

Ambassador Program for Recruiting Girls into Engineering—Appropriate Messages, Messengers, and Modes of Delivery

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Abstract – Although women make up more than half of the U.S. population, the percentage of women entering engineering is much lower. To address this discrepancy, the College of Engineering at Penn State has initiated an Engineering Ambassador Program that sends female engineering undergraduates to give talks in science and math classes within Pennsylvania high schools and middle schools. The main goal of these talks is to clarify what engineers do.

What distinguishes our program are the specific messages in the talks and the presentation style of our ambassadors. The messages of our program's talks come from recommendations in the recent text *Changing the Conversation* [1]. The primary presentation style that our ambassadors rely on is an assertion–evidence style taught in a special presentations course [2].

Evaluations of the presentations by almost 500 students at six different schools across Pennsylvania (including two all-girls schools) indicate that the presentations are highly successful at communicating the messages. More powerful evidence for the efficacy of this program lies in the volunteered responses of girls to these presentations.

Index Terms – women, females, engineering, recruiting, PowerPoint.

I. INTRODUCTION

In a recent presentation [3], Dr. Charles Vest, President of the National Academy of Engineering, stated that one of the reasons many women do not enroll in engineering is because the women state they want to work in a profession that “helps people.” Ironically, one could easily argue that engineers do help people in a variety of ways. As the recent text *Changing the Conversation* states, the message that engineers aid in the health, happiness, and safety of society is not getting out.

This paper presents the design and initial results of a new program from the College of Engineering at Penn State to disseminate two key messages cited by *Changing the Conversation* [1] as important for recruiting girls into engineering. Those two messages are as follows: (1) engineers make a world of difference, and (2) engineering is essential to our health, happiness, and safety.

The main goal of our Engineering Ambassador Program is to inform science and math students in high schools and middle schools about what it is that engineers do. By showing solutions that engineers have created for important societal problems, the program aims to persuade these students, especially the females, to consider engineering as a profession.

Around the country, other ambassador programs have arisen with the goal of recruiting girls into engineering [4, 5, 6]. What distinguishes our program from those other programs is that ours incorporates two other key elements to recruit females into engineering: the recent recommended messages from *Changing the Conversation* [1] for recruiting girls into engineering, and a presentation style that differs dramatically from the topic–subtopic approach that pervades engineering.

Section II of this paper presents a theoretical basis for the three key elements of the approach: messages, messengers, and modes of delivery. Discussed in Section III is how we are carrying out the program: selecting ambassadors, scheduling visits, preparing for visits, and making presentation during the visits. In Section IV, the paper presents the evaluation results from the first six visits. Given in Section V are plans for expansion of the ambassador program, not only at Penn State, but also to other institutions.

II. THEORETICAL BASIS FOR PROGRAM

As stated, what distinguishes our Engineering Ambassador Program from other engineering ambassador programs across the country is that ours brings together three key elements to recruit females into engineering: effective messages, effective messengers, and effective modes of delivery. This section presents the theoretical foundation for each of these elements.

Messages. As stated, the two central recruiting messages of our program arise from *Changing the Conversation* [1], a publication of the National Academy for Engineering (NAE). In response to polls showing that K–12 teachers and students generally have a poor understanding of what engineers do, the National Academy of Engineering (NAE) secured funding to identify, test, and disseminate a small number of messages likely to improve public understanding of engineering. The book that resulted, *Changing the Conversation*, is part of an attempt to disseminate the results. For the project, the NAE hired a communications firm (BBMG) to develop messages

and a market research company (Global Strategy Group) to test those messages on various groups.

Focus groups and surveys revealed preferences by girls for certain messages that state what it means to be an engineer. The consulting groups conducted focus groups on students and parents to determine what their views were. In general, the groups found that students and parents have a positive view of engineering. However, the focus groups found that most students understand that engineers “design and build things,” but do not really know what engineers do. Also, most students thought that engineering careers were sedentary with little contact with other people. In regard to gender, the study found that most girls believe that women can be engineers. However, when asked to name engineers, most students could only name men.

Out of five different messages considered, the surveys revealed that girls found the following two messages most appealing:

Engineers make a world of difference.

Engineering is essential to our health, happiness, and safety. As the authors of *Changing the Conversation* learned through focus groups and surveys, the first message appeals strongly to both girls and boys, and the second has particular appeal to girls.

Messengers. The messengers for our program are female engineering undergraduates who excelled in a special presentations course for engineers [2]. These messengers are only a few years older than the female high school and middle school students to whom they are presenting. Also, these messengers are often presenting in the very schools that they had attended. The rationale for using female engineering undergraduates for recruiting has been recognized by other ambassador programs [4, 5, 6]. That is, while girls in high school and middle school might not be able to envision themselves achieving the success of a female professor who is ten or more years older than they are, these girls are much more likely to envision themselves achieving the success of a female undergraduate only a few years older [7].

In our Engineering Ambassador Program at Penn State, while we instructed our engineering ambassadors to communicate the two identified messages of *Changing the Conversation* for recruiting girls into engineering, our ambassadors themselves came up with the content and style for the presentations. In other words, our ambassadors chose the examples to anchor the messages, they devised the structure for organizing and emphasizing those examples, and they created the visual aids to communicate those examples. We anticipated that presentations created by the ambassadors would resonate much more with the middle school and high school students than presentations crafted by faculty members. While the faculty advisor to the program (the lead author on this paper) certainly offered suggestions about the presentations, all the presentations had the indelible signatures of the ambassadors who created them.

Those signatures can be seen in the examples selected by our ambassadors to show that engineers make “a world of difference” and “contribute to our health, happiness, and

safety.” For example, in showing how engineers use principles of physics, one team of ambassadors chose the example of engineers designing spinal implants to correct illnesses such as scoliosis. Likewise, in showing how engineers use principles of calculus, another team of ambassadors chose the example of how engineers minimize the waiting time for rides at amusement parks.

Modes of Delivery. The third element that distinguishes our recruiting program concerns the ways in which our ambassadors present. These modes or strategies of delivery arise from a special presentations course for engineering undergraduates at Penn State [2]. While this course does teach many traditional techniques of speech, the course also teaches recent advances in presentations, particularly advances in visual aids.

For instance, our ambassadors do not follow the common practice of topic–subtopic slides that pervade engineering, including engineering education conferences. This common practice is marked by a topic–phrase headline supported by a bullet list or by a bullet list and accompanying graphic [8].

Instead, for their presentations in the middle schools and high schools, our ambassadors followed an assertion–evidence approach [9] that much more closely follows the tested principles of multimedia learning [10]. Recently, this approach was featured in an article in *The Scientist* [11] and a recent documentary by Ron Galloway [12], who created the widely circulated documentary *Why Wal-Mart Works*. As Garner et al. argues [8], this assertion–evidence approach not only makes the visual aids more effective at communicating the information, but also makes the structure much more focused and leads presenters to adopt a delivery that is much more engaging.

Figure 1 shows examples of visual aids from an ambassador presentation [13]. One feature is that the sentence headline focuses the audience on the main takeaway of the slide. A second feature is that the number of words per minute projected is significantly less than in the common practice approach [14]. A third feature is the reliance on visual evidence (photographs, drawings, diagrams, graphs, films, or equations) to support the assertion. A final feature is that all the typography and layout defaults of PowerPoint have been challenged so that text can be read quickly and so that the visual evidence is not crowded.

For some of the on-campus recruiting presentations that will be discussed in Section V, the ambassadors adopted another visual aids approach, which is credited to Stanford economics professor Larry Lessig. In the Lessig-style approach, exemplified by a conference keynote address given by Dick Hardt, the CEO of Sxip Technologies [15], many images and short phrases flash on screen as the presenter speaks. This approach, although effective, is time consuming to develop and requires much practice. However, when done well, the approach is fun and appears to be particularly engaging to younger audiences, perhaps because the pacing is reminiscent of an MTV video.

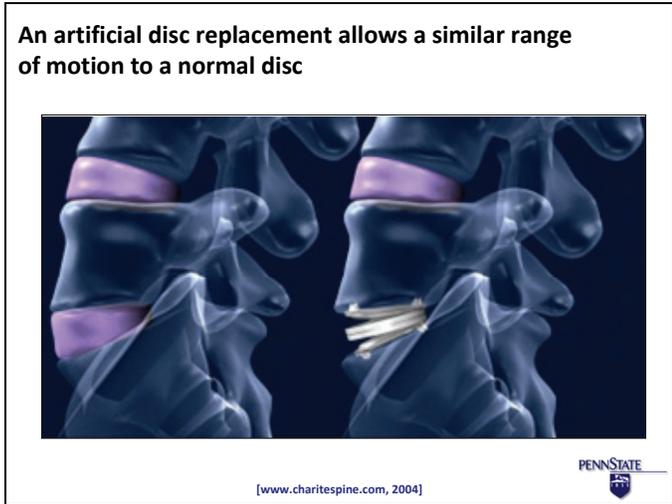
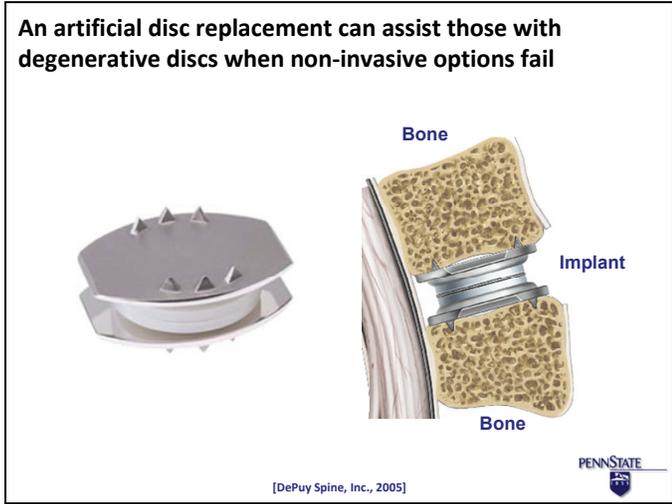


FIGURE 1

SAMPLE SLIDES FROM ENGINEERING AMBASSADOR TALK [13].

In all our presentations, though, our ambassadors are critical thinkers about visual aids—not only what types of visual aids are appropriate, but when visual aids are appropriate. Unlike the typical FIE or ASEE conference presentation in which slides are projected on the screen the entire time, our ambassadors do not hesitate, when the information is not suited to be communicated with slides, to blank the screen and to place the focus solely on the speaker.

III. HOW THE PROGRAM IS CARRIED OUT

Before our College of Engineering was willing to make a full commitment to this program, we had a two-person team of ambassadors make two pilot visits in May 2009 to area high schools. On these pilot visits, both ambassadors were rising seniors in bioengineering. The two pilot visits were unqualified successes.—as demonstrated by the attention given by the students, the high number of questions the students asked, and the positive evaluations given by the high school students to the ambassador presentations. In addition,

not only did the science teachers request the ambassador program to come back for Fall 2009, but other science and math teachers at these two schools asked that ambassadors come to their classes as well. Based on this positive response, the College of Engineering at Penn State decided to fund the ambassador program for 2009-2010.

This section discusses how we recruited ambassadors for the Program, the scheduling of the trips, the preparation of the ambassadors for those trips, and what kinds of presentations the ambassadors delivered on these trips.

Recruitment for Program. The engineering ambassadors in our program arose from female engineering undergraduates who had excelled in the special presentations course discussed earlier [2]. Each semester, about 125 students take this course, and about 20% of those students are female. Because we had taught the course for six semesters before we began recruiting for the program, we had a sizable pool of potential candidates. Of those 17 whom we initially invited, 16 accepted. Because two students had Co-Op obligations and two others had heavy course loads, the actual number who could serve as engineering ambassadors for Fall 2009 was 12.

This initial group of ambassadors represented six different departments: bioengineering, chemical engineering, industrial engineering, mechanical engineering, and nuclear engineering. This initial group consisted of four seniors, six juniors, and two sophomores.

An interesting lesson learned from the pilot visits in May 2009 was that the ambassadors preferred to give a team presentation as opposed to individual talks. In our initial vision for the program, we had assumed that to save time, each ambassador would simply rework one of the talks she had developed in the special presentations course. However, the first two ambassadors preferred to work together on a new joint presentation. In addition, because the second pilot visit called for a presentation to a physical science class, as opposed to a biology class as on the first visit, the two ambassadors made significant changes to that presentation (adding much new material) for that second pilot visit. Given how successful the pilot visits were and how the ambassadors preferred the team presentation, the team approach became the model for the program. This choice of a team presentation is a reflection of how much the program allows the messengers (the ambassadors) to shape the way the messages are delivered.

Scheduling of Visits. To schedule visits, the faculty advisor for the Engineering Ambassadors contacted science and math teachers in various schools around the state. She relied on contacts that our College had as well as science and math teachers that the ambassadors had in high school and middle school. In addition, an unexpected outcome occurred when two schools heard about the Engineering Ambassador visits to other area schools and then contacted the faculty advisor to request a visit to their school in Spring 2010. Table 1 presents a description of the schools visited in the first semester (Fall 2009) and the number of students who received presentations and completed evaluations of those

presentations. For the two largest visits, two teams of ambassadors went. Also, because of the distance of those schools from University Park, those two visits entailed the four ambassadors and faculty advisor arriving to the area the night before.

TABLE 1
AMBASSADOR VISITS FOR FALL 2009.

School	Description of presentations	No. of Students
Mt. St. Joseph's Academy, Philadelphia area, All girls school	3 physics classes 3 biology classes 1 general assembly	134
Moon Area High School, Pittsburgh Area	1 engineering drawing class 2 AP biology classes 2 AP chemistry classes	98
State College High School, State College	4 physics classes	90
Milton Hershey School, Hershey Eighth grade class	10 general science classes	69
Bald Eagle High School, Wingate	1 environmental science class 1 AP biology class 2 physics classes	62
Grier School, Tyrone All girls school	2 calculus classes 2 general science 1 careers talk	42
Total		495

Preparation for Visits. Preparations began with teams of two ambassadors preparing a 20-minute presentation in one of four areas: physics, chemistry, biology, or math. The teams chose the area that matched with their area of study. Once the team had developed a talk, the team presented it to the faculty advisor to receive coaching. Much attention was paid to revising the talks to be engaging to the high school student audience. Where possible, the presentations incorporated examples, questions to generate discussion, and hands-on demonstrations.

Then, the faculty advisor matched teams of ambassadors with the types of presentations that each school desired: physics presentation to a physics class, and so forth. In this scheduling, much depended upon the availability of the ambassadors at that time of the semester. One challenge realized early on was that these presentations required much work from the ambassador teams. Not only was significant time required to research the content, but much time was needed to create a focused presentation that followed the assertion–evidence structure. As Neeley et al. [16] point out, the assertion–evidence structure requires significantly more time to create than the commonly followed topic–subtopic approach. In addition, some teams added demonstrations to their presentations, which required even more preparation. Because the preparation for the presentations required much time and because the visits themselves usually involved being away from campus for an entire day, we had to make sure that the program did not load the ambassadors in a way that would hinder their studies.

Activities of Ambassadors on Visits. On visits, the ambassadors would speak to varying numbers of classes—

from two up to five. During these classroom presentations, the ambassadors would give a 20-minute presentation that shows the relevance of a concept from the class to an engineering project. The ambassadors then would field questions from the students as well as the teacher. These questions would focus on the content from the presentation, as well as questions about college life and preparing for college. In addition, an unexpected outcome was that schools often requested that the ambassadors speak at a special general assembly about careers in engineering. During the program's first semester, the sizes of these assemblies ranged from 8 to 69. For these assemblies, the ambassadors created a special careers presentation. All ambassadors on the visit would give this presentation as a team and then field questions.

IV. EVALUATION OF PROGRAM

During Fall 2009, the students at the schools evaluated the ambassador presentations. This section presents the results of those evaluations. Included are the overall evaluation results, a selection of the comments that students volunteered about those visits, and selected quotations from the ambassadors themselves about the experience.

Overall Evaluations. At the end of each visit, the students evaluated the ambassador presentations. In doing so, the 495 students (321 females and 174 males) self-reported on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree) how much they agreed with the three statements shown in Table 2. The high score on the first statement indicates that the presentations were successful at giving the students a clearer sense of what engineering is. In addition, the high scores on the next two statements suggest that the ambassador presentations helped persuade the students to accept those statements.

TABLE 2
EVALUATION RESULTS OF AMBASSADOR PRESENTATIONS.

	Total Mean (σ)	Female Mean (σ)	Male Mean (σ)
I have a better understanding of engineering as a result of the presentation.	4.32 (0.57)	4.44 (0.54)	4.10 (0.61)
Engineering is a profession that makes a difference in the world.	4.61 (0.52)	4.64 (0.49)	4.57 (0.58)
Engineering is important to our health, happiness, and safety	4.51 (0.60)	4.54 (0.59)	4.45 (0.58)

Selected Quotations of Students. Perhaps more telling than the evaluation results are the volunteered comments that students wrote on the evaluations. Given below is a sampling of comments from female students. One common thread in the volunteered responses was that the presentations changed the way that many female perceived engineering:

[The presentation] changed my perspective because I thought that only guys could work as engineers. Also, I thought engineering was when you fix trains.

Female 8th grader

[The presentation] made me realize that engineers don't just build machines but they help in many different ways in all kinds of fields.

Female high school student

Another common thread was that the presentations persuaded several students to consider engineering as a possible career path.

[The presentation] made me believe it's not just boring science. It actually made me consider pursuing a career in engineering

Female 8th grader

[The presentation] made me a lot more interested in engineering and the whole concept of it. Like working with people who help others.

Female high school student

The presentation definitely changed my perspective on engineering because I didn't really know the application of engineering other than building roads. I am actually really interested in this field.

Female high school student

I thought all engineering majors/engineers worked by themselves with data and research and math. I love biology, but I also love English, so was not really thinking about engineering, but it's now something I'm seriously thinking about.

Female high school student

Selected Quotations by Ambassadors. An unexpected outcome of the program has been that the ambassadors self-reported increases for their self-confidence in making presentations.

Having presented with seven different girls in the past four months has made me a better speaker. The team work, practice and execution that goes into each individual presentation correlates so closely to how an engineer approaches the design process towards the invention of a new project.

Engineering Ambassador, Junior

Having the opportunity to speak in front of such diverse groups of people has done wonders for my confidence. A year ago, I was not in any way a fan of public speaking, nor would I consider myself any good at it. However, after a few weeks as an Ambassador, I was confident enough to stand in front of some of the most important people of my academic career and present a talk on fluid mechanics. It was at the conclusion of that particular talk I realized that I am now capable of delivering a presentation to almost any audience, and now even look forward to it! I would consider communication to be one of my stronger skills, which, as an engineer, is a very valuable tool.

Engineering Ambassador, Junior

In addition, some ambassadors have stated that participation in the program reinforced their decision to go into engineering.

In our curriculum, it is very easy to get lost in neutron diffusion and forget about this big picture: "I am an engineer, and my work will benefit society one day." Being an Engineering Ambassador helps to keep this thought at the forefront of my mind, so that when I get frustrated with

a homework problem, I know that eventually my hard work will amount to something.

Engineering Ambassador, Senior

The Engineering Ambassadors Program reinforces my decision to become a mechanical engineering major at Penn State. To be given the ability to work with such intelligent and motivated people while doing work I absolutely love is an opportunity I am fortunate to have and one I would not trade for anything.

Engineering Ambassador, Junior

V. EXPANSION OF PROGRAM

The successes of the Engineering Ambassador Program in its first semester in Fall 2009 have already led to three kinds of expansion. This section explains all three.

First, word-of-mouth discussions among high school teachers have led to increases in the number of teachers desiring presentations. In one instance in Spring 2010, we had to increase the number of ambassadors brought to the school from four to six. In addition, 300 students showed up at the end of the day to hear these six ambassadors give the presentation on engineering careers (see Figure 2).



FIGURE 2
CAREER PRESENTATION BY ENGINEERING AMBASSADOR TO 300 STUDENTS AT MONTOUR HIGH SCHOOL IN PITTSBURGH [13].

Second, as with other engineering ambassador programs across the country, the College of Engineering at Penn State has begun using ambassadors for various on-campus presentations. For instance, several days in the Spring semester, hundreds of prospective students come to Penn State to learn what the university has to offer. During these one-day visits, those students interested in engineering attend sessions given by the College. For the Spring 2010 semester, the College decided to have the ambassadors speak at these sessions. In the morning sessions on these days, the schedule now includes a sophomore ambassador followed by a senior ambassador discussing their experiences at Penn State (in these presentations, the ambassadors typically use Lessig-style slides, which were discussed in Section II). The afternoon session now includes an ambassador team presenting examples of what engineers from different disciplines do.

The College also envisions having the ambassadors help with orientation of new students in the fall—both those students attending college for the first semester and those students transferring to University Park from branch campuses. For these presentations, the program will expand to include male ambassadors.

Third, through contacts in Norway who have adopted the presentation techniques taught in our special presentation course [17], the Oslo School District requested a meeting to learn about the Engineering Ambassadors program. The response at this meeting to the Engineering Ambassadors Program was positive, and the District is considering whether to pilot a similar program. Also contemplating the piloting of a similar program is the Mechanical Engineering Department at Virginia Tech and the College of Engineering at the University of Connecticut.

CONCLUSIONS

This paper has presented an engineering ambassador program at Penn State that uses, as several ambassador programs around the country do, female engineering undergraduates to recruit high school and middle school students into engineering. What distinguishes our program is that we have incorporated recommendations from the recent NAE text *Changing the Conversation* [1] in our messages. Moreover, we have incorporated recent advances in presentation techniques to make our presentation structure more focused, the delivery more engaging, and the visual aids more effective.

Evaluations of the presentations by almost 500 students at six different schools across Pennsylvania (including two all-girls schools) indicate that the presentations are highly successful at communicating the messages. More powerful evidence for the efficacy of this program lies in the volunteered responses of girls to these presentations. An unexpected outcome is that the program improved the self-confidence of our female engineering undergraduates. Another unexpected outcome was the interest that many schools had in a talk, by the ambassadors, about engineering careers.

One future test for the effectiveness of our program will be to compare the number of female students from the visited schools who enter engineering in the coming years versus the historical average of female students from those schools who have entered engineering. Another test will be whether the Norwegians adopt this program and, if so, whether we can disseminate the presentation skills to their ambassadors so that they have same kinds of success that we have experienced.

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