meet or "shadow".
   - NASA aerospace engineer, the First Lady, or an inventor
   - Skilled trades people, female astronaut, doctor, or grant writer
   - Crime lab expert, engineering students, and GMI graduates
   - Cartoonist, dentist, or surgeon general
4. List some concerns young women might have about engineering.
   - How do you become an engineer?
   - What is the salary range for engineering?
   - Is engineering an enjoyable career?
   - What are the newest disciplines in engineering, and which areas are becoming obsolete?
   - How marketable is an engineering degree?
   - What is the history of engineering?
   - What courses are needed in high school prepare for an undergraduate engineering program?
5. Suggest some topics young women might like to learn about GMI.
   - What courses and disciplines are offered at GMI?
   - How much do tuition and housing cost?
   - What are financial aid and cooperative education opportunities?
   - Are there extracurricular activities available outside the classroom?
   - What are the entrance requirements and those for graduation?
   - What is the student to faculty ratio at GMI?
   - What is the typical course load for a GMI student?

The Summer Program

Student input collected at the December planning forum were incorporated into the subsequent development of the summer program. The program, officially entitled "Engineering and Science for the Twenty-First Century Woman", was held at GMI's campus during the three-week period of July 12-30, 1993.

Class Profile

Thirty-six young women were selected to participate based upon their desire, commitment, enthusiasm, and interest in the program. High school grades were not considered. The students were equally distributed from the middle and high schools in the Genesee Intermediate School District. Most attendees were involved in the planning forum in the previous December. Of the participants, roughly one-third were Caucasian and one-half were African American. Half of the attendees were from grades eight through ten, and the other half were eleventh and twelfth graders, or had just finished high school. All of the attendees expressed intentions of graduating from college, and more than 78% planned to extend their education into graduate school. Five were interested in health professions, five were interested in engineering, and three were interested in chemistry. The rest of the attendees' interests included physics, home economics, foreign languages, education, information sciences, business, biology, and natural resources.

Student Expectations

The participants were requested to complete a five-question survey regarding their expectations prior to arriving at GMI. The students were first asked what attracted them to this program. Some students wanted to learn more about engineering and science, and some were encouraged to attend by their teachers. Some were impressed with the fact that this program was developed especially for *women*, and some were excited to visit a college campus. Finally, some of the attendees had participated in the December forum, and thus felt they had a vested interest.

A second question asked of the students was what they hoped to gain from their attendance at the program. Many participants wanted to learn more about engineering, and some wanted to get an idea about future careers. One wanted to meet new friends and teachers, and one wanted to bring up her grades in math and science. Some wanted to learn more about GMI.

Third, the students were asked what attracted them to science, math, and/or engineering. Some said that they had always excelled and/or enjoyed science and math. Some were encouraged by friends, relatives, and teachers, and one participant enjoyed engineering because there were few women.

Fourth, the participants were asked what deficiencies, if any, they perceived they had compared to their male peers which might inhibit their success in technical fields. The response of many participants was that they felt no deficiencies existed. One even stated that she could do anything she put her mind to. Another participant recalled being put-down regarding her math and science abilities by a fifth-grade teacher, but noted that

this caused her to be even more determined to succeed. Among the few deficiencies noted were physical strength, assertiveness, and encouragement from elders and peers.

Finally, the participants were asked if they were comfortable and/or familiar with machinery, tools, electronics, laboratory equipment, and computers. One young woman had participated in building a house, and had wired and repaired automobiles. Some had taken computer classes, some had computers at home, and some had hands-on laboratory experience through other pre-college programs. Many of the students, however, indicated very little exposure. Most wrote about a willingness to learn more.

Course Offerings

Participants in "Engineering and Science for the Twenty-First Century Woman" were exposed to laboratories, classrooms, and auditoriums attended by college students. They received hands-on experience with mechanical testing machines, injection molding machines, robots, measuring devices, lasers, and computer systems used by GMI students. They worked side-by-side with fifteen engineering, science, and management professors from GMI, and they were escorted from class to class by GMI students.

There were sixteen engineering and science and courses administered in the summer program, as follows:

1. Communication This course was given in a three-hour block to twelve students at a time. The class investigated both written and oral communication through two activities. The first activity involved understanding the format of a business proposal and business speech and the second activity involved performing in both areas.
2. Cost Accounting This course was given in a two-hour block to twelve students at a time. The participants were exposed to various cost processes and information including production cost, cost cycles, cost standards, and cost control.
3. Electronics This course was given in a three-hour block to twelve students at a time. Fundamental concepts of electronic circuits were introduced, then each young woman built her own AM radio to take home using components supplied in the laboratory.
4. Engineering Graphics This course was given in a three-hour block to twelve students at a time. The students used engineering sketching techniques to develop orthographic projections and isometric drawings.
5. Ergonomics This course was given in a three-hour block to twelve students at a time. A brief introduction and description of ergonomics and its importance were presented. Several laboratory demonstrations were used to show the importance of information about people and their capabilities. The demonstrations included the collection of anthropometric data, strength data, and several eye-hand coordination tasks.
6. Hologram Experiment This course was given in a three-hour block to 12 students at a time. Students made their own hologram to take home and "play back" under a regular incandescent light bulb.
7. Career and Parenthood: Compatible or Not? This course was given in a two-hour block to all 36 participants at the same time. Through reading, writing, and discussing, the students developed knowledge about the challenges of being a working woman/mother in modern society.

8. The Internet This course was given in a two-hour block to all 36 participants at the same time. The students sent letters via email to President Clinton and got responses. They also interfaced with NASA engineers and students from other universities.
9. Lego Experiment This course was given in a three-hour block to 12 students at a time. Using various Lego activities, the students learned the basic concepts and physics of a lever, gear, and pulley. They also learned to interface robots and other machines with computers.
10. Marketing This course was given in a three-hour block to all 36 students at the same time. The students participated in activities which reflected all aspects of creating and marketing a product.
11. Math Activity This course was given in a two-hour block to 12 students at a time. The math workshop involved a variety of activities to improve problem-solving and educated-guessing skills.
12. Polymer Processing-Plastics Activity This course was given in a three-hour block to 12 students at a time. The students made plastic parts using the injection molding and thermoforming processes. They also studied the effect on manufactured parts of changing machine parameters, and they measured the strength of the produced parts.
13. Robotics This course was given in a three-hour block to 12 students at a time. Introduction to the automatic guided vehicle was given and properties of sensors and safety features were discussed.
14. Self Esteem This course was given in a three-hour block to 12 students at a time. Students developed a collage shield that provided them the opportunity to know themselves better. They also heard various speakers which enhanced their understanding of challenges.
15. Tie-dye Experiment This course was given in a three-hour block to 12 students at a time. Using various chemical laws and properties, the students completed a tie-dye experiment on a tee-shirt which they kept.
16. Water Collection Analysis This course was given in a three-hour block to 12 students at a time. Students took pH readings at the Flint River, collected samples, and analyzed the samples in the laboratory to determine water quality.

Field Trips and Activities

Three separate days of the program were devoted to off-campus field trips. All of the students participated in the field trips, and many of their parents served as chaperones. The first field trip involved a tour of several University of Michigan engineering laboratories, including the solid state devices lab and the medical computing lab. The second field trip included an excursion to the Environmental Protection Agency and to Consumer's Power, the local utility company. The third field trip involved a visit to the Flint water sewage plant.

Throughout the program, students participated in a variety of activities, including ice-breakers, tours of the GMI campus and its facilities, and panel discussions with female students from GMI. They also attended a play entitled, "Count on Me", which provided an interesting look at the history of women's rights in Michigan. Students also gained insight from a series of speakers who addressed issues such as family and careers, success, assertiveness, and self-esteem. Orientation programs were offered to parents of

the attendees, discussing such topics as financial aid, college admission and application, and cooperative programs. A follow-up program held in August of 1993 included a residence hall experience and social activities, allowing the young women involved to interact with college women. The program culminated with an awards banquet to recognize the success of each student.

Program Evaluation

Faculty members were invited to evaluate the success of the program. Although many noted that the students seemed eager to learn, criticism of the behavior of the girls was prevalent. Comments in this vein included: the students were often difficult to control and keep quiet; their attention span seemed limited, as did their respect for authority; the age span within the classroom was too broad; and the ages were not well mixed. Some faculty members suggested that the application process be more stringent, so that student interest be sincere. Perhaps the best suggestion to alleviate the problem was offered by one faculty member who suggested an orientation program for the students to impress upon them the requirements regarding their behavior. The faculty member also suggested an orientation program for faculty to prepare them for behaviors typical of this age group.

When the parents of attendees were asked to evaluate the program, they responded positively that the program increased their daughter's interest in science and engineering and her awareness of career opportunities. They felt that their daughter had a better understanding of the requirements for engineering students and that their daughter benefited from personal contact with scientists and engineers. They wholeheartedly agreed that the program was worthwhile, and emphasized the need for similar summer science programs.

Finally, the participants were given the opportunity to judge how the program had affected them. Students felt that the program had increased their interest and understanding in math and science. They felt that they understood the requirements for success in engineering and science programs better. They noted that they would attend a similar program and that they would recommend the program to a friend.

Future Plans

In January of 1994, the responsibility for development of pre-college programs for women was transferred to the new Office of Women's Programs at GMI. A Twenty-First Century Woman Advisory Board was formed consisting of GMI faculty, staff, and students. Since its inception, the Board has been involved in the planning and implementation of a program mimicking that of 1993. The program will be in August of 1994. A second phase of the program has been developed for approximately 12 students who participated in the 1993 project. This "phase two" program will include a series of new courses, offered by an additional group of faculty members. Members of the Board intend to pursue the possibility of Federal and local grants for continued development of the "Engineering & Science for the Twenty-First Century Woman" program.