Engineering A Future at Tennessee Technological University

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Abstract

Engineering A Future (EAF) is an outreach program for girls in the 5th through 8th grade held at Tennessee Technological University (TTU) on the Saturday of Engineer’s Week. This program started in 2003 with an enrollment of 73 girls and was repeated in 2004 with 137 girls in attendance, the projected number of participants for 2005 is between 300 and 320. The girls come to the TTU campus for the day and experience a number of group and individual activities. The basic format for the program includes icebreaker activities at the beginning, followed by team activities with a break for lunch, and closing with awards and feedback. There have been several modifications made to the program, mostly in response to the feedback received.

A unique aspect of the Engineering A Future program is the pairing of engineering with education. This occurs in several ways. First, engineers from local industry and engineering faculty from TTU work with faculty in the College of Education at TTU to develop the activities that are used in the program. A second cooperation is formed with the student volunteers who work with the participant teams. Finally, a concurrent program, dealing mainly with education issues, is run for the parents and/or guardians of the girls, teachers, guidance counselors, and school administrators. This introduces the adults to the engineering career, the benefits of a career in technology-related fields, and the requirements a K-12 student must complete prior to being accepted into a typical university engineering program.

This program has been a success and there are plans to expand it into a day camp format and/or a residence camp in the future.

Introduction

Why is it that female students do not see engineering as a worthy profession? In many cases, girls are discouraged from pursuing science and/or engineering either outright or through the words and actions of those who have the greatest impact on their choices early in school. Those who do choose engineering usually have a strong role model, often a family member. One goal of the “Engineering A Future” (EAF) program is to provide that strong role model for those who do not have one already among their family and friends.¹

Many of the obstacles that lie in the path of young women seeking a career in science and/or engineering include individuals of influence (teachers, counselors, and school administrators) who lack understanding of the field of engineering in general and specifically to the career opportunities that engineering offers; societal stereotypes that engineering is primarily for males and that females are incapable of succeeding in engineering; and in many cases a lack of financial and / or family support. All of these obstacles can be overcome with help and while some of them are simply not true, it is crucial to communicate clearly how to navigate such
obstacles, perceived or real. The steps towards enabling more women to be successful engineers have to be taken early. Young women must be reached before the high school years to foster an interest in career options that are still considered non-traditional.\textsuperscript{2,3}

The Program History

Partnerships were formed among groups from varied backgrounds to achieve the common goal of developing a program with long-term impact to the female youth of the Upper Cumberland region of Tennessee. A core goal of these partners is to encourage young women to believe that they can have a career in engineering or another technology-related field. The partners included several female faculty members and students in the College of Engineering at Tennessee Technological University (TTU), the Cumberland Valley Girl Scouts Council, faculty members and students of the Tennessee Technological University College of Education, members of the Society of Women Engineers (SWE), employees of Fleetguard, Inc., and members of the American Association of University Women (AAUW). Each of these partners brought a unique skill or asset to the development of EAF. Clearly, the College of Engineering faculty members brought their talents as engineering instructors as well as their strong gifts as role models and mentors. They also brought their love of engineering and abilities to develop empirical lessons for the program. The College of Engineering students brought their energy and passion for the profession. The Cumberland Valley Girl Scout Council brought their belief that we need to encourage these girls to believe in their own potential, wherever that potential may lie, and the strong community ties that Girl Scouts has already established. The faculty members and students of the TTU College of Education helped guide the program to be age appropriate and in line with the educational goals of the State of Tennessee. The Society of Women Engineers is currently helping to fund the program and plans to distribute the program ideas among other sections within the Society. The primary funding source initially was within Fleetguard, Inc. (a local subsidiary of Cummins, Inc.). Fleetguard also serves as another source of the organizers for the program and a source for the personnel to run the program. The American Association of University Women supports the program by helping to recruit participants from the area schools and helps with the registration as well as preparing the materials for registration.

The format for EAF was established in the fall of 2002. Lunchtime meetings were held on the campus of TTU with representatives from all of the EAF partners. The meetings were very productive and a common format was easily agreed upon. This format included the provision that the major portion of the day would involve hands-on engineering activities. The participants would be placed into groups of 8 – 10 members, who would then rotate through 4 different 45-minute activities. Each group was given a different color as a form of designation. Female engineers from TTU and Fleetguard were chosen to lead these activities; these women will be referred to as activity leaders.

To facilitate conversation and interaction among the girls and team leaders, two activities were chosen to open the day; an icebreaker and a team building exercise. The icebreaker was developed to help the participants introduce themselves to each other. They received a bingo card or grid with each square describing a specific attribute. They were to roam freely among those present and introduce themselves. When someone matching one of the attributes on the card was found they signed their name in the appropriate grid square. The participant who could
fill the greatest number of squares within their grid within a time period would win that activity. This required that the participant meet up to 25 people and they were required to have one square completed by each member of their team including team leaders or their game card was disqualified. Once they knew the names of the other group members, they began a team building activity to promote the communication among the group members and get them working as a team. This is an important area of focus for individuals seeking engineering careers as industry conducts business as a cross-functional process.

During the initial program the groups completed 2 hand-on activities in the morning before lunch. During lunch another team building activity was conducted in discussion question format. The participants were asked to discuss what the world would be like without engineers. They were further asked to choose the one thing they would miss the most if there had never been engineers. A spokesperson was then asked to report the results to the audience. The teams were then dismissed from lunch to complete the remaining 2 hands-on activities. To close out the day, an awards ceremony was held in which prizes were given for the most signatures at bingo, the best answer to the problem in the team building activity, and the best response to the lunch question.

Key Aspects

The College of Education at Tennessee Technological University is a key partner in the EAF program. Faculty members from the college assist the activity leaders in developing and approving the activities. The activities are checked for age appropriateness, length, and consistency with the topics covered in the science classes of the EAF attendees, but with effort to avoid duplication of material and experiments these students will typically see in their schools. The activities completed at EAF will not be effective if the participants do not understand the science behind the project. The printed material that is used is also checked and approved by education faculty members. This material presents the relevant information needed to complete the activity and also gives some background and relevant career information as well as sources of additional information on the topic.

Another key role for members from the College of Education is serving as team guides. The teams of participants are given two college student team guides that accompany them throughout the day, one engineering major and one education major. These guides help the young women to navigate the campus, and aid in the completion of the different activities. The guides from the College of Engineering help their team with the engineering aspects of the activities and are more familiar with the areas of campus being used for the program. It is believed that all of these college students can relate well with the participants (due to their being closer in age than the activity leaders and other program volunteers) making the attendees less nervous throughout the day. Further, half of these college student guides will be teachers one day and this experience will give them incentive to perform hands-on activities in the classroom. It also gives these students a model of partnership between education and engineering to follow during their careers ensuring a long-term impact resulting from this program.

The involvement of the Girl Scouts organization is key in promoting the program and during the past two years approximately half of the total participants have been registered Girl Scouts.
Cumberland Valley Council has a great relationship with the local school systems. This makes recruiting participants through the local schools much easier than it might be otherwise. Participating in EAF includes registration in Girl Scouts for the remainder of the Girl Scout fiscal year for those participants who were not involved in scouting already. This gives all the girls a great opportunity to get involved in an excellent program and also allows the organizers to cover everyone on the Girl Scout’s insurance. Unfortunately, this also requires that all volunteers receive Girl Scout volunteer training and registration as a volunteer for the Girl Scout organization. This has been met with much resistance and the organizers are working on an alternative insurance source to allow individual EAF volunteers an option.

Since EAF began, the Girl Scouts have been responsible for designing the advertisement materials and communicating the EAF program to the community. They have coordinated with organizers and with the American Association of University Women (AAUW) to visit schools in the area. In 2004, a greater effort was made to advertise in the local newspapers, on the radio and local cable TV channel. The Girl Scouts is also handling the registration process, this includes receiving registration forms, developing the participant database, and handling the registration fee. A nominal fee of $10 was charged in 2003 and 2004; this fee has been raised to $12 for 2005.

AAUW is relied upon to coordinate the check-in of registered participants at the event. This group is also used as judges for the various contests that take place throughout the day. All attendees to EAF are given a souvenir bag with “goodies” to take home and an event T-shirt. The women of AAUW work tirelessly to assemble these bags.

Considering the age group being targeted, the organizers strive to give out as much extra stuff as possible. There are plenty of free handouts from various sources available for the attendees and other participants to pick up. Each girl receives a number of gifts in a souvenir bag when they arrive at EAF. This bag will also contain some important things, such as a writing utensil. Because the Girl Scouts are an important part of the program, one of their traditions was implemented into the EAF program in 2004. Girl Scouts exchange swaps, small crafts that can be worn on a vest or hat, when they attend various activities. These swaps are meant to represent the person giving the swap, this could be something personal, local, or regional depending on when, where, and with whom the swaps are being exchanged. The activity leaders distribute swaps that are relevant to their specific activity. Thus each team of participants will have a different set of swaps at the end of the day, highlighting the activities that they completed. These swaps are displayed prominently on the bag they received, or somewhere on their person. These are meant to be a more personal reflection of the EAF experience.

**Adult Workshop**

In conjunction with EAF, a program is conducted for the parents and/or guardians of the participants as well as other interested adults like teachers, guidance counselors, and school administrators. A panel is convened that includes the Assistant Director of Admissions at Tennessee Technological University, the Dean of the College of Engineering, the mother of one of the EAF organizers, a female engineering student, and at least one engineer from industry who is interested in increasing the number of female and/or minority engineers working for their
company. The Assistant Director of Admissions will first address the audience and provide information on the following topics.

- Preparing for success in college
- Funding a college education
- Estimating the costs of college education
- Emphasizing the importance of communication skills
- Emphasizing the need for as many math and science courses as possible pre-college
- Obtaining college credit prior to being in college
- Illustrating examples of various engineering curriculum

The Dean of Engineering discusses the TTU College of Engineering program including the areas of engineering majors available. The engineer’s mother will talk about her experience with her daughter becoming an engineer. This provides the audience a unique prospective on many of the challenges a young woman faces entering this non-traditional career and the opportunities, financial and other, available within technology related professions. The female engineering student will relay her experiences thus far in her education. Finally the engineer from industry will talk about her career in engineering. The engineer will also walk through an example of an activity that the 5th through 8th grade participants are completing during the day.

The floor is then opened for questions. The appropriate panel member will answer, allowing others to have input as needed or desired. The audience usually has many questions, especially about financing an education.

Success and Modifications

In its first year, 2003, EAF attracted seventy-three girls in 5th through 8th grade. The results of both participant and volunteer surveys indicated that the program was a success. Generally speaking, all of the information gathered on the surveys was positive. The main negative comments came from the 7th and 8th grade girls who indicated that many of the activities they completed at EAF included things that they had done before. During this inaugural year, participant teams were composed of 5th through 8th grade members. Activities that were age-appropriate for the 5th graders were sometimes not sufficiently challenging for the 8th graders on the same team. This precipitated the segregation of the 5th and 6th graders from the 7th and 8th graders for 2004. The older teams completed only two 100-minute hands-on activities, while the younger team stayed with the four 45-minute activities. This allowed the activity leaders for the older groups to go more in depth with the topic and require more advanced skills and knowledge of the participants.

When it became apparent that the activities were repeating some of what the attendees see in school, it was determined that the activities for the EAF program need to be changed from year to year. Each year a unique theme will be chosen. This would assure that girls who come for more than one year would not be completing the same set of activities each time. This is especially relevant as there has been a significant level of retention of attendees to the program. This theme influences the choice of hands-on engineering activities and the team building
exercises and lunchtime activities reflect the theme as well. The theme for 2004 was Aerospace Technologies. For 2005 the theme will be Ocean Exploration.

In 2004, EAF increased its enrollment from 73 to 137 young women. Attendee and volunteer surveys again were very positive; an example of these surveys can be seen in the appendix. The favorite activities were identified and will be repeated in 2005. The least favorite activities are not being repeated. In general, the majority of the activities were well liked and received a response of either good or great on the surveys. When asked on the survey if they would like to participate in a program like this at their school, 83% said that they would. Sixty-seven percent indicated a desire to participate in a day camp related to engineering. The survey also asked what they would change, 39% said they would change nothing, 21% said they would have more activities, and less than 10% wanted better food or less walking. Unfortunately, the older participants felt cheated in only getting to complete two activities when the younger attendees were still completing four activities. A compromise has been developed for the 2005 program in which the 5th/6th grade teams will continue to complete four 45-minute activities and the 7th/8th grade teams will complete three 75-minute activities and have an element of team competition.

Another challenge is the increased number of persons to be fed and the logistics to do this in a single time slot. During 2004 too much time was required to feed everyone and some of the last participants and volunteers to receive their lunch had cold pizza, often finding it difficult to find a desirable choice among the remaining options. For 2005’s program the activities will be re-arranged to provide a staggered lunch period. Also the attendees and volunteers will eat in the TTU cafeteria, which is equipped to accommodate the estimated 600 people involved in EAF. This should alleviate the long lines and cold food as well as give more food choices to accommodate individuals with food allergies.

In 2004 the participant teams were given the names of different star constellations to accentuate the aerospace technologies theme. Star Search, a bingo icebreaker, was developed using the attributes related to each of the constellations being used for the team designations. More than 75% of the participants indicated the activity was either good or great on the survey given at the end of the day. The team building activity, called “reverse engineering” didn’t really follow the theme, but represents a key aspect of engineering. All groups received a box with components from an electronic gadget that had been taken apart. The girls were required to “reverse engineer” or figure out what the gadget had been. This team-building activity received a lower score on the surveys than the other two, with only 68% responding that it was good or great. Some of the gadgets were harder to identify and this could explain the lower rating. The lunchtime activity was to take the pieces from the team building exercise and “re-engineer” them into something else. The participants were extremely creative, some groups made something related to the theme while others just made something fun. This activity also received a good or great rating from more than 75% of the surveyed participants.

For 2005, the organizers are anticipating over 300 participants in the program. It is believed that this is the limiting size for the resources available. As the number of EAF attendees increase, so does the required number of activity leaders and volunteers. The organizers recognize the need to keep the size of the teams to 6 members which means over 50 activities must be developed for the 2005 EAF program. This then requires 100 team guides, 50 activity leaders, and 50 activity
assistants. The local sections, both student and professional, of the Society of Women Engineers are the primary groups responsible for recruiting these volunteers. Unfortunately, the current membership of these sections is not sufficient to provide the needed numbers and other sources are being sought.

Also for 2005, the organizers have decided to target teachers, counselors, and school administrators to attend the adult workshop. It was the experience of many of the engineers involved in EAF that these key early education personnel were discouraging and even ignorant regarding engineering careers. To increase the number of female engineers we rely upon having teachers, counselors, and school administrators who are supportive and have an appropriate level of knowledge regarding engineering and technology-related careers to start the student off on the right track. The information presented in the adult workshop includes information they need to know. It is hoped that the attendance at this program will increase significantly. Each adult attending the 2005 EAF adult workshop will have the opportunity to receive a copy of the National Science Foundation’s “New Formulas for America’s Workforce: Girls in Science and Engineering” which is a compilation of programs throughout the United States that have been successful in increasing the interest and participation level of young women in technology-related fields. While this will not be something the parents / guardians will be particularly interested in, it is definitely a useful tool for those working within the school systems. Also, during the 2003 and 2004 sessions, several attendees have been home-school students. It has been the experience of the EAF organizers that those parents are very adept at utilizing all resources available to them and this should be something that they can also use.

Conclusion

With the success seen thus far, the organizers of EAF are planning for continued development. Expansion of the EAF program into a day camp could coincide with a regularly scheduled school break. Participants would attend for several hours a day for 4 to 5 days. The day camp program would continue to emphasize hands-on engineering activities. Once this is successful, the program would be expanded further into a residence camp during the summer. Housing the attendees on the TTU campus for several days will allow for more social interaction and also allow the organizers to expand on the length, depth, and type of activity that can be implemented. Significant support will be necessary to conduct this level of program and as such it is still in the somewhat distant future.

References


KRISTINE CRAVEN
Dr. Kris Craven received her BS, MS, and PhD in Mechanical Engineering from West Virginia University. She coordinated the Freshman Engineering program at WVU before joining the Basic Engineering faculty at Tennessee Technological University. She has taught Programming, Graphics, Thermodynamics, Dynamics, and Fluid Mechanics. Her interests include numerical modeling in heat transfer and fluid flow, and educational concerns.

SALLY PARDUE
Sally Pardue is an Associate Professor of Mechanical Engineering at Tennessee Technological University. She began her academic appointment in August 1999 following four years as a Research and Development Engineer. Dr. Pardue received her PhD in Engineering from Tennessee Technological University in 1995. Her research interests are random vibrations, machine diagnostics, cavitation, and NDE of composite materials.

KAREN RAMSEY-IDEM
Dr. Ramsey-Idem received her BS, MS, and PhD in Mechanical Engineering from Tennessee Technological University. She has worked for NASA at the Kennedy Space Center and Dow Chemical at its Plaquemine Plant and is currently employed at Fleetguard, In. a subsidiary of Cummins, Inc. Her current areas of responsibility include failure analysis and materials technology implementation throughout the corporation.

Appendix
Teen Input

What was your favorite thing about today?

What did you like least about today?

What is one important fact you learned today?

Please circle the best words to describe today’s activities?

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<tr>
<th>Star Search (Morning Activity)</th>
<th>Name Activity 1:</th>
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<th>Re-Engineering (Lunch Activity)</th>
<th>Name Activity 2:</th>
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<th>Reverse Engineering (Team Activity)</th>
<th>Name Activity 3:</th>
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<th>Name Activity 4:</th>
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What would you do different for next year’s event?

Would you like to do another program similar to this one at your school? Yes  No

Would you like a teen club at your school related to engineering? Yes  No

What other topic, if any would you like to see as a teen club at your school? _____________

Would you like to participate in a day camp related to engineering? Yes  No

Other comments (use other side of sheet if necessary).
Volunteer Input

How would you rate the event’s overall impact to the girls? _______________________________________
______________________________________________________________________________________

What seemed to engage the group the most? _________________________________________________
______________________________________________________________________________________

Do you think the event inspired the girls to consider a career in engineering? 
______________________________________________________________________________________

Did you feel prepared for today’s activities?   Yes   No

What overall improvements do you suggest? _________________________________________________
______________________________________________________________________________________

Would you consider volunteering for this activity next year?   Yes     No

Please evaluate each session below listing activity titles.

**Star Search** (Icebreaker)

What worked well?

What did not work well?

Any suggestions?

**Reverse Engineering** (Group activity)

What worked well?

What did not work well?

Any suggestions?

**Re-Engineering** (Lunch activity)

What worked well?

What did not work well?

Any suggestions?

**Activity 1:** __________________________

What worked well?

What did not work well?

Any suggestions?

**Activity 2:** __________________________

What worked well?

What did not work well?

Any suggestions?

**Activity 3:** __________________________

What worked well?

What did not work well?

Any suggestions?

**Activity 4:** __________________________

What worked well?

What did not work well?

Any suggestions?