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AC 2012-3009: USING STUDENT AMBASSADORS TO RELAY THEMES FROM CHANGING THE CONVERSATION IN ENGINEERING FIRST-YEAR SEMINARS

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Abstract

This paper describes the efforts at a large mid-Atlantic university to integrate themes from *Changing the Conversation* into First Year Seminars. *Changing the Conversation,* a 2008 book by the National Academy of Engineering, found that both male and female students were more attracted to messages describing engineering in terms relating to societal impact, such as the phrases, "Engineering makes a world of difference" and "Engineering is essential to our health, happiness, and safety." Although the research was conducted with younger students, the potential for using these themes in the undergraduate curricula could have the potential to impact persistence in engineering, especially for female students or those from other underrepresented groups. The purpose of the initiative described in the paper, which uses engineering students from a group called the Engineering Ambassadors to relay these messages in freshmen level courses, is to impact student perceptions of engineering and to provide information to students that will be critical in making career decisions.

In the Fall of 2011, a pilot program was launched in two sections of a Chemical Engineering First Year Seminar. Engineering Ambassadors made four separate visits to each section, focusing on the following topics: 1) An overview of College of Engineering Majors, 2) Options within Chemical Engineering, 3) Student experiences in the College of Engineering, and 4) How to be a successful engineering student. Woven through each presentation were themes from *Changing the Conversation*, focusing on how engineers are essential to health, happiness and safety. The students were mentored by a faculty member whose background is in Communication. The quality of student presentations was high, utilizing the assertion-evidence method of slide design.

Data was collected to determine whether the following project objectives were met: 1) Students in the First Year Seminars will have a greater understanding of the possible careers in engineering as well as the engineering majors; and 2) Students will be more likely to define engineering in terms associated with health, happiness, and safety. The data showed that the students had a very positive reaction to the Engineering Ambassador visits, although a larger sample size would be necessary to more clearly understand the impact.

Introduction and Background

A recent book by the National Academy of Engineering, *Changing the Conversation*,[1] describes the results of a marketing study intended to identify messages likely to improve public understanding of engineering. The study demonstrated that many people do not understand the role engineers play in our society. The primary message used to define engineering as the "application of science to the real world" was not found to be appealing, particularly to female students. Messages that were more appealing to all students, but particularly to women, included the following: "Engineering makes a world of difference" and "Engineering is essential to our health, happiness, and safety." The goal of this project is to integrate messages from *Changing*

the Conversation into First Year Seminars (FYS), to impact student perceptions of engineering, and to provide information to students that will be critical in making career decisions. This paper describes a project to integrate these messages into First Year Seminars (FYS) at Penn State University. The purpose of the initiative, which uses engineering students to relay these messages, is to impact student perceptions of engineering and to provide information to students that will be critical in making career decisions.

The recent National Academy of Engineering book, *The Engineer of 2020*, emphasizes the importance of training successful engineers who are well-rounded, being both technologically proficient and also possessing attributes such as strong leadership, communication skills, and ingenuity.[2] In order to meet the challenges of the world, these engineers need to be cognizant of the social implications of technological decisions and implementations. As the document states, "Successful engineers in 2020 will…recognize the broader contexts that are intertwined in technology and its application in society" (p. 156). The National Academy charges universities and colleges to develop engineers that have these attributes and are ready to meet the global challenges facing us. Similarly, Sheppard, Macatangay, Colby, & Sullivan describe the need for a new type of engineer who is aware of environmental and human relationships.[3] "Working with others, in this country and around the world, to understand and formulate problems, engineers are immersed in the environment and human relationships from which perception of a problem arises in the first place."

Although these and other papers state the importance of developing engineers who have an understanding of the societal impact of technology and engineering implementations, most courses within the traditional engineering curricula have not been changed to meet these needs, still primarily focusing on acquisition of technical skills without discussion of the impact on society, people, or the environment. Engineering students may be unaware of the contribution that engineers make on society. Students may also be unaware of the intertwined nature of engineering, technology, and society. By including themes from *Changing the Conversation* into engineering classes, particularly focusing on the societal impact that engineers have, students may have a better understanding of the skills necessary to be a successful engineer.

Another area of concern in engineering programs is recruiting and retaining female students and students from other underrepresented groups. In a large quantitative scale examining the MIDFIELD database which contains records for over 75,000 engineering students, Ohland and colleagues[4] found only approximately 21% of all engineering students were female while the persistence rate varied by institution. Most institutions have dedicated a significant amount of resources to recruiting and retaining their female students and students from underrepresented groups.

Seymour and Hewitt identified several reasons why students leave science, math, and engineering majors.[5] Reasons related to competence, confidence, persistence, assertiveness, interest in the discipline, interest in the career, and a support system. As summarized by Matusovich, Steveler, and Miller,[6] "…choices to leave SME fields tend to reflect the reasons they originally chose SME fields. Persisters were more likely to have chosen engineering based on interest. Non-persisters tended to choose SME fields for reasons not related to the nature of the work associated with the major such as the influence of family members, high school

teachers, and others, for materialistic reasons, and/or through uninformed choices, such as choosing engineering because they did well in high school math and science courses (p. 290).

In their study, Matusovich and her colleagues found that women did not have a strong connection between engineering-related values and their attainment value, or the value that an individual places on an activity as it fits with one's identity. The authors had suggestions on how to encourage students to persist in engineering by focusing on greater understanding of engineering and possible careers. As they stated,

> In other words, we can encourage students to stay in engineering by helping them associate a perceived engineering identity with their personal identity and demonstrating the value of this association. Doing this requires an understanding of what students value and then connecting this to one or more of the many different ways of practicing engineering. We must help students understand what it means to be an engineer not only by teaching a variety of engineering skills, but also by exemplifying the breadth of activities engineers perform in their daily work. Perhaps this is another way of saying that engineers work in many varied jobs and situations as they participate in a wide variety of activities. (p. 300).

Bailey and Sheppard[7] conducted a small sample case study of first-year students who were leaving engineering majors. One of the students interviewed was an electrical engineering student who left the major because of her passion for public health, a major that would be considered a helping career. Another student who was interviewed had a strong interest in "humanistic studies," something he felt was not met by his major in engineering. While these are not necessarily representative or generalizable to the larger population, one possible reason that students leave the field is that they may not see a connection between the engineering major and the desire to promote health, happiness and safety of people or the desire to contribute to society.

Other reasons that students may leave engineering could be feelings of lack of guidance or advisement, lack of community engagement, difficulty with introductory courses particularly in math, and scholarship or financial problems.[8] Besterfield, Atman, and Shuman[9] conducted a three-year longitudinal study to examine how student attitudes may be related to their persistence in engineering. "Students who left in good standing started their undergraduate career liking engineering less and had a lower appreciation of the engineering profession than the other students" (p. 9).

Inclusion of the *Changing the Conversation* themes in First Year Seminars can impact persistence in several ways. First, integration of these themes can help students see the link between engineering and societal impact. Students who have an interest in helping people may see a greater interest in engineering as a career. In addition, the model used in this project helps to inform students about a variety of careers of engineers, which may improve persistence based on the findings of Matusovich, et al.[6] Additionally, student ambassadors can provide information about engineering and the resources available to them. The ambassadors can provide information on how to be a part of the engineering and university community, how to get guidance and advice from faculty and other resources, and how to succeed in tough classes, all of

which could be related to potential reasons for leaving engineering according to Fleming.[8] The student ambassadors can provide information to first year students on how to choose their major. This information is critical so that students can make informed decisions on whether they have selected the appropriate major or even whether engineering is right for them.

By including *Changing the Conversation* themes, which were shown to be of interest to both boys and girls, perhaps we can increase interest in the discipline. By teaching students early on about the types of careers they may have in engineering, perhaps they can increase interest in these careers. And finally, by discussing the opportunities and resources available to them in the college and at the university, perhaps we will increase the likelihood that they will find a support system.

History of the Engineering Ambassadors

In May 2009, the Engineering Ambassador program at Penn State was created as a pilot project to test the outreach strategy of having outstanding female engineering undergraduate students visit math and science class in high schools to provide relatable role models in the engineering field and to have those role models communicate messages about engineering that would interest more girls in choosing these careers. One key strategy of the program was to get out two key messages cited by *Changing the Conversation* 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.

A 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. A secondary goal is to improve the presentation confidence and leadership skills of the ambassadors.

The program began with 12 female engineering undergraduate students. Initial support for the program was provided by the College of Engineering and a National Science Foundation Grant (EEC-0835075) for recruiting more women into mechanical engineering. As a result, the majority of the ambassadors during the first year were Mechanical Engineering students. These students were recruited from special sections of a general education public speaking class for engineering students. During the 2009-2010 academic year, the Engineering Ambassadors visited 8 schools in Pennsylvania and spoke to about 1,000 high school students.

Due to the outstanding communication skills of the Ambassadors, the College of Engineering at Penn State began also using the ambassadors for on-campus recruiting in 2010. Over the course of several days in the spring semester, hundreds of prospective students come to campus for an informational visit. During these one-day visits, those students interested in engineering attend sessions given by the College. In one of the morning sessions, an ambassador talks about why they chose engineering and their current academic and professional experiences. In an afternoon session, an ambassador team presents examples of what engineers from different disciplines do. The ambassadors potentially influence many prospective students and parents' understandings of engineering during these recruiting visits.

Because of the additional use of ambassadors in on-campus outreach to prospective students and families, the Engineering Ambassadors program expanded greatly in 2010-2011. The size of the program went from 12 female students to 36 students and included male students. In 2010-2011, the Engineering Ambassadors visited 10 middle and high schools in Pennsylvania and influenced approximately 2,500 students through these school visits. Additionally, they gave numerous presentations and tours on campus to prospective students and families. In total, for the 2010-2011 school year, the Ambassadors impacted approximately 5,000 prospective students, families, and teachers. It is important to note that the messages of *Changing the Conversation* are emphasized during every Ambassador interaction and presentation.

For the current 2011-2012 school year, there are 46 Engineering Ambassadors. Of these 46 students, 30 of the Ambassadors are female engineering students. Table 1 displays the distribution of the majors of the Engineering Ambassadors.

Table 1: Number of Engineering Ambassadors by Major

Major	Number
Aerospace	2
Agricultural and Biological	1
Architectural	1
Bioengineering	3
Chemical	4
Civil and Environmental	2
Computer Science and Engineering	3
Electrical	4
Engineering Science and Mechanics	3
Industrial	6
Mechanical and Nuclear	17
Total	46

This year, the Engineering Ambassadors will visit 10 middle and high schools and will continue to work actively on the recruiting initiatives of the College of Engineering with a commitment to recruit more students from populations that are traditionally underrepresented in engineering. We expect to visit approximately 2500 students in middle and high schools this year and an additional 2500 prospective students and families through on-campus visits. Finally, we are expanding our interactions with first year engineering students as described in the current project.

Training of the Ambassadors

A distinguishing characteristic of our Engineering Ambassador program is that ambassadors are highly trained in effective communication. Each Engineering Ambassador takes 6 credits of specialized communications training: CAS 100A and ENGR 397, which are described further below.

A prerequisite to applying to become an Ambassador is that students must have taken CAS 100A: Effective Speech which is a 3-credit public speaking class. Furthermore, the College of

Engineering has specialized sections of CAS 100A which develop skills and strategies for effective scientific presentations.[10] Thirty-six of the current 46 Ambassadors have taken this specialized CAS 100A course, so the course is a very effective pipeline of students that have important foundational training and skill in communication prior to becoming Ambassadors. In CAS 100A for Engineers, students learn communication strategies regarding delivery and visual aids that distinguish them from their peers.

During their first semester in the program, Ambassadors are considered to be in training and they take a 3-credit course ENGR 397 that serves as their specialized training for the types of skills needed to be a successful Ambassador. ENGR 397 is a professional development elective course that teaches advanced communication skills for engineering students through service-learning experiences with the Engineering Ambassador organization. Innovative presentation techniques, communication strategies (written and oral) for varied audiences, and utilization of current and emerging web communication technologies are studied. The Ambassadors primarily use the assertion-evidence design for their presentation format.[11] Engineering Ambassador projects and events provide the context and practice forum for concepts and skills learned in the course. Additionally, there is a focus on effective leadership and networking in the course.

Description of Events in the FYS courses

In the summer of 2011, a team consisting of three chemical engineering professors, the advisor of Engineering Ambassadors, the coordinator of first-year seminars in engineering, and an educational psychologist from the Leonhard Center for the Enhancement of Engineering Education at Penn State developed a plan to include presentations by the Ambassadors in College of Engineering First Year Seminars. Initial funding for the project was provided by the Leonhard Center. The goal of using the Ambassadors in the first-year seminars is two-fold. One aim is to increase students' understanding of engineering, including possible careers. Students that are better informed about possible career options will make better-educated decisions about their future major and careers. While the primary interest of this project is to enhance the understanding of different engineering disciplines, students should also come to the appropriate conclusion if they feel that engineering is NOT the right career. A second aim is to change the perceptions of engineering by female students, who historically have lower retention rates than male students. The themes within *Changing the Conversation* have been found to be more attractive to female students. Although the College of Engineering invests considerable resources in recruiting and retaining women, much of the emphasis is on activities conducted outside of the classroom. Inclusion of *Changing the Conversation* themes inside the FYS classroom could potentially have an impact on female students' perception of engineering, beyond the critical efforts currently underway focused on women in engineering.

In order to communicate the messages of *Changing the Conversation* to first year students, four different opportunities were created for ambassadors to interact with engineering students in their first year seminar courses. Each section that participated in the project received the same series of events. However, note that the second event varies depending upon if the section is a general section or a section that focused on a specific major. The events were 1) a presentation of how the engineering majors impacted different industries, 2) a presentation on the specific options within a major, 3) a presentation that focused on the cumulative experiences of one senior student, and 4) a panel discussion on how to be a successful engineering student. Following each

event, there was much opportunity for students to ask questions about the content covered. Below is a more detailed description of each of the four events.

Event 1: Majors by Industry

During this 20-minute presentation, the ambassadors discussed six major areas where engineers may have careers: energy, transportation, healthcare, food, entertainment, and humanitarian efforts. During each section of the presentation, a specific project in that industry was highlighted (for example, solar power was discussed in the energy section and amusement parks were highlighted in entertainment) and the ambassador discussed all of the different types of majors that would work on the example project (for example, several types of engineers including architectural, industrial, and mechanical might work on the design and construction of a cruise ship). The goal of this presentation is to show the broad applicability that many majors have to many different industries to show how an engineer could impact and work on many different and important projects.

Event 2: Specific Options within a Major

Two variations exist for this event. In the fall of 2011, the Ambassador visits were piloted only in Chemical Engineering specific sections. For these sections, this presentation focused on the four different options that Chemical Engineering majors choose to focus on within their major (i.e. bio, energy, polymers, general). An ambassador who was a chemical engineer presented this talk and provided specific examples of the types of careers and research opportunities with specific faculty possible within each option.

In the spring of 2012, the Ambassadors will also be making visits to general engineering first year seminars. In the general engineering sections, this event will focus on an interesting research project occurring within each major in the College of Engineering to provide brief information on each major. Each research project emphasizes *Changing the Conversation* themes. For example, a project will be discussed that shows how mechanical engineers at [the authors' institution] are modeling the flow of a cough using Schlieren photography to better study the transmission of disease.

Event 3: Cumulative Senior Student Experience

This event is composed of one ambassador in their senior year providing a 15-minute presentation that discusses the variety of personal experiences that the student has achieved during their college career. The goal of this presentation is to inspire the freshmen students to see the possibilities that are available during college and to motivate those students to take initiative to pursue these opportunities for themselves. The ambassador is able to discuss how their "extra-curricular" experiences (internships, research, activities, etc) shaped both their college experience and the opportunities that have opened up to them regarding future careers. The first year students can begin their college careers seeing an example of someone who has been through the experience and has reached goals relating to future careers. The ambassador is a relevant role model, a peer to whom students are able to relate. Additionally, the examples provided show how the work that the student has done in their engineering college career is consistent with the messages of *Changing the Conversation*. These personal stories are inspiring and accessible, but not intimidating, as they come from a peer rather than a faculty member. The

ambassador makes a significant effort during the presentation to not only discuss an accomplishment, but to also discuss how they were able to obtain the opportunities addressed. The goal of this presentation is to promote the image of a role model engineer in a way consistent with the *Changing the Conversation* messaging.

Event 4: Panel Discussion on Skills for Success

During this event, four ambassadors facilitated an interactive panel event in which they covered the following four topics relevant to being a successful student: internships, study abroad, study skills, and extracurricular involvement. Each ambassador hosted a "station" that focused on one of the four topics. Small groups of students spent 10 minutes at each station before rotating to the next station. The ambassador provided a 3-5 minute informational conversation starter about the topic and then the remaining time was used for questions and discussion with the students.

Summary

In summary, the goal of each of these events was to utilize the Engineering Ambassadors as relatable role models to communicate the messages of *Changing the Conversation* to first year students. These messages are important to keep fresh in the mind of new undergraduates as they deal with the challenge of core math and science classes that are prevalent in the first year two years of study. This series of presentations aimed to illustrate the variety of opportunities available and to inspire students to seize those opportunities, thus enhancing their commitment to their chosen field of engineering.

Project Objectives and Assessment Methods

The objectives of the Ambassador visits to the first year seminars are as follows:

1. Students who hear a presentation by the Ambassadors in the FYS and participate in the revised FYS will have a greater understanding of the possible careers in engineering. Students will better understand the possible options in the discipline hosting the FYS as well as in other engineering disciplines.

2. Both male and female students will be more likely to define engineering in terms associated with health, happiness, and safety, themes emphasized by *Changing the Conversation.*

During the pilot program in the chemical engineering FYS in the fall of 2011, both formative and summative assessment data was collected from students. Students were first asked to complete an informed consent document, consistent with the requirements of the Institutional Review Board at Penn State. Prior to the first Ambassador visit, the students completed a pre-survey which asked them questions about their engineering identity, their familiarity with engineering and chemical engineering, and their perceptions of engineering. A 5-point 16-item Likert-type scale was used to gather information about students' engineering identity and perceptions of engineering. In addition, students were presented with a series of 23 words or phrases and asked to indicate how well they felt it described engineering, using questions drawn directly from National Academy's *Changing the Conversation* study. A four-point scale was used with anchors of "Not well at all," "Not very well," "Somewhat well, and "Very well." Finally,

students were asked to write down whatever came into their mind when thinking of "chemical engineering."

At the end of the semester, students completed a similar post-survey which again asked questions about engineering identity, familiarity with engineering, and how they would describe engineering. The series of descriptors of engineers from the *Changing the Conversation* study was once again presented to the students. Again, students were asked to describe chemical engineering in their own words. This final survey also asked several global questions about students' perceptions of the Ambassador program. The results of these surveys are used to determine if students' feel they have a better understanding of the possible careers in engineering and the options within chemical engineering, as described in Objective #1 above.

In addition to these two surveys, students completed a brief 3-question survey following each Ambassador visit. The purpose of these surveys was primarily formative in nature with the intent of gathering information to improve the visits for subsequent semesters. These surveys asked the students what was most helpful about the session, what they felt was most important, and what should be changed or improved. Students also had the opportunity to provide comments. The responses to this survey were coded using N-Vivo software. The categories that were coded included the following: 1) perceived benefits of the Ambassador visits and 2) suggestions for future Ambassador visits.

A total of 44 student participated in at least one piece of the assessment of the Engineering Ambassadors visit. Of these, only six students were female; the remaining students were male. Most reported being Caucasian. Three reported being of Asian descent and two reported being from two or more races. A total of 22 students completed both the pre-survey and the post-survey. [1]

Assessment Results

Results from pre- and post-surveys

Table 2 displays the descriptive statistics for the items that appeared on the pre- and post-surveys. A series of paired t-tests were conducted to examine whether students' perceptions had changed from the pre-survey to the post-survey. Of the items included on both the pre-survey and the post-survey, four items were found to be significantly different in the two administrations. On the post-survey, students were less likely to state that they wanted to be an engineer so they can make a lot of money [$t(19) = 2.349$, $p = 0.030$]. They also felt they were more familiar with what a practicing engineer does [$t(19) = -2.629$, $p = 0.017$] and what a practicing chemical engineer does [$t(19) = -3.584$, $p = 0.002$]. Students also rated the following statement more highly on the post-test: I am familiar with what engineers do in disciplines other than chemical engineering [$t(19) = -2.979$, $p = 0.008$]. While not significant, the mean for most of the items moved in a direction indicating that the ambassador visits along with other experiences in the first-year seminar had an impact.

On the post-survey, students were asked specific questions regarding their experiences with the engineering ambassadors. The results were very positive. All of the students who completed the post-survey felt that learning about the experiences of other engineering students was helpful. A

[1] Due to logistical issues with the length of the courses, the post-survey was only administered in one section.

great majority (95.5%) felt that they were better informed about the opportunities that would help them to be successful as a college student. Over 80% of the students felt that the visits helped better understand what chemical engineers and what other types of engineers do. A total of 86.4% felt that they have a better understanding of how chemical engineers help people and society as a result of the ambassador visits. Approximately 77% of the students thought hearing the information from students was more effective than hearing it from faculty members. Less than half felt that the visits helped them to be more confident of their decision to be a chemical engineering student. Approximately 9% felt that the visits had encouraged them to consider another major.

In order to visually examine students' descriptions of chemical engineering, two word clouds (also called a content or tag cloud) were generated. A word cloud is somewhat new to the qualitative analysis data but is beginning to emerge as a method for providing analysis of textual data in a visual manner.[12, 13] The word clouds were generated using the software TagCrowd (available at http://tagcrowd.com/). The top 50 words were displayed in the tag clouds. The larger and darker words illustrate those that more frequently were written by students in their responses. Figures 1 and 2 display the word cloud for students' descriptions of chemical engineering from the pre-survey and the post-survey, respectively. A common definition of chemical engineering was "using chemistry to solve real-world problems." While some students talked about the impact of chemical engineering on the world, most students discussed terms such as problem solving, chemistry, oil, energy, polymers, etc. Most other definitions on the pre-test primarily focused on problem solving. Out of the 44 students who completed the pre-survey, there were three students (all male) who clearly defined chemical engineering in terms relating to *Changing the Conversation:*

- Creating products to help others live healthier and better lives
- The enhancement of the human well-being through improvement of the way materials, pharmaceuticals, and other chemically related things are produced, manufactured, and distributed
- I think of people that use problem solving skills and innovative technology to solve problems in the world as well as to create products used on a day-to-day basis.

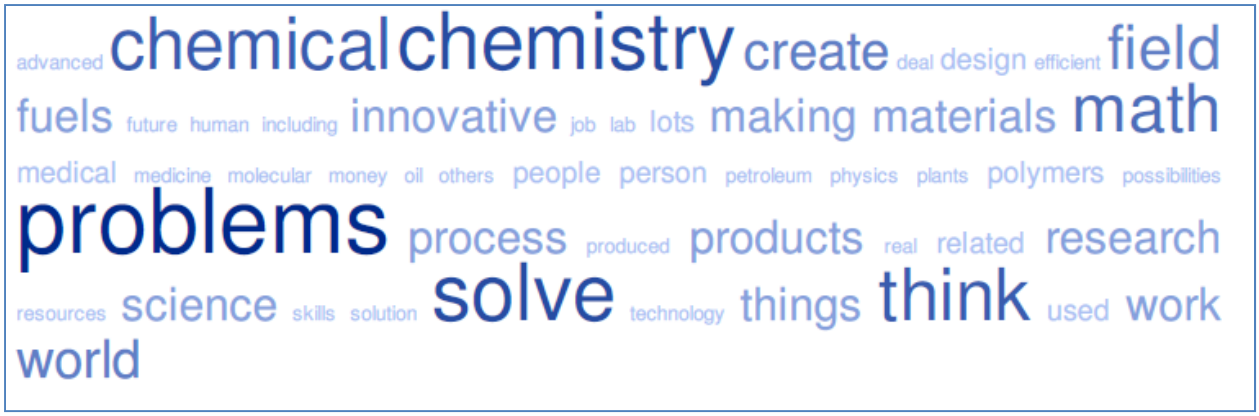

Figure 1: Pre-survey word cloud on description of chemical engineering

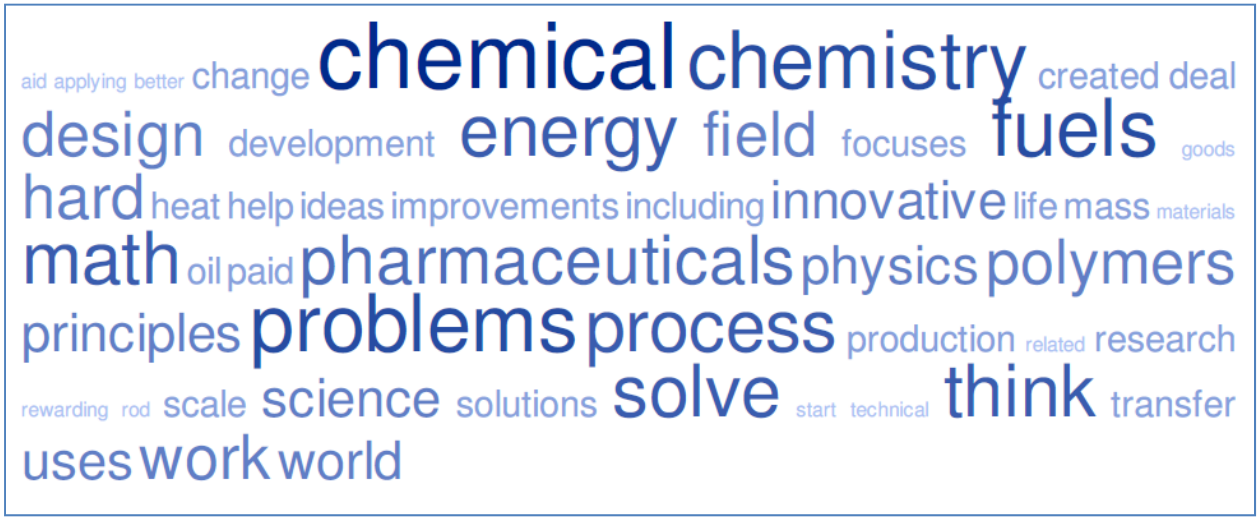

Figure 2: Post-survey word cloud on description of chemical engineering

Out of the 22 students who completed the post-survey, there were several that showed themes that were consistent with *Changing the Conversation:*

- Chemical engineering is a [type] of engineering that will change society for the better. (female student)
- The development of new ideas dealing with chemistry that work to help people around the world and usually make tasks become more efficient.
- Chemical engineering is a field of engineering that focuses on creating solutions for societal problems, by applying principles of chemistry and other sciences.
- Smart, science, math, physics, hard work, rewarding, well paid, respected, useful, life changing, helps the world.
- Solving problems in order to make improvements to the world using chemical/knowledge of chemistry. (female student)

Students were asked to rate a set of 23 words on how well they felt they described engineers. Descriptive statistics for these items are available in Appendix C. On the post-test, the words that students rated as most descriptive of engineers and the field of engineering were the following: work is rewarding, get results, hard-working, problem solvers, and must be good at math and science. The words that students rated as least descriptive of engineers and the field of engineering were nerdy, sits at a desk all day, mostly men, mostly white, and boring. Paired t-tests were conducted between students' ratings on the pre-survey to the post-survey. Only one comparison was found to be statistically significant. On the post-survey, students rated "work is rewarding" significantly higher than on the pre-survey [$t(19) = -2.041$, $p = 0.01$]. While there were some other mean differences, none were significant possibly due to the small sample size.

Feedback on individual events

Event 1.

As mentioned above, the first visit by the Ambassadors provided an overview of how different types of engineering fit into various industries. The most frequently coded category regarding perceived benefits of the visits was that students felt they gained **greater knowledge of engineering careers.** Exemplar quotes from students that fell into this category follow:

- They told us more about engineering possibilities than any other person has at [the university].
- Today, I learned about industries in which engineers participate that I had not previously known, like the food industry.
- What a broad array of "occupations" there are in engineering
- The session was extremely helpful in explaining the impact engineers have on the world. The session also opened my eyes to other forms of engineering and aided me in understanding what engineers of different sorts really do.

A second benefit frequently coded involved students' understanding of the **interdisciplinary nature of engineering**. For example, one student reported learning how "different engineers often work together on one thing." Another student said, "The most important thing I learned is that as a chemical engineer, I would most likely be working alongside many other types of engineers in the field." Yet another student said, "The most important thing I learned today from the engineering ambassador is that it often takes the cooperation of many different kinds of engineers to complete the many tasks that engineers are involved with."

Other perceived benefits learned from this session included a **better understanding of chemical engineering** and an understanding of how engineers **contribute to society.** For this latter theme, one student said, "The session was extremely helpful in explaining the impact engineers have on the world." Another student said, "The most important thing I learned today was that engineering really can be rewarding and does make the world a better, more efficient place on a day-to-day basis." Although less frequently endorsed, other benefits noted by students included understanding how engineering **impacts our lives**, that engineering is a **rewarding profession**, and that engineering is **not just math and science.** It is also important to note that many students noted the presentation format (which was a Prezi slide show) to be "cool" or "interesting."

The most frequent suggestion by the students to improve the first event was that they wanted a more in-depth discussion with more details. While this was a desire of the students, the first event was intended as a general overview with greater details to follow in later sessions. Other frequently listed suggestions included a desire for more information on chemical engineering rather than on other disciplines, and more interaction with the Ambassadors. It is worth noting that one section of the first year seminar had the Ambassadors visit later in the semester. Some of the suggestions from the first set of visits were implemented in the second set of visits. Therefore, the suggestions for greater levels of interactivity seemed to diminish by the time the second visits were conducted.

Event 2.

The second event went more in depth into chemical engineering as a discipline and the different specialization options available within the major. This session was led by a chemical engineering student. There were two clear themes that emerged regarding the perceived benefits of this session. First, many students noted that the session helped to provide clear information about the **options available within the major**, as noted by the following quotes:

- I had no idea that there was specialization inside of degrees while you are still in school.
- I knew very little about the different chemical engineering options until the presentation…
- I learned a lot about the options. Before today, I wanted to do the biomolecular option, but now I think I want to do polymers.

Importantly, along with this theme, students noted that specializing in one option did not limit future career choices or opportunities. As one student wrote, "The most important thing I learned is that just because you study something like polymers does not mean you are restricted to that field." Another student said, "Even if I choose a specific option, I can get a job outside of that field." Other students felt that the most important thing that they learned is the ability to adapt or customize the chemical engineering program to suit the individual. "I can choose to do what interests me the most and adapt my program for me. Another student said the most important thing they learned is that "it is possible to 'create your own focus.'"

The second major theme that emerged was that students noted that the session helped them to learn more about the **career opportunities** available to chemical engineering graduates. As one student stated, "The ambassadors really helped with explaining the vast amount of career options chemical engineering makes available." Another student said that a benefit of the presentation was learning "A lot of information about different options within chemical engineering and types of jobs or fields we can go into."

Students did not provide many suggestions on how to improve this session. The most frequently listed suggestion included providing a greater amount of interaction with the Ambassador.

Event 3.

The third event by the Ambassadors was broader, focusing on the undergraduate student experience. The primary theme from the student responses focused on **opportunities**, including

clubs and activities, **research and academic, career resources**, and **internships, co-ops, and study abroad**. The following are exemplar quotes from the survey responses:

- I thought his presentation was engaging and interesting, and it really helped me to realize how many opportunities I have at [the university].
- [The Ambassador] helped me realize that pursuing an engineering degree and being involved in clubs and activities can be balanced well.
- The most important thing I learned is that there are many opportunities waiting for me to get involved in, in my major.
- I got to learn about different ways to get involved, with clubs, organizations, co-ops, and internships.
- I learned a lot about internship and co-op opportunities and how they would affect my school life.
- It was nice to learn about engineering opportunities such as the co-ops and internships. It puts into perspective how important getting involved is.
- I had not realized that the importance for me to get involved in something such as some kinds of organizations, clubs. And it would be better for me if I can get an internship in the future.

Several students commented on the quality of the presentation, as illustrated by the following quote: "The thing that was most helpful about today was his use of many pictures and unique word animations to make the presentation flow really well."

The students provided several suggestions on this visit including providing additional time for questions, having greater interaction with the group, and more information on how to create résumés.

Event 4.

As described more fully above, the final event consisted of an interactive "panel" in which students split into small groups to meet with individual students. Each student was responsible for discussing a different topic relating to being a successful student. The student responses to the panel were very positive. The greatest perceived benefits included information about **internships**, **opportunities on campus**, and **how to succeed** as a student.

A frequent theme that emerged was the enjoyment of the **interactive group format** and good **interactivity**. The following quotes illustrate these themes:

- It wasn't like the other presentations that we've seen. The ambassadors involved us more, and I felt as if they were talking to me.
- Having each ambassador going around to the small groups helped make it feel more personal.
- I liked the small group with rotating ambassadors; it gave a more personal feeling.
- Having different speakers and having groups made it more interesting.

Overall benefits and suggestions

Once again, as an additional way to examine the data from the student surveys following each of the events, two word clouds were generated. Figure 3 illustrates the word cloud for the students' responses to the first two questions in the student surveys, compiling the data across all four events. These questions were 1) What was helpful about today's session with the Engineering Ambassadors, and 2) What was the most important thing you learned today from the Engineering Ambassadors? The word cloud helps to support the findings from the content analysis, focusing on things that the students found helpful, including information on co-ops, internships, career, opportunities, and getting involved.

Figure 4 displays the word cloud for the suggestions that students provided regarding the Ambassador visits. Words that did not help the understanding of the data were removed from the analysis (including engineering, presentation, maybe, think, and thought). The most frequent used word was "nothing" indicating that many students were happy with the visit and did not provide any suggestions for improvement. Other words that indicate possible suggestions included specific, detail, interaction, discussion, longer, and videos.

Figure 3: Word cloud featuring most frequent words used in student responses regarding benefits of Ambassador visits

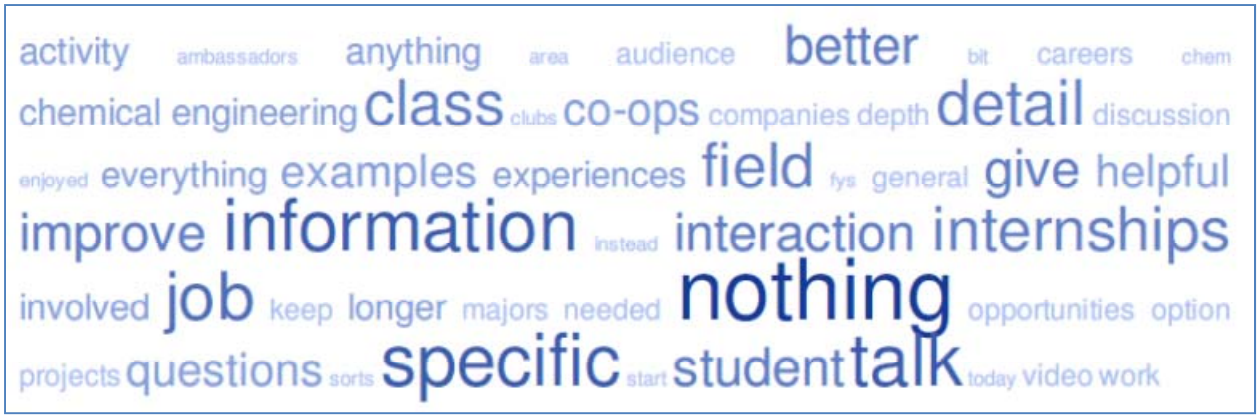

Figure 4: Word cloud featuring most frequent words used in student responses regarding suggestions for future Ambassador visits

Discussion and future directions

The introduction of the Engineering Ambassadors to first year seminars at Penn State has been an exciting endeavor. The students have been quite positive about the visits, especially concerning their increased understanding of engineering, future career possibilities, the opportunities available in the undergraduate experience, and the strategies necessary to be a successful student. The students also seemed to be aware of the strong presentation and communication skills of the Ambassadors and commented on these skills quite frequently.

In the spring of 2012, plans have been made to introduce the program in five first-year seminars. Two of the seminars will be in chemical engineering. The remaining three seminars are not housed within a major but are general engineering first year seminars. The decision was made to slowly expand the program in order to better be able to control scheduling. However, future plans are to continue to grow the program so that instructors from across the College of Engineering could invite the Ambassadors to give these presentations in their first year seminars. A lunch is being planned in the spring of 2012 to invite an additional cohort of first year seminar instructors to learn about the efforts and the assessment and to possibly participate in the fall of 2012.

While the student response regarding the visits has been tremendously positive, there were some limitations on the assessment and data collection. First, no comparison or control group was available to examine changes from the beginning of semester to the end. While the survey indicated that students were more aware of what engineers and chemical engineers did as a career, for example, it is impossible to attribute this solely to the Ambassador visit. The experience in the first year seminar and other first-year courses could also be a factor influencing students changes in perceptions. Another limitation of the assessment in this study is that responses from only 22 students were available on the pre- and the post-test. While the statistical mean of many of the items moved in the expected direction, most were not significant possibly due to the small sample size. Additional assessment in the spring semester will help to boost the response rate and potentially yield better understanding of the impact.

Another limitation of the study is the few numbers of women who were enrolled in the first year seminar. Data was available for only 6 of the 44 students, making any comparisons by gender not feasible. Again, we hope that additional data in the spring semester will better enable us to understand the impact of the project on female students.

One possible future assessment plan would be to longitudinally examine the impact of the Ambassador visits over time. How would the visits impact persistence in the major? This would be a difficult question to examine. While the authors hope that the visits do have some impact, it would be difficult to attribute changes in retention rates to the first year seminar. This may be a possible data collection strategy to explore once the first year seminar ambassador visit expands to a greater degree.

While we feel confident that the Ambassador visits had an impact on students' understanding of the nature of engineering and chemical engineering, their knowledge of opportunities on campus and their understanding of future career possibilities, it is harder to judge whether students' were more likely to consider themes from *Changing the Conversation* in their mental models of engineering. There were a greater number of definitions (even from a smaller sample) on the post-survey which included themes of health, happiness, and safety and the contribution of engineering in society. However, the sample size is still very small. Although themes from *Changing the Conversation* were woven throughout every event, the students did not always mention these in the survey. In the post-event surveys, the first event seemed to trigger the most responses relating to these themes. After the other events, students were more focused on reporting benefits that were related to their future careers or their majors or how to be a successful student. The integration of *Changing the Conversation* themes into first year seminar is just one small step into changing the culture of the engineering curricula. The difficult challenge is considering how these themes can be included in other courses throughout the curricula.

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Appendix A: Descriptive statistics for items on pre- and post-surveys.

	Pre-Mean[2]	Pre-Standard Dev	Post-Mean	Post-Standard Dev
I believe I have the skills to be a successful chemical engineer.	4.45	0.51	4.09	.75
I want to be an engineer so I can make a lot of money.	3.73	0.55	3.45	.80
Engineers are creative	4.36	0.73	4.50	.51
An engineering degree will guarantee me a job when I graduate.	3.45	0.74	3.68	.89
I am familiar with what a practicing engineer does.	3.45	0.86	3.77	.87
I am confident engineering is the career for me.	3.73	0.83	3.86	.77
I sometimes doubt that I have the skills to be a successful engineer	2.36	0.95	2.32	1.09
My parents would disapprove if I chose a major other than engineering.	1.50	0.91	2.00	.87
I sometimes have doubts whether chemical engineering is the right major for me.	2.86	1.04	2.95	.95
I want to be an engineer so I can help people.	4.00	0.87	4.00	.98
My parents want me to be an engineer.	2.95	0.90	3.27	.77
Engineers are generally bad at communication.	1.77	0.61	1.64	.49
I am familiar with what a practicing chemical engineer does.	3.45	0.86	3.86	.64
Engineers have contributed greatly to fixing the problems in the world.	4.5	0.51	4.68	.48
Engineering is a profession dedicated to helping people	3.82	0.73	4.05	1.05
I am familiar with what engineers do in disciplines other than chemical engineering.	3.45	0.74	3.95	.56
Chemical engineers help people and society.[3]	N/A	N/A	4.45	.60

[2] Means and standard deviations were calculated using all possible data. Paired comparisons were conducted using data from students who had completed both the pre-survey and the post-survey.

[3] Item added on post-survey.

Appendix B: Descriptive statistics for additional items on post-survey

	Mean	Standard Deviation	Percent who Strongly Disagree or Agree	Percent who Agree or Strongly Agree
The visits by the Engineering Ambassadors helped me to better understand what chemical engineers do.	4.05	0.84	9.1%	86.4%
The visits helped me better understand what other types of engineers do.	4.14	0.71	0%	81.8%
As a result of the visits, I am more confident of my decision to be a chemical engineer.	3.41	0.85	13.6%	45.5%
As a result of the visits, I have decided to consider another major.	2.36	0.79	63.6%	9.1%
As a result of the visits, I am better informed about opportunities that can help me become a successful student.	4.36	0.58	0%	95.5%
As a result of the visits, I have a better understanding of how chemical engineers help people and society.	4.09	0.75	4.5%	86.4%
Learning about the experiences of other engineering students was helpful.	4.36	0.49	0%	100%
Listening to other students talk about engineering and their experiences is more effective than having faculty talk about these topics.	4.05	0.84	4.5%	77.3%

Appendix C: Descriptive statistics for words describing engineers or engineering as a field

	Pre-Survey Mean	Pre-Survey Standard Deviation	Post-Survey Mean	Post-Survey Standard Deviation
Creative	3.48	0.63	3.73	0.46
Work is rewarding	3.60	0.59	3.95	0.22
Fun	3.17	0.62	3.14	0.71
Get results	3.64	0.48	3.77	0.43
Hard working	3.90	0.30	3.91	0.29
Have a positive effect on people's everyday lives	3.74	0.50	3.68	0.57
Inventors	3.50	0.55	3.68	0.48
Leaders	3.52	0.63	3.64	0.58
Nerdy	2.57	0.86	2.41	0.67
Original thinkers	3.36	0.62	3.45	0.51
Problem solvers	3.98	0.15	3.91	0.29
Well-paid	3.74	0.45	3.64	0.49
Must be smart to get into this field	3.40	0.59	3.45	0.51
Must be good at math and science	3.76	0.43	3.82	0.39
Builds, constructs, and makes things	3.36	0.62	3.23	0.75
Designs, draws, and plans things	3.45	0.59	3.18	0.73
Sits at a desk all day	2.05	0.70	1.86	0.47
Mostly men	2.45	0.86	2.23	0.75
Mostly white	2.14	0.75	2.00	0.69
Good communicators	3.14	0.65	3.27	0.63
Well-respected	3.60	0.50	3.68	0.48
Entrepreneurial	2.86	0.75	2.91	0.81
Boring	1.48	0.55	1.64	0.66