Planning Approach for the Society of Women Engineers Mentoring Girl Scouts

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Abstract

Utah State University College of Engineering is actively working on recruiting and retaining women in engineering. This project is one that combines the two toward affecting both goals at once. The Society of Women Engineers (SWE) section at USU has organized a mentoring system with the local Girl Scout council. The primary idea is a top-down mentoring approach where activities are designed and run by women and girls that are a step ahead of the participants. In this way, each group is "paying back" the mentoring to the next lower level.

The USU student SWE section runs a mentoring program to help Cadette and Senior Girl Scouts (middle and high school girls) earn an interest patch related to science and engineering. Engineering professionals mentor the SWE engineering students and provide a panel discussion for the older scouts. Thes older Girl Scouts then join the SWE section in running a Badge-in-a-Day Engineering clinic for Junior Girl Scouts (grades 3 through 6). In this way, the elementary school girls are introduced to the fun aspects of science and technology, having a good time while sampling hands-on projects. The middle and high school girls learn about science and technology more in-depth by working directly with the SWE members on their projects, then having the opportunity to teach what they have learned to the younger girls. The SWE members become involved in reaching out to the next generation of potential engineers. When the SWE members become active in helping others learn about science and engineering, they are more likely to feel camaraderie with their peers, mentoring each other, and thus are less likely to feel isolated and drop out of engineering. Thus, by this tiered mentoring approach, we are recruiting the younger girls into potential engineering careers and working to retain the college level women in their engineering programs.

Planning for this project was done using a Logic Model formulation, which begins by defining the desired long term objectives. Given the available inputs, one can then plan the desired shorter term outcomes and the activities that would help meet those goals. Using this organized approach, it is then much easier to determine how to best measure whether the objectives are being met. This approach was highly successful and resulted in an evaluation process that was integrated into the project.

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Introduction

It is well known that women are under-represented in engineering (see the statistics on the SWE website: http://www.swe.org/SWE/ProgDev/stat/stathome.html.) Although the percentage of women in engineering is gradually increasing, it is still quite small. Undergraduate enrollment in engineering in 1998 was 19.7% women, up from 12.1% in 1979, with graduate enrollment changing from 5.4% to 18.5% female over a similar time period (NSB 1998). Women employed in the engineering workforce moved from 5.8% in 1983 to 10.6% in 1999 (US Census Bureau 2000), although this number varied greatly by field. For example, 7.1% of employed mechanical engineers are women while 16.8% of industrial engineers are female. Women engineering students also change majors at a higher rate than men. Many studies have looked at these statistics and tried to explain the issues involved (for instance, see the review in SWE Magazine, Summer 2003).

Thus, a priority of SWE and many universities, including USU, is recruitment and retention of women into the engineering profession. To aid in this endeavor, SWE has formed a partnership with Girl Scouts USA and various SWE sections have held workshops or programs for various levels of Girl Scouts.

This project sought to address both recruitment and retention through a tiered mentoring approach to a series of Girl Scout workshops. USU's student SWE section has been involved with programs for Girl Scouts in the past (2001 and 2002). In this project, the outreach was expanded into different levels, the mentoring process was formalized, and the planning process led the project.

In laying out the planning for the project, we prepared a logic model (Figure 1) to help us think about the process. We started with the participants as resources: USU student SWE members, Cache Girl Scout Service Unit, and professional women engineers. When the funding from a SWE ExxonMobil Development grant was added, there were sufficient inputs to affect the planned outputs. Long term impacts would include retaining the student SWE members in engineering, recruiting younger women into engineering, and fostering a collegiality among women in engineering at all levels. Short term outcomes that are indicators of these impacts included fostering a collegiality among the student SWE members, giving the younger Girl Scouts a positive view of engineering, encouraging the older Girl Scouts to consider a career in engineering, and giving all participants a positive view of the potential for women in the engineering profession. Project activities were designed to affect these outcomes. The primary activities were to be the two engineering badge workshops for Girl Scouts – one at the middle and high school level and the other at the elementary school level. To accomplish these goals would require a series of organizational meetings between the SWE members and women engineers, primarily the SWE faculty advisor. Other input from professional women would be a career panel at the workshop for older Girl Scouts that would also be

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attended by the student SWE members. To measure whether the activities produced the intended outcome, we carefully crafted surveys for each group plus planned to gather information on numbers of attendees and their backgrounds. The survey results are discussed in the assessment section below.

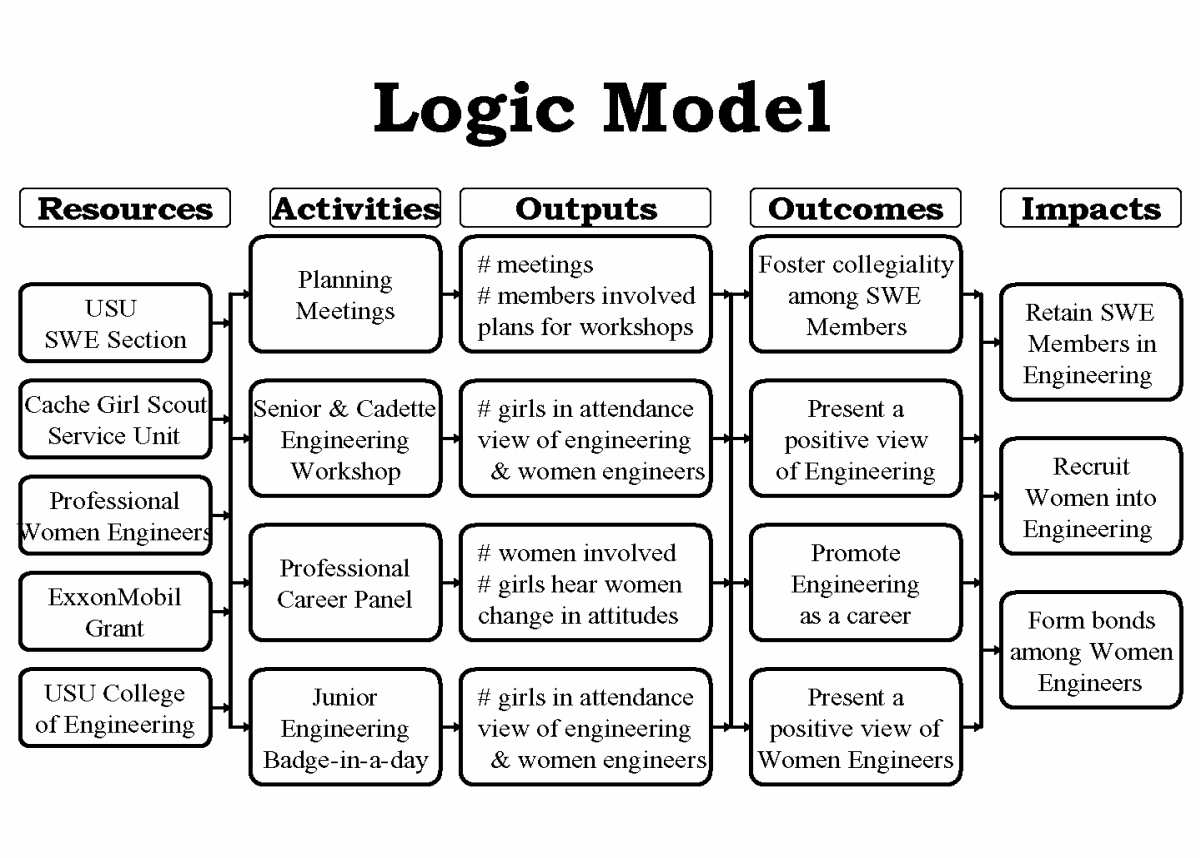

Figure 1. Logic Model for planning outreach project.

The glue holding the project together was the tiered mentoring approach. Specifically, professional women were recruited to be part of the project, as mentors, the career panel, and experts on specific topics being presented. The student SWE members did all the planning and direct implementation of the workshops while mentoring the middle and high school Girl Scouts. These older Girl Scouts would then be teamed with the university students to hold hands-on workshops for elementary school Girl Scouts. The purpose of working with the younger girls was two-fold: first we sought to excite them about science and engineering, and second, the older girls and SWE members would become directly involved in teaching what they have learned, completing a cycle designed to retain SWE members in engineering and convince the middle and high school girls of their ability to pursue and succeed in technical fields.

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Implementation

Planning

The student SWE members spent quite a bit of time and effort planning the Girl Scout workshops. Meetings were held once a week for 6 weeks prior to the events. Attendance at these meetings averaged 6 to 8 people with 5 or 6 SWE members coming weekly and 1 or 2 newcomers each meeting. In the first few meetings we discussed what kind of workshop we wanted to hold, when it would be, how long it would last, and what the main focus would be. Then we made assignments of which SWE members would organize and run which workshops. There were a lot of good ideas and brainstorming in these meetings. The last few meetings were spent organizing the details and finalizing plans.

The workshop was advertised throughout the Cache Service Unit of the Girl Scouts through fliers and emails sent to all adult leaders. SWE and their faculty mentors were sure to obtain all the necessary Girl Scout permissions and required forms. Along with fliers about the program there were mini camp registration forms designed by the Girl Scouts of Utah Council, plus Girl Scout permission forms. On the permission forms, we added permission to use photographs and anonymous survey results to advertise, promote, and report on the program.

As is becoming increasingly important in outreach projects, the planning phase included plans for project assessment. How can we be sure that a project meets its goals if we don't plan in advance to assess the outcomes? With this in mind, we made a project planning chart based on projected outcomes (listed in the introduction) and brainstormed how to best measure whether goals were met. The authors met with a local expert in education evaluation plus scoured the literature to determine best practices for assessing informal outreach projects.

One goal for this project was to include mentoring for the university SWE members. Thus, although the SWE members designed and ran the workshops, the faculty advisor worked as a mentor throughout the process. She is a Girl Scout leader herself and has run similar programs for Girl Scouts in the past. Her experience was very valuable in advising the college women. Other professors and women from industry additionally worked with SWE members and the Girl Scouts during the workshops. However, perhaps the most important part of the mentoring was the peer mentoring between the SWE members as they worked closely together planning and implementing the workshops.

Cadette/Senior Workshop

The first workshop was held on a Saturday for Cadette and Senior Girl Scouts (middle and high school age). The workshop was designed around earning the Space Exploration Interest Patch for Cadette and Senior Girl Scouts (Girl Scouts USA 1997), which fit in nicely with the interests of SWE members, Girl Scouts polled, and resources

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available locally. The goal of this workshop was to give the girls some challenging hands-on projects that spur their curiosity as well as introducing them to what engineers do through the university SWE members and professional women engineers. In addition, we were careful to use both cooperative and individual hands-on projects to enable each girl to explore the topics both on her own and with a small group. The workshop was divided into three segments. The first segment opened with a general introduction to engineering by discussing the mathematic concepts needed to boost a rocket into orbit. Then SWE members worked with an engineering professor to introduce the optics of lenses. The girls experienced the optics through shining laser beams through clear concave and convex gelatin lenses in different combinations. The lesson was finalized with a discussion of how telescopes magnify an image, then each Girl Scout had the opportunity to build a simple telescope. The second segment focused on exploring the night sky. It opened with a brief prepared presentation by SWE members on comets, quasars, black holes, and other phenomena. The Girl Scouts, working in small groups, chose a constellation, learned a traditional story about it, and made a large poster of it using glow-in-the-dark stars on dark blue paper. Then each group presented their poster and story to the group, enhancing the learning experience.

The third segment was hands-on design and construction of a balsa wood airplane. After a short presentation on lift, thrust, and drag by a graduate student, the girls worked in teams of 2 or 3 to design and build their own airplane. It was amazing to see the creative designs. Then each plane was tested in the university wind tunnel, which was a real hit with the girls and a wonderful culmination of their experience.

In between the segments a lunch break provided time for camaraderie among and between groups. After lunch, there was a question and answer period with a panel of professional women from higher education and industry. Each of four women gave an introduction to what she does as an engineer, her educational background, and how she combines work with family. The girls enjoyed asking these women questions about their work and how they deal with issues such as childrearing. Figures 2 and 3 show some of the aspects of the Cadette/Senior Workshop.

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Junior Girl Scout Workshop

A second workshop, concentrating on Junior Girl Scouts, was held five days after the Cadette/Senior workshop. Junior Girl Scouts represent girls in grades 4 through 6. We also invited third grade Brownie Girl Scouts who are in the process of bridging into the Junior program. Twenty-seven Junior and Brownie Scouts attended, representing ten different elementary schools within the Cache Service Unit area.

The Junior workshop was designed around the Sky Search Junior Girl Scout badge (Girl Scouts USA 2001). The workshop was run by student SWE members and assisted by Cadette and Senior Girl Scouts who had attended the workshop described above. The girls were registered as they arrived and sent to a station to work with SWE and older Girl Scout volunteers on constructing a star chart and learning how to read it.

Figure 2. SWE members work with Cadette and Senior Girl Scouts to understand optics concepts using gelatin and in building balsa wood airplanes.

Figure 3. Women mentors discuss their family and careers and girls test their balsa wood airplanes in a university wind tunnel.

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Then they were divided into three small groups to rotate through three separate workshop segments: 1) an optics segment where the older girls helped the younger girls understand the same optics experiments that they had done previously; 2) a segment on identifying constellations, finding them with a star chart, and learning traditional stories about them, allowing the older Girl Scouts to make use of the star charts and stories from their earlier workshop; and 3) space exploration, including learning about astronauts in space and the tools they use, plus a demonstration of a package of experiments to be launched in the space shuttle. The Cadette and Senior Scouts were integrated into presentations and worked closely with small groups of younger scouts on the projects. This helped the younger scouts experience and learn the concepts while it cemented those concepts in the older scouts (see Figure 4).

Figure 4. SWE members and Senior Girl Scouts work with Junior and Brownie Scouts to understand star charts and cultural stories related to constellations.

Assessment of Impact

To determine the success of these workshops, assessment instruments were used for three different groups – SWE members, Cadette and Senior Girl Scouts, and Junior Girl Scouts. As noted by Poole, et al. (2001), it is difficult to assess engineering outreach programs without impacting the results. The number of questions was purposely limited, but we chose to do matched pre- and post-workshop surveys to determine the impact of the program on attitudes. Questions included information about age, school, parents' occupation, favorite subject (Girl Scouts only), extracurricular activities, and reasons for choosing engineering (SWE members only). In addition, a chart was included to measure attitudes about engineering as shown in Figure 5. The same chart was filled out by each Girl Scout before and after the program.

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Please choose the closest answer to the following questions from: Strongly agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD)

	SA	A	N	D	SD
Engineers do important work					
Engineers do fun and interesting work					
Women have a place in engineering					
It is possible to balance an engineering career with family					
I would consider a career in science, math, or engineering					

Figure 5. Chart used for measuring attitudes about engineering.

It was interesting to summarize and interpret results. Only a portion of the results are discussed here. Figure 6 is a histogram of the response of the youngest group, the third through sixth graders, to the statement that "Engineers do fun and interesting work" as measured before and after the workshop. Initially, the response was divided pretty equally between Strongly Agree, Agree, and Neutral. After the workshop, there are fewer in the Neutral category with most moving into the Strongly Agree and Agree categories. As we note that one girl marked Strongly Disagree, we point out that some of the youngest girls were confused by the categories and needed help. Others were somewhat annoyed at filling out the same survey a second time. But overall, it appears that the workshop served its purpose in interesting the girls in engineering topics while earning a badge.

The histogram in Figure 7 measures the response of the middle and high school girls to the statement "I would consider a career in science, math, or engineering." It indicates that more girls Strongly Agree after the workshop. Figure 8 combines all ages of Girl Scouts to look at the matched before and after workshop data to examine reaction to the statement "Women have a place in engineering." Before the workshops, 90% of the answers were in the strongly agree or agree category, indicating that this group of girls already had a high concept of women in engineering. The label "improved" in that figure refers to an answer moving into a more positive response to the statement. After the workshop, 23% had improved their opinion, primarily indicating a movement from Agree to Strongly Agree. The 5% whose opinion worsened were in the Brownie/Junior group and may be related to difficulty of the youngest girls in filling out the survey.

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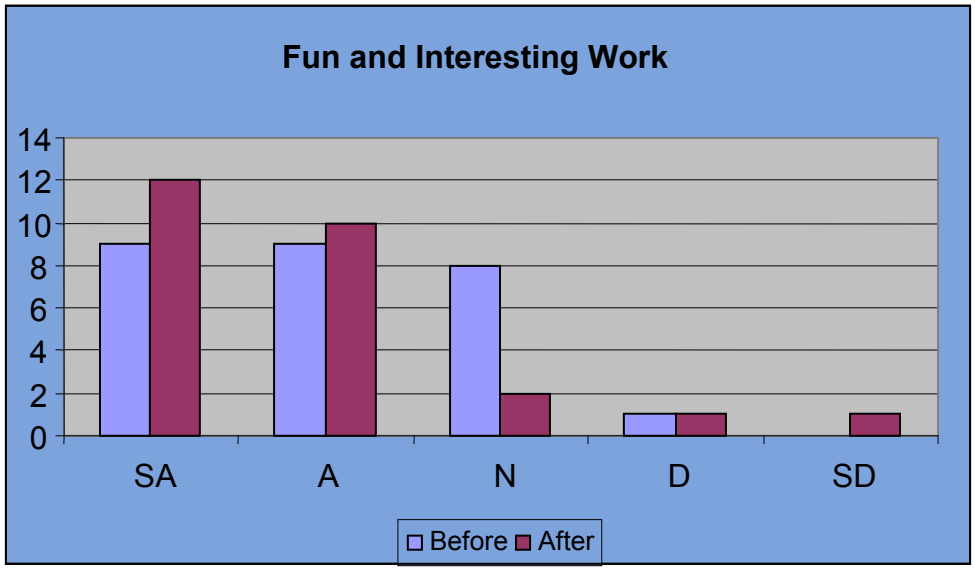

Figure 6. Response to statement "Engineers do fun and interesting work" by Junior and Brownie Girl Scouts.

A separate survey of student SWE members was conducted to obtain their opinion of whether or not the program met its objectives. All respondents felt positively (checked Agreed or Strongly Agreed) that the Girl Scout events built bonds between SWE members and that the Girl Scout event was successful. Eight of the nine respondents were positive about the Girl Scout event building bonds between SWE members and Girl Scouts, with the other response Neutral. The same breakdown was present in response to the statement "It is possible to balance an engineering career with family." The weakest response was to the statement "I think the Girl Scout event built bonds between SWE members and professional women" with four Neutral responses and the rest positive. One question asked the SWE members what got them interested in engineering. Three answered their family got them interested while two answered that it was their beginning classes in math and engineering. Other responses included that they liked the challenge, enjoyed figuring out how things work, or that they wanted to be an astronaut.

Overall, we find these results heartening and hope that we are not overly optimistic in interpreting them to indicate that the project met its goals of improving some girls' view of engineering and the potential for them to have a place in it.

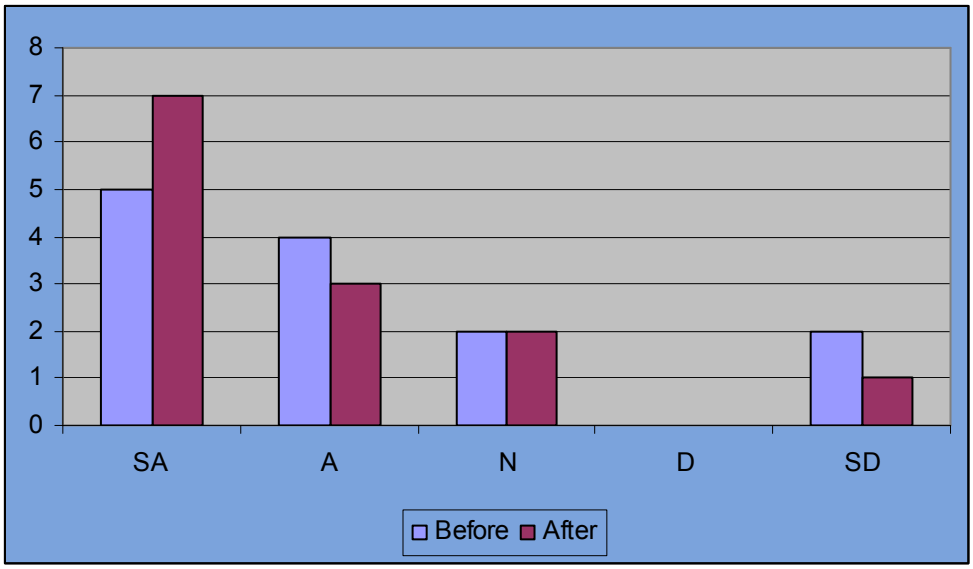

Figure 7. Response to statement "I would consider a career in science, math, or engineering" by Cadette and Senior Girl Scouts.

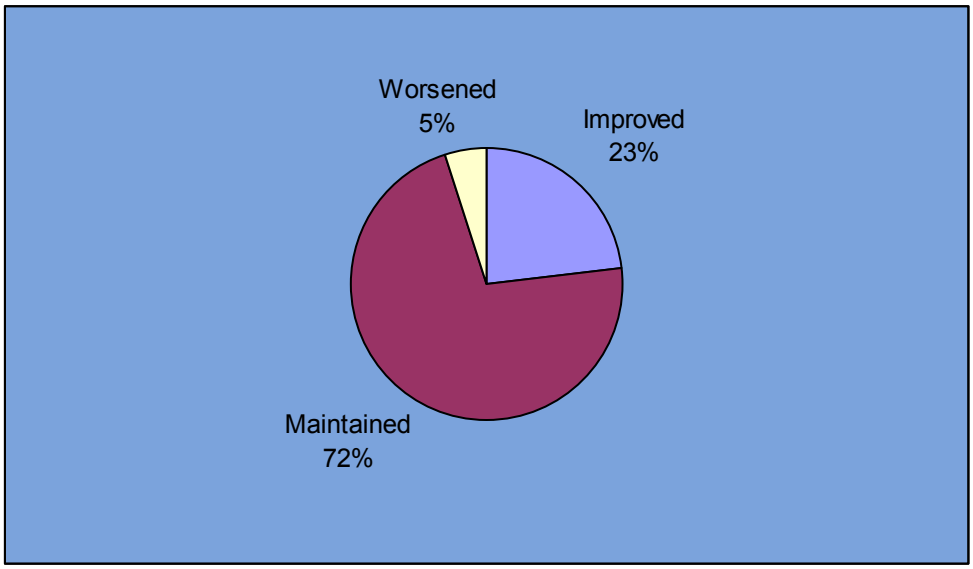

Figure 8. Change in response to statement "Women have a place in engineering" for combined survey of all Girl Scouts.

Conclusions

The USU SWE section Girl Scout outreach project use of a tiered mentoring approach to recruit and retain girls in engineering has proven to be successful. The outputs as discussed above indicate that the Girl Scouts came out of the workshop with a more positive view of engineering and the potential for women to make a contribution in

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the field. More of the middle and high school girls said they would consider a career in science, math, or engineering after the workshop than before. In addition, the SWE members worked together beautifully, becoming closer to each other while planning and running the Girl Scout workshops. They also helped the older Girl Scouts participate in the second workshop for the younger Girl Scouts, allowing them to demonstrate the principles they had recently learned. In addition, the women engineers who participated enjoyed getting to know each other and interacting with the SWE girls and the Girl Scouts. The interaction between the professional women and the SWE members was the weakest link in the mentoring portion of the project, likely due to lack of time by many professional women. However, the interactions that did occur were quite positive.

Our advice to groups planning similar workshops in the future is to fully involve all the participants from the planning stage onward. The SWE members and older Girl Scouts increased their technical knowledge, organizational skills, and collegiality by being in charge of the preparation and the implementation of the workshops. Finally, the SWE group provided a worthwhile service and had fun. We encourage other groups to design and implement their own outreach projects.

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Dr. Sue Ellen Haupt, as an Assistant Professor in Mechanical Engineering, was faculty advisor to the USU SWE student section, as well as a Cadette/Senior Girl Scout leader during this project. In addition to engineering, she enjoys outreach projects with K-12 students. She has recently moved to the Computational Mechanics Division of the Applied Research Laboratory at The Pennsylvania State University.

Jessica Gregory was Chair of the SWE Mentoring Girl Scout Committee in 2003. Shortly afterward, she was elected President of the USU SWE student section. She is graduating with a B.S. in Electrical Engineering in 2004 and plans to complete the M.S.E.E. by 2006. She is from Shelley, ID and her hobbies include cooking, genealogy, racquetball, and homework.