AN ABSTRACT OF THE THESIS OF

Kristina Gail Schmunk for the degree of Honors Baccalaureate of Science in Environmental Engineering presented on May 31, 2012. Title: Framing Engineering for Women in Undergraduate Recruitment

Abstract approved: ____

Eric Hill

Women are highly underrepresented in undergraduate engineering majors, with women making up just over 15% of students in engineering and computer science at Oregon State University. High school girls' interest in pursuing engineering in college is affected by the way language is used to frame engineering careers. The status quo engineering frame is made up of terms that are generally unappealing to girls. Shifting the frame around engineering to better fit frames used by most women will attract more women to engineering. An improved frame should emphasize the skills used in engineering other than math and science, engineers' connections to society, and other values associated with engineering careers.

Key Words: Engineering, Women, Framing, Language, Recruitment

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Framing Engineering for Women in Undergraduate Recruitment

by

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A PROJECT

submitted to

Oregon State University

University Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Environmental Engineering (Honors Scholar)

Presented May 31, 2012
Commencement June 2012

Honors Baccalaureate of Science in Environmental Engineering project of Kristina Gail Schmunk presented on May 31, 2012.

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Kristina Gail Schmunk

Acknowledgements

The author would like to express sincere gratitude to Eric Hill for his role in supporting, advising, and guiding my work to complete this thesis. Many thanks for helping me channel my passion and energy into an end product that is finished, rather than perfect. Also, I would like to express sincere thanks to Ellen Momsen and Dr. Janet Lee for their input, encouragement and feedback. This thesis could not have been completed without the efforts of my fellow College of Engineering Ambassadors, whose suggestions and opinions on the saliency of my research and recommendations were truly helpful. Finally, I would like to acknowledge the contributions of my family and friends who supported me throughout this process and assisted in the final proofing of this thesis.

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1 Introduction

1.1 Personal Statement

When I was a high school student in 2007 making the decision where to go to college and what to study, engineering was not on my radar. I particularly excelled in math and science: I took college calculus, biology, chemistry and physics in high school. However, I also enjoyed Advanced Placement classes in literature, history, and government. I wanted to study something in college that put all my skills to good use and would allow me to make a positive impact on society. I was vaguely familiar with engineering as a field; my mother started college in nuclear engineering in the 1980s (she didn't stay in it- as one of two women in her class, the lack of support was overwhelming), and I had seen presentations on engineering at various career days and Talent-and-Gifted events. Like most teen girls, I did not see the field of engineering as dynamic or diverse enough to interest me.

This changed when I was invited to Oregon State University for a special recruitment dinner hosted by the University Honors College. One of the presentations that evening was an honors thesis by one student who was working on engineering coastal structures. It had never occurred to me that engineers (1) could do things other than build bridges, computers, and nuclear power plants, and (2) were doing timely, interesting things that benefited society. After that, I was hooked. I started doing research on the types of engineering, and ultimately made the decision to attend Oregon State University and study engineering.

It amazes me how little it took to change my mind about engineering. I had seen a half dozen career presentations by engineers and computer scientists in high school that led me to believe that the technical nature of engineering meant it was an anti-social, narrow, static field. It only took one presentation about a current undergraduate student's research to pique my interest and completely reverse my perceptions of engineering, and I have not been disappointed since. My personal experience made me ask: What were those earlier presenters doing wrong that made me so disinterested in engineering, and what was it in the honors student's presentation that was so effective at changing my mind? And, can these lessons be applied to engineering outreach more broadly to increase the number of women in engineering programs?

1.2 Women in STEM

Currently, there is a shortage of engineers in the United States, according to the President's Council on Jobs and Competiveness (2011). The Jobs Council reports that the US graduates 120,000 engineers a year, compared to around 1 million in China and India. The council set as a goal to graduate 10,000 additional engineers per year in order to maintain the United States' competiveness in the global economy (United States, 2011). One relatively simple way to increase the number of students enrolling in engineering programs would be to close the gender gap. Nationwide, women earn around 20% of undergraduate degrees in engineering and computer science (American Association of University Women [AAUW], 2010). Based on 2007 graduation data, 35,000 additional engineers would graduate each year if as many women as men earned degrees in civil, mechanical, electrical and chemical engineering (AAUW, 2010).

Historically, the gender gap in engineering could be partially attributed to a math and science achievement gap in high schools. In the last twenty years, however, that gender gap has been closing and now is essentially non-existent. Females have outpaced males in grades and credits earned in high school math and science courses since the early 1990s (AAUW, 2010). From 2006 to 2011, the percent of Advanced Placement tests in science, technology, engineering and mathematics (STEM) subjects taken by women has held constant at 47% (College Board, 2010). Closing the achievement gap in high school has not translated to an equivalent increase in female enrollment in engineering programs, however.

Some STEM fields such as the biological and agricultural sciences exceed 50% women, partially because these fields typically fit well with women's societal roles (AAUW, 2010). A ratio of 35% women is necessary to achieve a critical mass (Bilen-Green & Froelich, 2010). Other fields such as chemistry, math and statistics, and earth, atmospheric and ocean sciences have surpassed 40% women (AAUW, 2010). Chemical engineering comes close to the "critical mass" ratio at 34% women (AAUW, 2010).

As of Fall 2011, 5,213 graduate and undergraduate students at Oregon State University are in engineering programs – of these, only 807 are women (Metzger & Tran, 2011). Oregon State University's ratio of women to men in engineering is 15%, about 5% lower than the national average (American Society of Engineering Education

[ASEE], 2011); this can partially be attributed to the fact that Oregon State's largest engineering programs – Mechanical, Industrial and Manufacturing Engineering (MIME) and Electrical Engineering and Computer Science (EECS) – have the lowest ratios of women to men. (See Appendix A for an explanation of the school and major codes.)

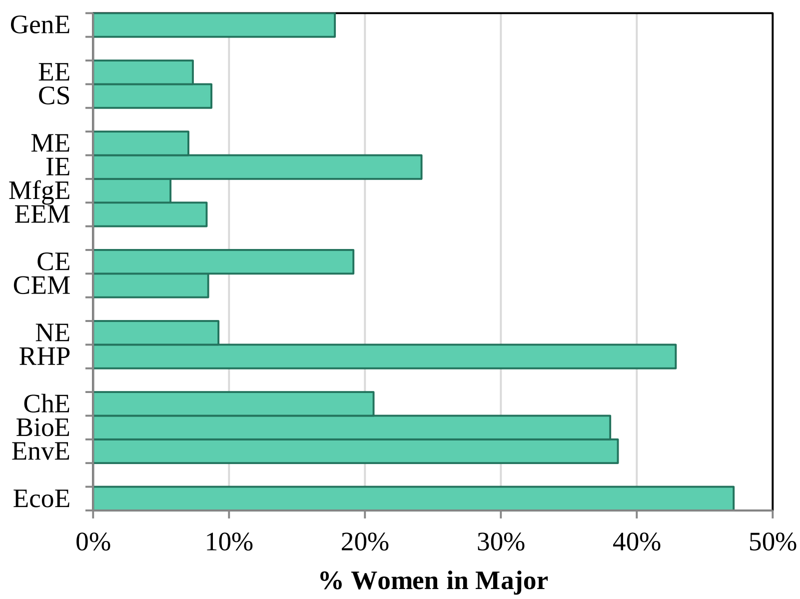

Figure 1: Percent of students that are women in engineering majors at OSU

The majors at Oregon State University that attract the highest proportions of women compared to men are those whose titles directly relate to human health or the environment. Radiation Health Physics (RHP), Bioengineering (BioE), Environmental Engineering (EnvE), and Ecological Engineering (EcoE) all have higher than 35% women (ASEE, 2011). On the other hand, seven majors have lower than 10% women, and all but two of these are in the MIME and EECS departments (ASEE, 2011). Furthermore, the only major in these two departments that has more than 10% women is Industrial Engineering, at 24% women (ASEE, 2011).

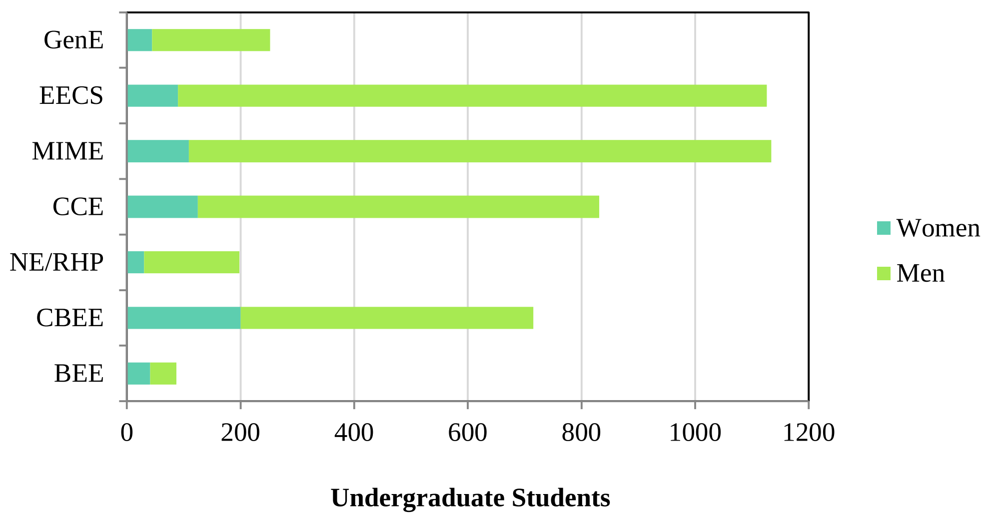

Figure 2: Make-up of students by gender in engineering at Oregon State University

There is not a great difference in the total number of students in EECS, MIME and CCE compared to CBEE, however the number of females in these three departments represents a much smaller percent of the total students. The distribution of women in engineering at Oregon State is skewed toward the departments that encompass medically and environmentally focused majors, compared to the overall distribution of students in engineering. Over one half of all students (mostly men) reside in the MIME and ECE departments, but only one-third of women. Women are overrepresented in CBEE and BEE compared to the total distribution of students – the fraction of women in these programs is about twice the overall fraction (Metzger & Tran, 2011).

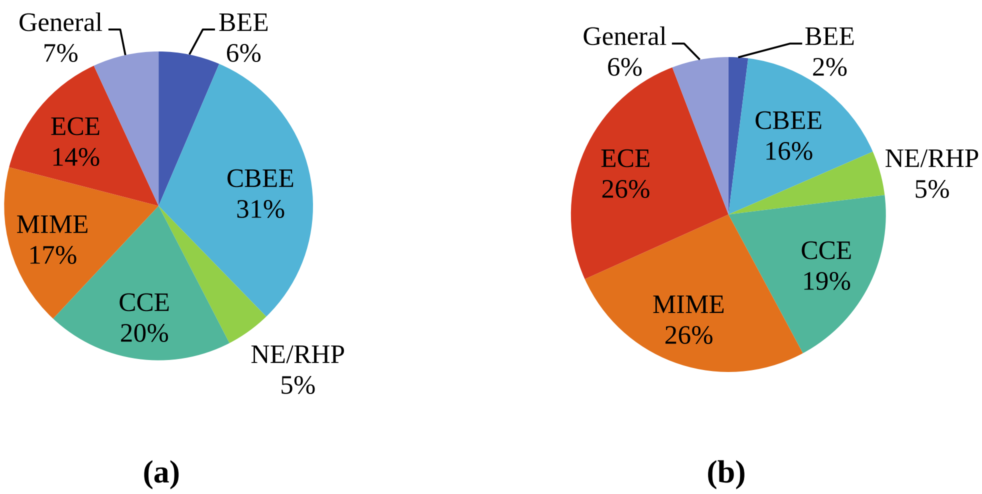

Figure 3: Distribution of (a) women and (b) all students in engineering at OSU

While engineering occupations have the lowest proportion of women in any of the STEM occupations (AAUW, 2010), there are signs that progress is being made in closing the gender gap. The number of women working in engineering occupations has increased steadily in the last fifty years from less than 1% in 1960 to 10.6% in 2000 (AAUW, 2010). In 2006, women earned a higher proportion of the total engineering and computer science doctoral degrees than bachelor's degrees (AAUW, 2010). This indicates that women who are interested and able to get their undergraduate degrees in these fields are more likely than their male counterparts to go on to earn the most advanced degrees, increasing the number of women on the cutting edge of engineering and computer science.

Most high school girls currently do not consider engineering as a possible career. Several studies suggest that only 5-20% of high school girls are interested in, or are considering, studying engineering in high school (Intel, 2011; AAUW, 2010; Extraordinary Women Engineers Project [EWEP], 2005). These same studies suggest that anywhere between 35-40% of high school boys are interested in or are considering an engineering career (National Academy of Engineers [NAE], 2008; Intel, 2011). It is not surprising that women make up such a small part of the engineering community with a maximum of only one fifth of girls in high school even interested in learning more about the field of engineering in college.

1.3 Terministic Screens and Framing

Picture the typical engineer on the job. Chances are good that you pictured a middle-aged, white male, sitting alone in his stark cubicle. Now picture a kindergarten teacher. Chances are good, this time, that you pictured a smiling, happy woman interacting with her students in a bright, colorful classroom. These images that we readily associate with people in a given profession are more than just stereotypes; they speak strongly to how society generally views the professions of engineering or teaching kindergarten; we tend to view the engineer as antisocial and the kindergarten teacher as nurturing. These stereotypes are part of an overall frame of words, images, ideas and qualities we use to filter the way we evaluate careers.

The status quo perception of engineering is a construction of terms that corresponds to a specific meaning for the general public – such as the middle-aged, slightly anti-social, white male engineer. While the construction of this status quo frame was not deliberate, it certainly exists consistently among the general public, and it has definite implications for the types of people interested in pursuing engineering careers – most notably for high school seniors making decisions on what to study in college.

Kenneth Burke's "Language as Action: Terministic Screens" from his work *Language as Symbolic Action* (1966) outlines the theory of symbolic frames used as the primary analysis tool in this thesis. Burke calls his concept "terministic screens."

The concept of terministic screens is developed from a theory of two different categories of human language: "scientistic" v. "dramatistic" language. Scientistic language is the language concerned with the definitions and naming of things and with what things are and are not (Burke, 1966). Dramatistic language is based on the symbolism of actions and is concerned with speculation and ambiguity (Burke, 1966). Thus, words have a definition, or scientistic meaning, but they also have a contextual, or dramatistic, meaning. Although Burke (1966) makes a distinction between these two types of meaning, his essay argues that all language, by its nature, is symbolic. Burke (1966) writes that language, through its attempt to be a "reflection of reality," is functionally a "selection of reality" and therefore a "deflection of reality." The symbolic constructions of language, or "terministic screens," are significant for both what they include and for what they exclude.

Symbolic terms can be constructed in ways that separate things, or in ways that connect things. From the perspective of the human condition, language can be used either to divide us from the immediate world at hand, or to connect us to a higher level of awareness. Note that both are essentially the same function, but one places emphasis on disconnect and the other on unification (Burke, 1966).

Burke (1966) argues that everything described with language by people is interpreted through a terministic screen. Language is composed of terms, and all terms are interpreted through different terministic screens. Therefore, the terms we use in language determine the terministic screens through which that language is framed. Burke (1966) argues that even scientific observations are implications of the terminology used to describe the phenomenon.

Framing is the construction of terministic screens to create a symbolic perception of an idea, event, or concept for a broad range of people. An important result of Burke's terministic screen theory is that although each individual had their own unique "personal equations" that affect the terministic screens they use, each person is also connected by the symbolic nature of language (Burke, 1966). Effective framing occurs when individual differences are overridden by terministic screens that apply on a broader basis.

Examples of effective framing are found in abundance in US politics. Parties deliberately frame issues in ways that direct the public's attention in specific ways. For example, people who come to the US without a valid visa are referred to as "illegal immigrants" in much political speech. Calling these people "illegal" frames the debate in terms of the legality, and pre-establishes that these people are criminals (Chase & Matheny, 2011). No matter what the issue at hand is, the persons in question are already framed as not belonging here and as not conforming to society. Immigrants' rights advocates, on the other hand, prefer to use the term "undocumented workers," shifting the public's focus to the economic motivation for people to come to this country to find work (Chase & Matheny, 2011).

Framing of career choices may not be as deliberate as political framing, but the effect on public perception is just as strong. Many frames impact undergraduate recruitment decisions, such as the social frames through which students decide what colleges they like, the economic frames through which they evaluate where to attend college, and the frames through which parents evaluate their child's decisions about college.

This thesis will focus on frames used to evaluate choices of major or career, specifically those surrounding engineering. The framing mechanism in decisions of what to study in college is one where students match themselves with a particular program. A student ideally settles on a particular program when her/his self-perception and her/his perception of the given program overlap, i.e. when the student can "see herself/himself" successfully pursuing that program. In turn, university recruiting is aimed at students directly: It might emphasize the benefits to the individual for joining a certain program, or it might emphasize a "something for everyone" approach, but either way it is targeted to appeal to the student on an individual basis.

In the following thesis, I will outline the construction of the status quo frame surrounding engineering career choices, as well as the disconnect between this frame and the terministic screens primarily used by young women to filter career choices. I will propose an alternative construction of terms surrounding engineering to deliberately realign the frame to attract more women to engineering and other related STEM fields.

2 Review of Current Literature

There is currently no shortage of literature and studies related to reducing the gender gap in STEM fields. Literature topics range from comprehensive studies and project reports describing the various factors that contribute to gender disparity as a whole to evaluations of specific programs for girls in STEM. Until recently, literature on women in STEM tended to explain the gender gap by the supposed innate mathematic superiority of men, or that women are inherently disinterested in STEM work or are unable to achieve work-life balance in STEM fields (AAUW, 2010). In the last few years, however, the most significant reports on women in STEM have instead asserted an equal capability of women given the same opportunities as men. The focus has also shifted toward a proactive approach to defeating stereotypes and better cultivating interest in STEM in girls and women.

The American Association of University Women (2010) compiled an extensive research report aimed at addressing the title question, "Why So Few? Women in Science, Technology, Engineering and Mathematics." The report focuses on biases and stereotypes about women in STEM fields and how these can affect women's interest in pursuing STEM careers (AAUW, 2010).

The National Academy of Engineers (2008) issued the report "Changing the Conversation: Messages for Improving Public Understanding of Engineering" as a follow-up to the 2002 report "Raising the Public Awareness of Engineering." The report is targeted at developing messages that can be used by the engineering community to improve the public's perception and understanding of engineering. The NAE hired a consulting firm to develop and market-test specific messages for different segments of the populations (NAE, 2008).

The Female Recruits Explore Engineering (FREE) Project (Eisenhart, Bystydzienski, & Bruning, 2010) was a project that followed high school girls in Iowa, Ohio and Colorado from grades 10-12 and in their freshman year in college. The project focused on exploration of engineering careers during the high school years, and on how that career exploration and other factors such as race, socioeconomics, and living in a rural/urban location affected the girls' decisions whether or not to major in engineering in college. FREE also followed the girls that chose engineering in their first year of college, tracking the influence of family/peers, the obstacles, and the supports for girls who chose to pursue engineering in college (Eisenhart, Bystydzienski, & Bruning, 2010).

The Extraordinary Women Engineers Project (2005) was a collaborative effort between the American Association of Engineering Societies (AAES), the American Society of Civil Engineers (ASCE) and the WGHB Educational Foundation. The project culminated in a report issued in 2005 aimed at addressing the question, "Why are academically prepared girls not considering or enrolling in engineering degree programs?" The report made the assumption that girls do not consider engineering programs because the girls and their career-choice mentors (parents, teachers, etc.) do not understand what engineering careers are, and do not consider them as options. The goals of the report were to assess high schools girls' career motivators, their current interest in and awareness of engineering, and to evaluate messages that might be effective in increasing interest in and awareness of engineering (Extraordinary Women Engineers Project [EWEP], 2005).

In addition to the multitude of professional engineering and engineering education societies that have recently dedicated themselves to addressing concerns of women in engineering, several organizations have developed solely to address these concerns. One of these is the Women in Engineering ProActive Network (WEPAN), established in 1990 by several university engineering programs to support female students in engineering programs. Today, WEPAN's members include all varieties of universities and community colleges, not-for-profit groups, large and small companies, and government agencies (Women in Engineering ProActive Network, 2010).

This thesis is focused on a synthesis of the current literature in the context of framing engineering as a field for high school girls. While there are innumerable factors that ultimately contribute to the gender gap – from cultural influences on young girls that devalue technical careers to the lack of female faculty in engineering programs – this thesis will limit its scope to high school engineering recruitment (i.e. outreach to high schools by ambassador programs, engineering pamphlets, campus tours, etc.).

3 Establishing the Frames

3.1 Dominant Themes for Women

An abundance of research has been conducted to characterize the different patterns of social behavior in men and women in society, and whether these patterns are caused by nature or by nurture. This thesis takes for granted that different social patterns exist between the sexes, no matter the cause for the difference. It should be noted that the divergent behavioral and communication styles explained in this section certainly do not apply to all men or all women, but rather explain the way men and women differ in our society in the most simplified sense. Most people fall somewhere on the continuum of behaviors, with most men and most women grouping at opposite ends of the spectrum for some specific tendencies.

As children, boys tend to play aggressive, physical games while girls tend to talk more in their play (Myers, 2008). When placed under stress, more men exhibit "flight or fight" responses, while more women "tend and befriend" (Myers, 2008). In leadership positions, men are more focused on directing tasks, while women focus more on team-building (Myers, 2008). These social differences extend to differing communication styles of men and women. Women are more skilled than men at expressing emotions non-verbally; the exception is anger, which men typically communicate more effectively (Myers, 2008). Men relate to others around them by emphasizing status and independence while women use a social currency of intimacy and connectedness (Tannen, 1990). When asked to describe themselves to others, women are more likely to use relational terms: "I am the mother/daughter/sister of…," "I am so-and-so's friend," etc (Myers, 2008). In resolving conflicts, women tend to compromise, evade issues, and appease others to maintain a happy relationship; men generally resolve conflicts through appeals to established rules and status, and physical violence (Tannen, 1990). Thus, it can be said that women generally respond better to language that emphasizes connectedness and appeals to social intimacy. The dominant communication surrounding engineering recruitment emphasizes status and independence – which are more appealing overall to men.

As engineering has long been a male-dominated field, simplification and generalization of a dominant female frame is useful to determine the ways engineering is not connecting with the majority of women. Specifically, this generalization tells us that a shift in the frame to a focus on relationships and connections within engineering will appeal to more women and girls. Emphasizing one end of the continuum, where historically the other end has been emphasized, is likely to result in an overall frame that is somewhere in the middle. This outcome will benefit not only women, but all persons who have historically been left out of the status quo engineering frame.

The factors that teen girls identify as important in a future career are strongly related to the working conditions; they want a career that is enjoyable and flexible, with good working conditions, and that pays well. Girls also associate **values** with their ideal careers. Research shows that the general values society places on different occupations directly impacts the gender distribution in that occupation (Zurn-Birkhimer & Holloway, 2008). Girls specifically seek careers that have a "direct benefit to society" (Zurn-Birkhimer & Holloway, 2008) and "make a difference" (EWEP, 2005). Girls also seek careers that are seen as acceptable for women by others (Eisenhart, Bystydzienski, & Bruning, 2010), as evidenced by the concern girls express that there are not very many women in engineering. Two-thirds of girls believe that interest in a career is extremely important, while less than 15% believe that prestige and recognition are extremely important in career choice (NAE, 2008). Of students already interested in engineering, interest in engineer careers was cited as the top reason for interest (Intel, 2011).

The financial and job security benefits of engineering careers have also been shown to be attractive to both high school girls and boys (Intel, 2011). In a study conducted by Intel (2011), messages about the financial benefits of engineering related to income and job-security had the biggest impacts on making students reconsider engineering as a career. Of the four "financial" messages tested, the three related to high salaries and low unemployment were ranked 1st, 2nd and 4th most effective (Intel, 2011).

3.2 The Status Quo Engineering Frame

The Extraordinary Women Engineers Project (2005) surveyed high school girls ages 14-17 from across the country involved in a variety of Advanced Placement courses. The girls were asked, in an open-ended question, to give the first two words that come to mind when they think of an "engineer." Their top twenty substantive responses represent the current, status quo frame through which most high school girls view engineering. This frame has five parts: the **people** engineers are, **qualities** engineers exhibit, **skills** engineers use, **jobs** engineers do, and the working **conditions** within engineering. The words that make up high school students' status quo frame are presented in Table 1 (EWEP, 2005).

Table 1: Words associated with "engineering" by teens (EWEP)

People	Qualities	Skills	Jobs		Conditions
Men	Smart	Math	Design	Trains	Hard
Boys	Really smart	Science	Build	Bridges	Complex
Dilbert	Nerdy	Problem-solving	Cars	Machines	Too difficult
			Engines		Boring

The NAE (2008) also asked teen girls which words they most often associated with "engineering" and the results for the most popular responses are consistent with the EWEP survey results. The NAE (2008) grouped like responses together and ranked them by most associated with engineering. For teen girls, the strongest responses are presented in Table 2.

Table 2: Words most associated with "engineering" by teen girls (NAE)

Rank	Words	Frequency
1	Math /numbers/physics/computers/science	23%
2	Builders/building/construction/bridges	15%
3	Mechanic/machines/industrial	14%
4	Cars/automotive/trains	10%

The EWEP (2005) and NAE (2008) surveys reveal that teen girls mainly view engineering through the frame outlined in Table 1. Teen girls' strongest associations with the status quo frame are in the areas of engineers' skills and jobs.

Missing from the status quo frame are positive **values** associated with engineering careers. Most teens have generally positive views of engineering and engineers (Intel, 2011), but that does not necessarily imply that they associate engineering with a particular set of values. The lack of specific value associations is more likely the result of teens not having exposure to or familiarity with engineering, rather than an ingrained bias that an engineering field does not support positive values.

One of the most damaging parts of the engineering status quo frame for women is that women must be exceptional to be successful in engineering fields. A common belief among the public is that engineers are people that are exceptionally good at and passionate about both math and science (Eisenhart, Bystydzienski, & Bruning, 2010). The majority of engineers in the workplace, in fact, were not exceptionally high achievers in math and science in high school (AAUW, 2010). Nevertheless, beliefs that one must be exceptional to be an engineer lead even high-achieving girls who are interested in engineering to question whether they would be able to be successful (Eisenhart, Bystydzienski, & Bruning, 2010). This element of the status quo frame is often reinforced by authority figures to teen girls. High school teachers and counselors typically report that they believe the students that would be most interested in engineering are those on the honors track (smart/really smart), those heavily involved in math and science, and boys (EWEP, 2005). As a result, students fitting the status quo frame are encouraged by their teachers to consider engineering, reinforcing the frame for **other students** who are not actively encouraged because they do not fit the frame.

High school instructors and counselors view engineering through very similar frames as the dominant frame used by teens. One educator expressed their opinion on the differing interests of teen boys and girls: “males are still math- and science- oriented and females are more people/helping-oriented” (EWEP, 2005). This comment demonstrates a false dichotomy that presents engineering (a math- and science-oriented field) and the ability to help society as mutually exclusive. This is a commonly held misconception in teen girls, as well.

The engineering community also reinforces the idea that math and science skills dominate the engineering field and that engineering is very difficult. In advice given to teen girls interested in learning more about engineering, professional engineers strongly reinforced the current frame (EWEP, 2005). Selected pieces of advice include:

- “Math and science! Work to excel in both disciplines!”
- “Engineering is difficult and stressful, but you will realize you’re gaining… much more knowledge and experience.”
- “Engineering is one of the toughest majors in college; you need to have confidence to get through it.” (EWEP, 2005)

The first statement reinforces the girls’ strong associations with math and science skills, and use of the word *both* reinforces the idea that engineers must be equally very good at and enjoy both subjects, rather than one or the other, or one more than the other. The statement places emphasis on these two skills to the exclusion of other, arguably equally important, skills. The use of the word *excel* reinforces the idea that you must be exceptionally capable in these areas, rather than competent. The word *work* implies that attainment of these skills may not be enjoyable – “boring” – or is difficult to do – “hard,” “too difficult,” etc.

The second piece of advice explicitly reinforces the perception of negative working conditions within engineering. The positive outcomes of an engineering career are presented as the abilities to overcome challenges and gain knowledge, which do not align well with the values teen girls seek out in potential careers like flexibility and overall enjoyment.

While the final statement may be true, nothing about this engineer's advice is oriented toward instilling confidence in young women that they can get through it. It also explicitly reinforces the idea that engineering is "hard" and "too difficult."

Another way that the frame is commonly reinforced is in how women engineers are presented to the public by recruiters and other groups seeking to attract females to engineering. In portrayals of the successful female engineers, exceptional women are often upheld as examples (Bilen-Green & Froelich, 2010). This reinforces the idea that women **must be exceptional** to be successful. While the average male may succeed as an engineer, females must be outstanding.

In addition to the problems associated with the status quo perception of engineering, most teens simply do not know what engineers do. According to a recent survey by Intel (2011), engineering ranks low among the professions with which teens are familiar. Girls are generally less familiar with engineering than boys, ranking it lowest in familiarity compared to the professional jobs of teacher, doctor, lawyer, architect and scientist (NAE, 2008). One third of teens cannot name any potential career opportunities for engineers, even the career paths such as building bridges or machines that are typically considered in the status quo frame (Intel, 2011). Another study indicated that as many as 70% of female high achieving math and science students know little to nothing about engineering (Eisenhart, Bystydzienski, & Bruning, 2010).

4 Improving the Engineering Frame

4.1 Frame Re-alignment

The lack of women interested in pursuing engineering careers is a strong indication that the status quo frame is not attractive to most women. Applying Burke's concept of terministic screens, new terms can be used in the language describing engineering to effectively shift screens through which engineering is interpreted. A major frame realignment will need to include terms from the dominant female frame. Shifting the frame with new terms will capture the attention and interest of more women, as well as more men who also do not fit within the status quo frame. The new engineering frame should provide a broader portrayal of the People, Qualities, Skills, and Jobs in engineering, and should redefine the working Conditions and Values associated with engineering. A few key strategies can be used to most effectively target elements of the new engineering frame toward women and girls in ways that are meaningful and beneficial.

4.2 Stereotype Threat

Experimental research has shown that stereotypes about women and girls in STEM fields negatively affect female interest and participation in STEM (AAUW, 2010). The status quo engineering frame contains within itself a stereotypical image of the engineer – "nerdy," narrowly-focused, and while highly intelligent, lacking in social skills. This stereotypical image, if portrayed in engineering recruitment materials, can result in a phenomenon dubbed "stereotype threat" (AAUW, 2010). Stereotype threat contributes to girls' career decisions as they are pressured not to express interest in STEM in order to avoid being associated with the stereotypical image (AAUW, 2010). Often, women steer away from STEM activities rather than having to repeatedly confront and defend themselves against stereotype threat (AAUW, 2010).

Stereotype threat affects the performance of women in STEM fields. Research has shown that girls do not do as well on math tests as boys when the stereotype threat that men are better at math is made explicit, while they perform similar to boys when the stereotype threat was not made explicit (AAUW, 2010). Stereotype threat has also been shown to impact girls in test taking situations when the stereotype is demonstrated implicitly, such as having more males than females in a testing room (AAUW, 2010).

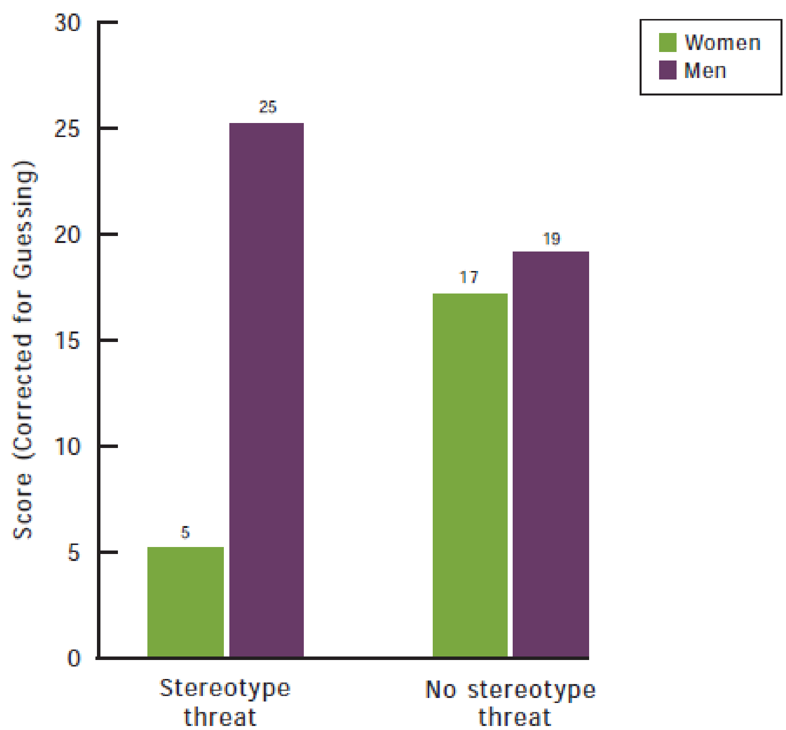

Figure 4: Performance on a challenging math test by gender

Stereotype threat not only affects actual performance on STEM tasks, it affects students' standards for their own performance. Girls believe they have to score higher in order to indicate that they have a high ability at the task when they are told men are generally better at task than when the stereotype threat is not made explicit (AAUW, 2010). In Figure 4, students were asked the question, "How high would you have to score to be convinced that you have a high ability at this task?" (AAUW, 2010). Girls' standards for their performance increase significantly when the stereotype is explicit. This result has important implications for recruiting in engineering programs, where the stereotype threat is present implicitly as part of the status quo frame. This may be one reason why adequately prepared high school girls are still concerned that studying engineering would be too much work or too difficult for them (Eisenhart, Bystydzienski, & Bruning, 2010).

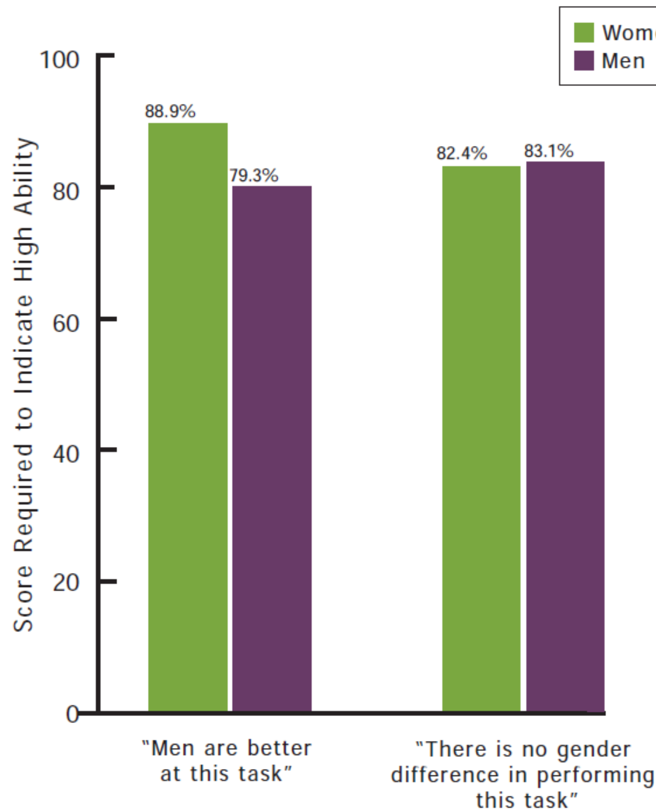

Figure 5: Standards for performance on math test by gender

One study followed the performance of all-female as well as mixed-gender teams of middle-school students participating in the KISS Institute for Practical Robotics Botball Program (Weinberg, Pettibone, Thomas, Stephen & Stein, 2007). The study found that belief in traditional gender roles negatively impacted the girls' self-concept of their abilities in math and science. The study also found that girls on the mixed-gender teams with strong team mentors experienced the greatest increase in confidence in their abilities related to STEM, over the girls on the all-female teams with strong mentors. Both the all-female and the mixed-gender teams were participating in the same project at the same time in the same place, so the difference in results between the two types of teams could be the result of stereotype threat. The girls on the all-female teams tended to downplay their abilities when interacting with boys from other teams, while girls on the mixed-gender teams did not, indicating that the stereotype threat may have been made more obvious to girls on the girl-only teams. While the effective mentors on both types of teams worked to counteract beliefs in traditional gender roles, the girls on the mixed-gender teams had the experience of defying the stereotypes about girls in STEM on two fronts. While girls on both teams broke away from gender role stereotypes by participating in STEM activities in the first place, participation in the mixed-gender team allowed girls to also test and defy the stereotype that girls are not as good at STEM as boys. Girls on the all-girl teams were not able to directly evaluate their abilities in STEM compared to boys, except in inter-team interactions when team mentors may not have been as effective at negating the stereotype threat as they could be in intra-team interactions (Weinberg, Pettibone, Thomas, Stephen & Stein, 2007).

In engineering recruitment, stereotype threat can be managed explicitly as well as implicitly. Engineering ambassadors or other representatives of the field should never use language that reinforces gender stereotypes in engineer. Additionally, the representatives themselves should attempt to defy the stereotypical images whenever possible, i.e. representatives, either in person or in recruiting media, should include women as well as men, and be of diverse backgrounds and interests. Portraying engineering as a field where both men and women thrive is an important part of diminishing the opportunity for stereotype threats to impact girls' career decisions.

4.3 Emphasizing New Skills and Qualities

Recent efforts to reframe the field of engineering have called into question the current emphasis placed on science and math skills. While these skills certainly are foundational to engineering, other skills such as communication, teamwork and creativity are likewise important and often overlooked. Some have expressed concern that de-emphasizing the role of math and science skills in engineering recruitment would lead to under-preparation in those areas in high school by students interested in engineering. The role of math and science skills is such a strong part of the status quo frame that there is very little likelihood that not emphasizing math and science skills would result in the public not knowing that these skills are foundational to engineering.

"Changing the Conversation" (2008) highlights the need to shift the focus away from math and science skills in order to better "market" the field of engineering to the public. The report recommends that the focus should be placed on how engineers make a difference in the world, rather than on specific personal attributes needed to be an engineer. The medical profession was cited as an example of this type of approach:

> The medical profession does not market itself to young people by pointing out that they will have to study organic chemistry or by emphasizing the long, hard road to becoming a physician. The image of a physician is of a person who cures disease and relieves human suffering. When promoting engineering, our appeal should tap into the hopes and dreams of prospective students and the public. This approach would also have the virtue of placing math and science, correctly, as just two of a number of skills… necessary to a successful engineer (NAE, 2008).

The UNESCO International Centre for Engineering Education sponsored a survey of industry, academics and students to evaluate what skills and attributes were considered the most important for the modern engineer to master (Nguyen, 1998). Different skills were emphasized by each sector (Nguyen, 1998), but the skills considered important by industry are emphasized here because most engineering students will make their careers in industry.

Technical knowledge and intellectual skills were two of the most important general skills for industry, but, perhaps surprisingly, the most important attribute of the modern engineer in industry was "attitude" (Nguyen, 1998). Technical knowledge and skills taught exclusively in engineering education, such as engineering fundamentals and engineering practice, were found to be more important to industry than other technical skills (Nguyen, 1998). Nearly 80% of industry representatives cited engineering fundamentals and applications as important, while less than 40% cited computer science and technology or probability and statistics as important (Nguyen, 1998). More engineering students than industry members reported science fundamentals and computer science as important to the modern engineer (Nguyen, 1998), perhaps reflecting closer associations with the status quo frame than industry members.

The most important intellectual skills cited by industry were problem-solving skills and communication skills, with over 80% citing each as important (Nguyen, 1998). Less than half the industry respondents cited design skills or logical thinking skills as important. While most teens recognize problem-solving skills, design skills, and logical thinking as an ingrained part of engineering, few recognize the role of communication, even though it is the skill most valued in industry (Nguyen, 1998).

While "attitudes" were designated the most important skill to the modern engineer, they can be hard to define and assess objectively. There seems to be the most variation in the specific skills listed under attitudes than under the other categories of technical and intellectual skills (Nguyen, 1998). The attitudes most often cited as important to industry were competence, integrity, and commitment (Nguyen, 1998). Integrity and commitment are defined through very relational terms, as "trust and loyalty to the organization and colleagues," and "dedication to the organization," respectively (Nguyen). These attributes fit very well within the dominant female frame that places importance on relationships and connectedness, as they demonstrate the importance of connections to others in engineering. Other attributes cited as important that are strongly present in the dominant female frame include flexibility, approachability, conscientiousness, and tolerance (Nguyen, 1998).

The results of the industry survey indicate that skills that allow one to build successful relationships are just as important as the technical skills typically associated with engineering. Emphasizing the attitude attributes and intellectual skills required for engineering provides a better fit with the frame most often used by women to evaluate careers. More women are likely to be interested in a career that emphasizes communication skills and personal integrity than one that deems mathematical and scientific proficiency as the key skills. Another point that could be emphasized is that engineering as a subject is not the same as mathematics or the sciences as subjects, although they are all related – just as reading comprehension and creative writing, while related, are not the same thing. The engineering frame could be dramatically improved by de-emphasizing the skills that are more likely to intimidate women, such as math and science, and instead emphasizing skills needed in engineering that come right out of the primary female frame.

4.4 Connectedness and Community

Emphasizing connectedness and community has been shown to be an effective way to increase interest in engineering activities. For example, girls were much more interested in activities when they explicitly described the connections between the engineering activity and the needs of society. In “Changing the Conversation” (2008), 45% of teen girls found the activity “Protecting rainforest by developing new ways to farm” to be “very appealing,” while only 17% were interested in activities related to “Turning deserts into farmland.” Teen boys were equally interested in both within the margin of error, 33-35%. Half of teen girls liked “Using DNA to solve crimes,” while 20% were interested in “DNA tests.” Again, boys found both activities to be of comparable appeal (NAE, 2008). This result is significant – roughly twice as many girls were interested in an activity when they could see how it was connected to society in general, i.e. when it was made plain that the activity would result in a positive impact on society. Also noticeable in this example is that both activities represent jobs done by engineers that are currently within the status quo frame – it is unlikely that girls would be just as interested in “building bridges to help people get to work,” which reinforces the status quo frame, as they would be interested in more novel engineering applications such as using DNA analysis to solve crimes.

Engineers’ connections to communities can be portrayed visually in print media and presentations. Engineers can be shown in their interactions with others or in hands-on activities to demonstrate connectedness. When possible, images that portray individuals of different status should be avoided, as hierarchy and status are typically frames that appeal more to men (Tannen, 1990). Ideally, engineers should be portrayed as interacting cooperatively from an equal level, as this frame best communicates positive relationships and connectedness to women (Tannen, 1990). For example, two engineering students working on a project together is a more favorable portrayal of an engineering activity than an engineering student and engineering instructor interacting.

4.5 Financial Security

A recent survey by Intel (2011) and the non-profit group Change the Equation found that emphasizing the employment opportunities and job security in engineering had a positive effect on the overall interest in engineering careers, increasing interest by over 60%. The most effective messages were those related to financial wellbeing and job security. The only message related to financial benefits of engineering that tested poorly was the claim that engineering is the most common college major among CEOs, which tested last among 24 tested messages (Intel, 2011). This message plays into status, prestige and power in addition to financial benefits. The most effective financial messages play into financial security by emphasizing high wages, job opportunities, and low unemployment in engineering.

The success of some financial wellbeing messages over others indicates that effective framing will emphasize security in engineering careers over the potential for status or power. Research also indicates that language relating to power and independence is typically used by men to describe their motivation for choosing a particular career – in one case as a university professor – while women in the same field emphasize their connections to the other faculty and to students as their primary motivation (Tannen, 1990).

The effectiveness of financial messages, and particularly financial security messages, may be the result of the economic recession and slow recovery. A poll by Junior Achievement in April 2012 found that only 56% of teens believe they will be able to make more money than their parents, a 37% drop from last year's value of 89%, which is closer to the historical norm (Bell & Donash, 2012). A poll by the Harvard University Institute for Politics (2012) found that a majority of young voters, age 18-29, were concerned about issues relating to the economy, such as unemployment and job creation (77%), affordable health care (60%), and the tax burden (60%). As more young people become concerned about the economy, messages relating to financial security are likely to resonate better. Survey results prior to or at the beginning the recession give more mixed reviews on the effectiveness of financial messages for generating interest in engineering (EWEP, 2005; NAE, 2008), further indicating that teens are sensitive to messages relating to the current state of the economy.

5 Recommendations for Framing Engineering

1. Avoid using examples from the status quo frame as much possible, even if they seem otherwise innocuous, as they may serve to reinforce other, more damaging elements of the frame.
2. Avoid portraying engineering as a field dominated by men, either implicitly or explicitly. Also avoid portraying engineering as a field which does not interest most women. This can be done verbally and visually.
3. De-emphasize the importance of math and science skills in engineering. Instead, emphasize the importance of communication skills, flexibility, and other relational skills in engineering.
4. Demonstrate engineering careers as flexible, rewarding, and leading to good quality of life.
5. Provide examples of how engineering benefits society. Use language that specifically connects each activity to society.
6. Show engineers engaging with others in images and presentations, ideally in social contexts where relationships are cooperative.
7. Emphasize the financial and job security benefits of pursuing engineering.

6 Suggestions for Improved Recruiting at Oregon State

6.1 The College of Engineering Ambassador Program

One key finding of the Extraordinary Women Engineers Project was that the career influencers for high school girls, including teachers, "are not familiar with how to guide students toward engineering. The positive stories about engineering are not being told to this audience" (EWEP, 2005). Oregon State University's College of Engineering Ambassador program addresses this need in Oregon. Ambassadors, who are current engineering students at Oregon State, are the public face of engineering at OSU at a variety of outreach and recruiting events both in Corvallis and around the state. One of the most important recruitment activities that Ambassadors participate in are visits to Oregon high schools each year, usually during the first week of winter break for OSU students, when high schools are still in session. The main portion of the high school presentation is a PowerPoint presentation, which is (ideally) delivered by a pair of Ambassadors working together. Women and minorities in engineering are typically overrepresented in the Ambassador program compared to the College of Engineering in general.

6.2 "So tell me, why do you want to be an engineer?"

The College of Engineering and several Ambassadors were involved in making YouTube videos about engineering during the last year. Ambassadors Justin Chi and Cassandra Loren made a short video which won the Bechtel Student Engineering Video

Contest for Engineers Week in 2011. "So tell me, why do you want to be an engineer?" is aimed at promoting engineering to the general public. In the video, Mr. Chi and Ms. Loren, along with six other Oregon State engineering students, provide personal answers to the title question. Responses include the following from female and male students, respectively:

- Female students:
  - To build sustainable infrastructure with no net impact on the environment
  - To develop more advanced nuclear space propulsion for a cleaner atmosphere
  - To engineer better prosthetics so more people can enjoy sports
  - To engineer geothermal piles to heat buildings
- Male students:
  - To engineer technology to harvest solar power more efficiently
  - To create manufacturing systems to ensure US economic competitiveness
  - To engineer more sustainable and efficient highway systems
  - To develop sustainable water resources for developing countries (Chi & Loren, 2011)

This video complies extremely well with recommendations 2, 5 and 6. Half of the engineers featured in the video are women and half are men. There are also several minority students featured. The men and women in the video all give examples that strongly connect the engineering activity they enjoy to a need in society, such as environmental health, sustainability, and human comfort. Because the men and women are portraying engineering in the same way, the video does not come across as pandering to or targeting women specifically. The images in the video show the engineers in non-stereotypical locations such the sunny atrium in Kelley Engineering center and the planted beds outside Kearney Hall. Students are also shown engaging in hands-on activities. The social contexts presented in the video show the engineers in cooperative relationships, such as interacting with other students (Chi & Loren, 2011).

Figure 6: Bechtel video contest entry by Justin Chi and Cassandra Loren (pictured)

The only substantive flaw in the video is in the initial introduction. The opening credits flash the text, "So tell me, why do you want to be an engineer?" The first spoken lines feature Cassandra Loren iterating that her favorite subjects in elementary school were math and science, unlike most kids who preferred recess. This strongly appeals to the status quo frame, reinforcing that those who study engineering prefer math and science over all other subjects. This statement is followed by an incredibly compelling narrative about how she decided to pursue bioengineering in order to "contribute to medical advancements, and… drastically improve the lives of those around me" (Chi & Loren, 2011). The video would be enhanced by eliminating the Ms. Loren's initial statement about math and science, and skipping to the example about how she found her passion for bioengineering. The rest of the video portrays very positive messages about engineering, but the initial statement about math and science could have the adverse effect of causing some young women to tune out before they get to the really strong parts of the video. The majority of this video uses terms that fit extremely well within the dominant female frame, and with some minor edits, it would make an incredibly strong recruitment tool for women in engineering.

6.3 "Top Five Reasons to Study Engineering at OSU"

The next video being reviewed was created specifically for recruitment at Oregon State by Women & Minorities in Engineering at OSU. Unlike Justin Chi and Cassandra Loren's video that had a general audience in mind, this video is specifically targeted at women and other underrepresented groups in engineering. The video features an all-female crew of engineers listing the benefits of studying engineering at Oregon State University, through counting down the "top five." Using a diverse, all-women cast of engineers fits recommendation 2, i.e. avoiding portraying engineering as a field dominated by men/that does not interest women. The reasons to join engineering at OSU include (in the order they were presented):

1. The Opportunity to Work with Great People
2. The Ability to be Creative
3. The Promise of a High Starting Salary

4. Traveling and Flexibility
5. You Can Change the World (Women and Minorities in Engineering [WME], 2011)

The first reason to study engineering at OSU, "the opportunity to work with great people," is a good message for framing engineering for women because it appeals to a value associated with engineering (recommendation 4). Working with great people is connected to the value women place on having good working conditions, and it also reinforces connectedness, relationships, and ties to the community. The second reason, "the ability to be creative," also ties into values in engineering careers, and implies flexibility of ideas. The fourth reason, "travel and flexibility," also ties well into recommendation 4.

The third reason to study engineering at OSU, "the promise of a high starting salary," appeals to financial security afforded by engineering (recommendation 7). The high salary is framed as "only one of the perks of engineering… not the only reason to choose engineering" (WME, 2011), which serves to downplay salary as a status symbol. This is good for fitting high salaries into the dominant female frame that emphasizes security over status, but the message could be made even stronger by going a step further to make clearer the job security and financial security aspects of engineering.

The final reason to study engineering at OSU is the ability to "change the world." This part of the video demonstrates the rewards associated with engineering (recommendation 4) and also portrays engineering as benefiting society (recommendation 5). The language used by the engineering students to describe how they can/will change the world with engineering specifically connects activities to benefits. The strongest moment in the video is when an engineering student in computer science says, “I’ve seen through my own experience... that we do design software that real people use, and it does improve their lives (WME).”

One fault of the video, however, is the appeal to math and science skills. One of the engineers says, “Engineering is math plus science, plus… creativity.” Math and science are tangible skills, while creativity is much more intangible, and the phrasing used here can give the impression that creativity derives only from the use of math and science, and not from the innate nature of engineering. This statement does not fit recommendations 1 and 3, and would be better left out. In another part of the video, another speaker explains that while people think engineering is all about math and science, it’s really about solving the world’s problems with creativity. This way of framing math, science, and other skills in engineering is a better fit with the dominant female frame. It could be made even stronger by further emphasizing other more tangible skills than creativity, such as communication skills.

6.4 Ambassadors’ High School Presentation 2012

The PowerPoint presentation included in Appendix B was delivered by Oregon State University College of Engineering Ambassadors to high schools in Oregon in late 2011 (Oregon State University College of Engineering Ambassadors, 2011). The following changes can be made to the presentation to align it with the improved engineering frame.

Slide 2, which reads, “Why do I have to learn math and science?” should be removed because it appeals to the status quo frame and to math and science skills. If it is really necessary to include a reference to these skills to conform to the wishes of the high school teachers, this slide should go at the end of the presentation, so as not to create an initial association with the status quo frame from the beginning that will detract interest from the rest of the presentation. Anecdotally, I put this slide at the end for my high school presentations in December 2011, and observed more interest and involvement in the presentation that I had seen in any previous presentations with this slide at the beginning.

Slide 3 asks, “What is engineering?” The answer given by Ambassadors has been, “Engineers use math, science and creativity to solve problems.” Instead of emphasizing that engineering is math and science with a little problem solving, a new definition could be developed that uses terms that are not associated with the status quo frame as much as possible. One improved definition could be the following: “Engineers use their imagination and analytical skills to invent, design, and build things that matter” (Engineer Your Life, n.d.). While this definition uses some of the terms in the status quo frame, those terms are frame engineering in new ways, such as using “build” to say “build things that matter.”

Slide 4 is used to present an overview of the different types of engineering through a life-cycle analysis of gummy bears. For example, chemical engineers would work on developing the flavors and dyes used in the gummy bears, and civil engineers would design the facilities they are manufactured in. This fits the recommendations for reframing engineering fairly well, because it represents activities not typically associated with the status quo frame, namely making and distributing gummy bears. One slight weakness in this example is the lack of connections to society; the benefits of gummy bears to society as an example of engineering are not as strong as an example from the medical field, for instance.

"Engineering = Math +Science + Creativity" on slide 7 should be removed. A substitution using the new definition should be added. For example, "Engineering = Creating things that matter." The example of the design process here emphasizes that engineering uses skills besides math and science. Engineering examples from the status quo frame such as cars, machines, and bridges should not be used for design process example.

The Robotics Club Mars Rover design example used in slides 8 and 9, while relevant to Oregon State University engineering activities, represents an engineering activity typically associated with the status quo: cars, engines, machines, etc. The word "design" is already part of the status quo frame, so using two additional examples from that frame reinforces it more strongly than using a design example not already in the frame. The Mars Rover example could be used in conjunction with another design example not featuring terms from the status quo frame, such as the portable kidney dialysis machine currently being studied in CBEE.

The image of the "gutter challenge" on slide 10 fits recommendation 6, i.e. engineers working in cooperative relationships. The images in slide 12 make use of activities in the status quo frame involving cars and machines, as well as engineers in hierarchical relationships (top left). This slide could be improved by exchanging one or both car images for other examples, and using more images that depict cooperative relationships. Also, most of the students portrayed in actual engineering activities are men, so more images portraying women should be used to demonstrate that engineering, in practice, appeals to women.

Slides 13 and 14 depict an example of a direct benefit to society: engineering better structures in tsunami zones. Because the desire to help people is so common among women, the presentation could be made stronger by expanding the examples in this section. In addition, examples of engineering activities in the rest of presentation should also be connected to the ways engineering helps society.

The examples showing that engineers are sustainable in slides 15-17 provide an opportunity to emphasize the connections between engineering and society. Slides 15-17 can fit recommendation 5 by using language that specifically connects sustainability and alternative energy to the needs of society.

Slides 18-19 depict values associated with the good working conditions in engineering, specifically the ability to travel as an engineer. The images depict engineers in hands-on activities, working with other engineers in cooperative relationships, and in ways that directly benefit others. These slides fit the dominant female frame very well. Emphasis could be placed here on the importance of engineering skills such as communication and flexibility.

Slides 20 and 21 emphasize financial and job-related benefits to choosing engineering, including high starting salaries. Statistics on the engineering unemployment rate could be added to further emphasize job security in engineering. This section could also include a direct reference to what a “good job” means to most young women: flexibility, making a difference, and a positive working environment. The examples that engineers work outdoors and in education, law and business imply flexibility, but explicit terms could be used to create stronger associations with the dominant female frame.

Slide 22 could be revised to include other classes of importance in engineering, such as writing classes and classes that emphasize critical thinking. Exactly what it means to take “as many math and science classes as possible” is likely to be interpreted differently by young men and young women. Young women have higher performance standards for themselves in math and science than young men (AAUW, 2010), so a young man is likely to feel that he needs less math and science to be prepared for engineering than a young woman would feel is needed. This slide could be revised to advocate taking four years of math and science or taking math through pre-calculus to be prepared for engineering. Ambassadors should communicate that taking math through pre-calculus is enough to begin an engineering career, and that engineers are not necessarily always people who are exceptional in math and science. Many engineers are motivated to do engineering because of other interests, and recognize that math and science skills are a few of the many skills used by engineers to create things that improve society.

One of the more consistent disconnects between the improved engineering frame and the language used by current students is the appeal to math and science skills. Most current engineering students chose engineering because some part of the status quo frame was attractive to them. For many, this was the prevalence of math and science in engineering. Research has shown, however, that recruiting more women depends upon an evolution of a frame that deemphasizes math and science, which can be difficult for Ambassadors who were specifically attracted to engineering because of that emphasis.

Anecdotally, this is the part of my thesis that has received the most resistance from fellow engineering students. College of Engineering Ambassadors should be trained to understand that while math and science are foundation skills to doing engineering work, they should not be the foundational skills emphasized in engineering recruitment if the goal is to attract new types of students to engineering. This approach has the benefit of attracting more diverse types of people overall, in addition to framing engineering more attractively for women.

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Appendix A: Engineering Major and Department Codes

GenE – General Engineering (pre-engineering students who are undecided as to a specific major)

Engineering departments:

EECS – School of Electrical Engineering and Computer Science

MIME – School of Mechanical, Industrial, and Manufacturing Engineering

CCE – School of Civil and Construction Engineering

NE/RHP – School of Nuclear Engineering and Radiation Health Physics

CBEE – School of Chemical, Biological and Environmental Engineering

BEE – Biological and Ecological Engineering

Engineering majors:

EE – Electrical Engineering

CS – Computer Science

ME – Mechanical Engineering

IE – Industrial Engineering

MfgE – Manufacturing Engineering

EEM – Energy Engineering Management (in MIME)

CE - Civil Engineering

CEM – Construction Engineering Managemetn

NE – Nuclear Engineering

RHP – Radiation Health Physics

ChE – Chemical Engineering

BioE – Bioengineering (in CBEE)

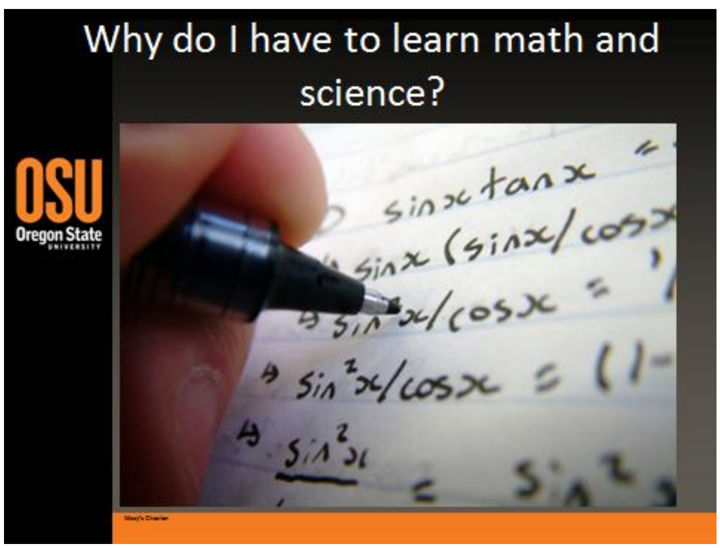
EnvE – Environmental Engineering

EcoE – Ecological Engineering

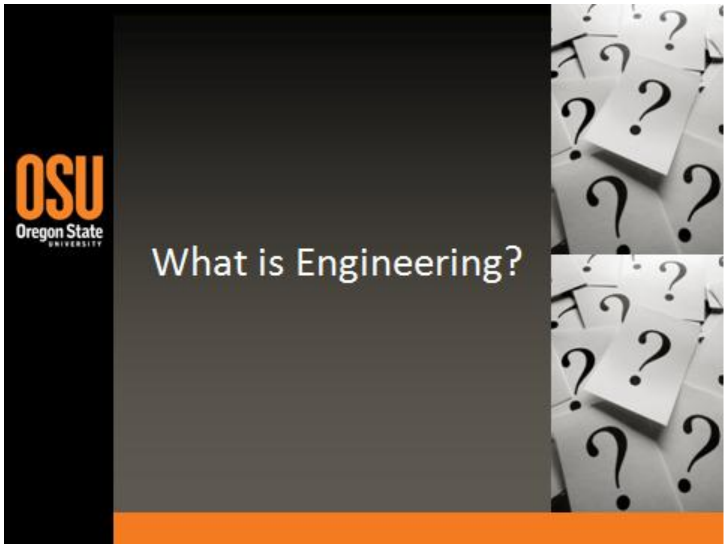
Appendix B: 2011 High School Visit Presentation by Oregon State University College of Engineering Ambassadors

Slide 1

Slide 2

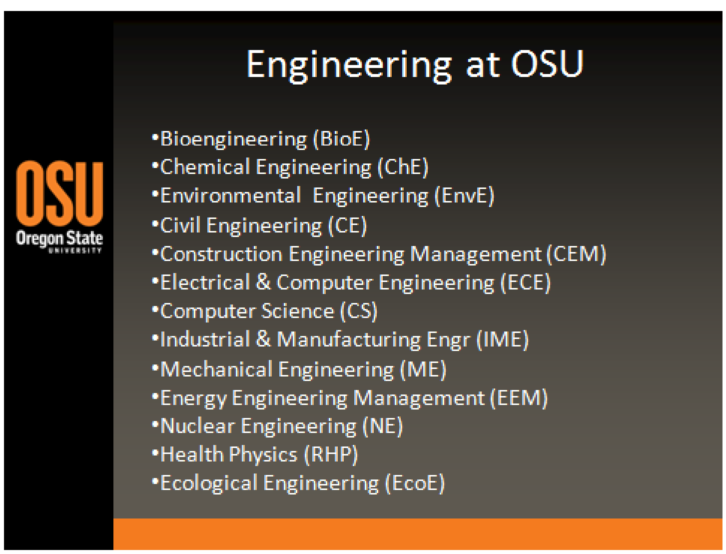


Slide 3

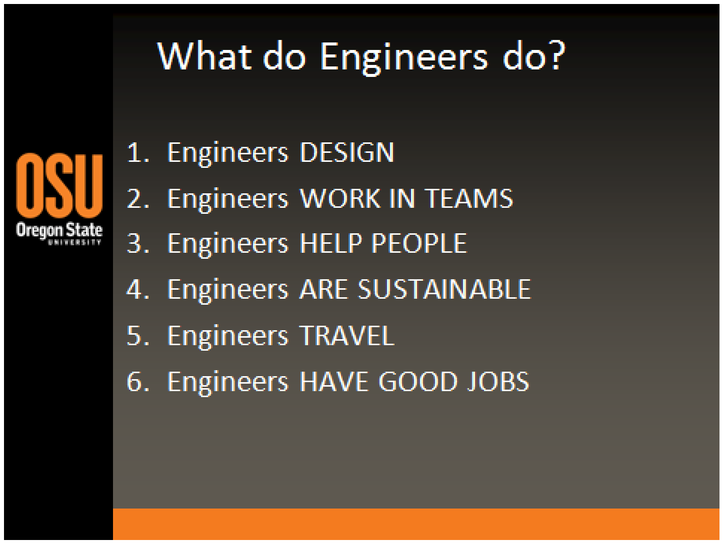


Slide 4

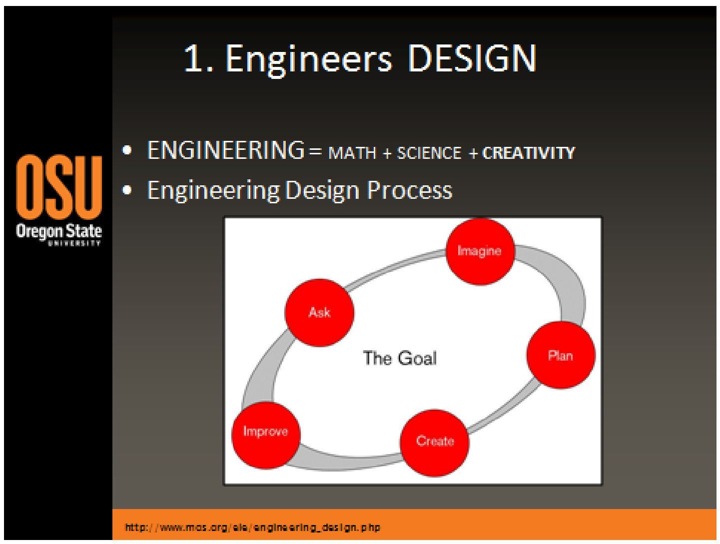
Slide 5



Slide 6

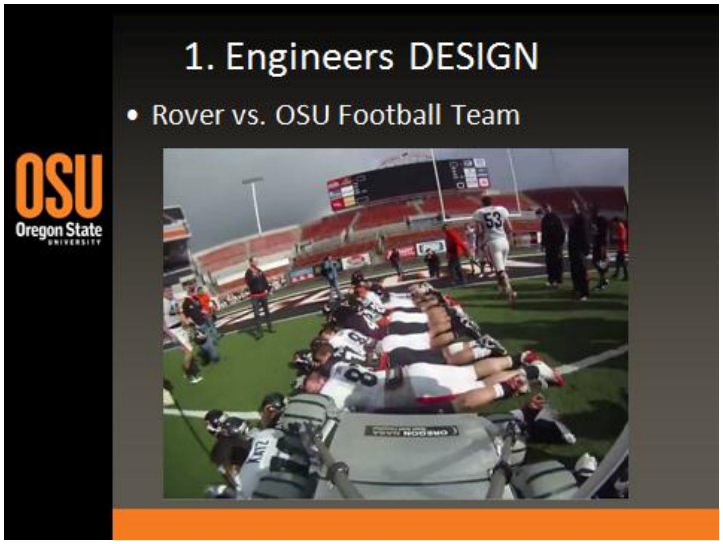


Slide 7



Slide 8

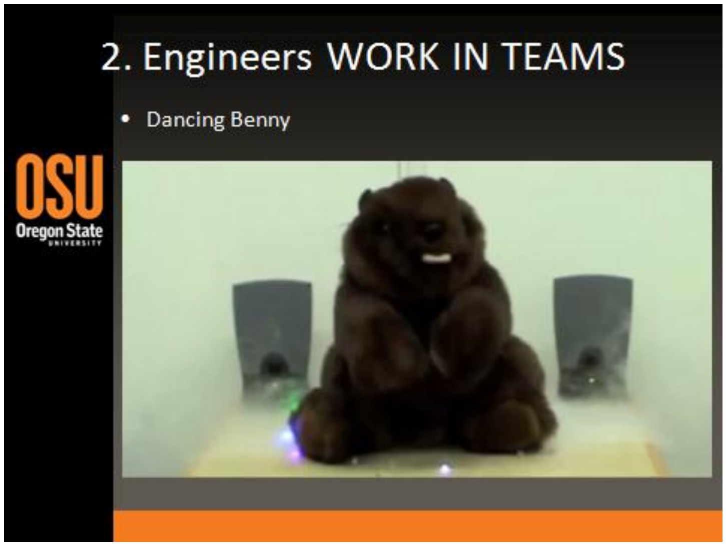
Slide 9



Slide 10

Slide 11

Slide 12



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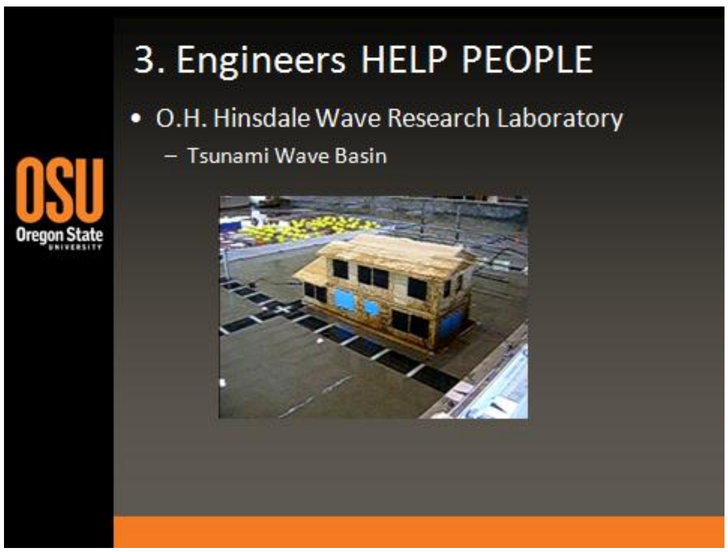

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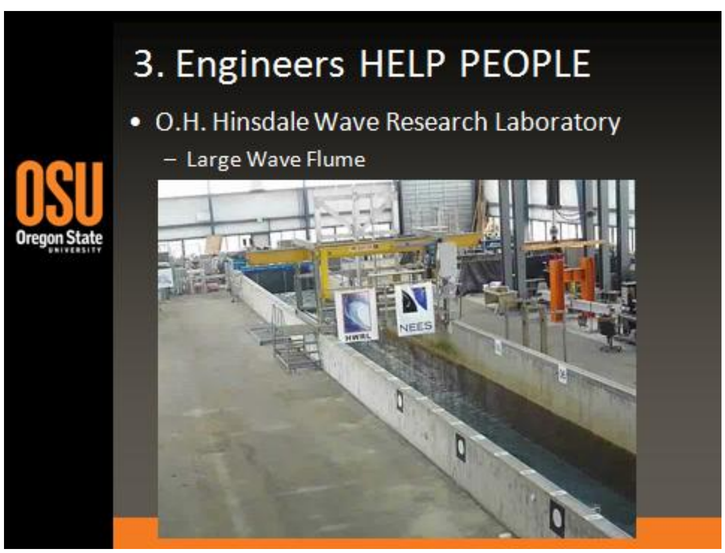

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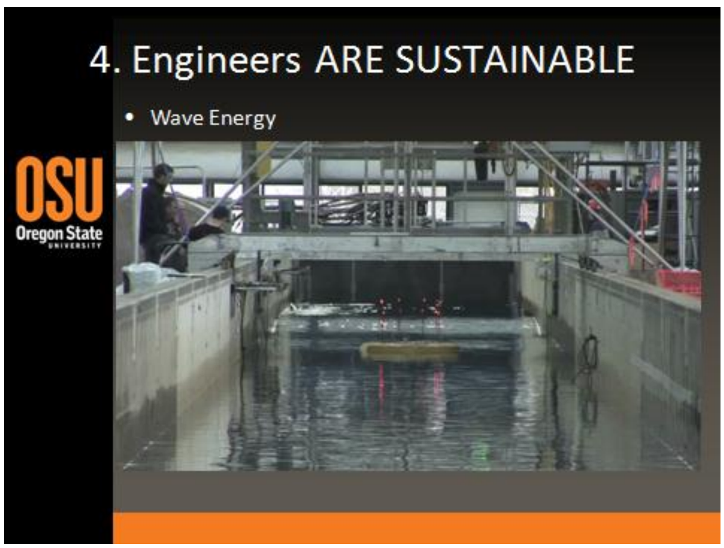

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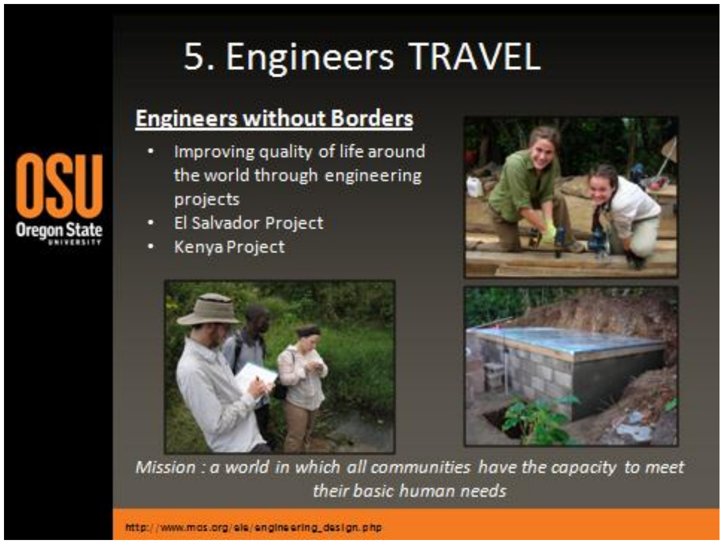

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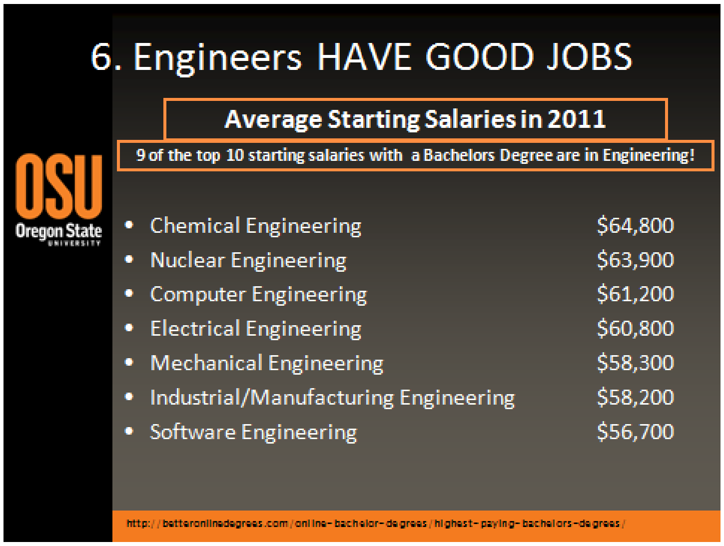

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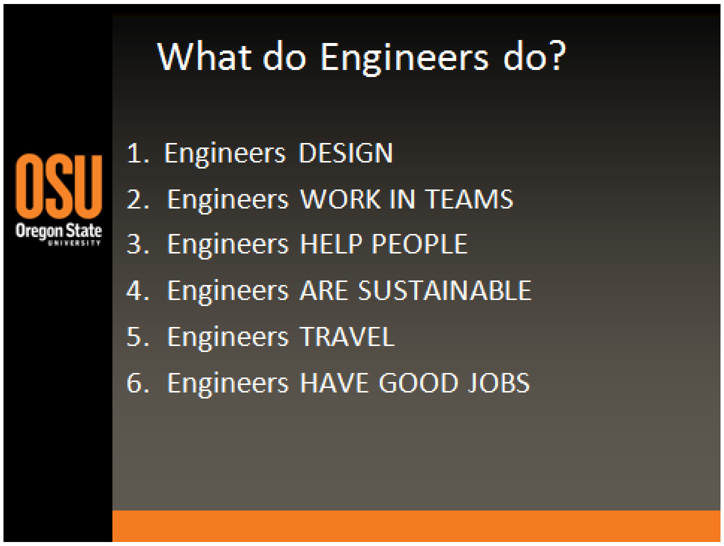

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