Who Should Be an Engineer?
Messaging as a Tool for Student Recruitment and Retention

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Choose a job you love, and you will never have to work a day in your life.
—Confucius

Being an engineer takes creativity, hard work, and perseverance. As Marie points out in the excerpt below, excelling in engineering, as in other professions for which excellence is the goal, also takes desire.

“Why do you want to be an engineer? It is sooo hard!” Marie, a current Ph.D. engineering student at the University of Colorado Boulder, was asked this question by a young woman she was mentoring through a local community education program. “Anyone can be an engineer,” Marie answered. “You can do it also. You just have to want to do it.”

According to educational researchers, compared to people in other professions, K–12 students and teachers have a poor idea of what engineers do (NAE, 2008). And no wonder! Take a look at the TV lineup of sitcoms, most of which are based on the lives of physicians, lawyers, investigators, and police officers. Few media outlets provide opportunities for people to be entertained or informed about the lives of engineers.

Consider some real-world examples we’ve encountered when implementing our NSF-funded GK-12 TEAMS (Tomorrow’s Engineers... creAte.

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iMagine. Succeed.) Program at the University of Colorado Boulder:

A 4th grade girl, learning for the first time about engineering, asks her University of Colorado engineering fellow, “Miss Jodi, can engineers wear make-up?” Jodi, a master’s student in chemical engineering, replies, “You bet they can.”

An enthusiastic 6th grade Latino boy shyly approaches his engineering fellow and asks, “Miss Abby, can engineers have Mohawks?” Abby, a Ph.D. student in civil engineering, replies, “Yes, Humberto, they sure can! Engineers can wear their hair any way they want!”

Humberto and many other Latino boys in his middle school are bringing back the Mohawk hair style with passion and creativity—honoring their skills by practicing and sharing ideas among friends (Figure 1). Passion. Creativity. Practice. Sharing ideas. If we stretch our thinking, the creation of a 6th grader’s Mohawk has characteristics in common with the innovation process that underlies engineering.

The steps in the creation of Humberto’s Mohawk are loosely analogous to the steps in the engineering design cycle: identify the problem (need a bold hairstyle), brainstorm design solutions (lots of popular hair styles out there), select a design to prototype (Mohawk style, short length), create/build, analyze, test, and iterate (do it again and again until you meet your requirements and you look cool). From this perspective, Humberto might be an engineer in the making. He is already applying creative processes that could be used in engineering design.

Humberto’s original question, “Can engineers have Mohawks?” is loaded with possibilities, as he explores his own identity as a future engineer. In a way, he is already asking “Can I be an engineer?” Yes, indeed . . . who really belongs in engineering?

The Problem—or Challenge

The United States has to do a better job of identifying and nurturing mathematically talented young people, regardless of their gender, race, or national origin (Hyde and Mertz, 2009). As stewards of K–12 engineering education, counselors and teachers often raise concerns about the type of student who might become an engineer. If we received a dollar for every time we have been asked by a student, teacher, or parent, “Can my child be an engineer?” or “What type of student can endure the rigorous study it takes to be an engineer?”, we could reduce our fundraising to a minimum.

Unfortunately, we disadvantage our nation’s young people during their identity-forming years by referring to engineering as a “rigorous,” math-dominant, “unattainable” career. Rarely, if ever, do we hear the medical profession marketed by emphasizing that becoming a doctor takes “years of rigorous study.” In addition, people believe that by becoming doctors they will be helping others. But engineers, whose efforts also contribute to the health, happiness, and well-being of society, are not widely known as people who help others. At best, we market engineering as “problem solving”—which pales in comparison to helping people in the minds of young people . . . and adults.

Based on a perception of the gender-appropriateness of certain occupations, children may start to think about “jobs” and form their career identities as early as 3rd grade (Turner and Lapan, 2005). They wonder if they will grow up to be policewomen, teachers, ballerinas, dentists, basketball players, or, especially, doctors. They seldom imagine that they will become engineers. Their early perceptions of engineering—if they are even aware of the field—are of a not-so-fun job that can only be done successfully by people who love both math and science.

On average, girls and women tend to prefer working with people, whereas boys and men tend to work with things (Lubinski and Benbow, 2006). Research for the 2008 NAE Changing the Conversation study revealed that young girls preferentially select images of women

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2 Not the student’s real name.
doing engineering, whereas boys select images of things that represent engineering.

If these tendencies are representative, then engineering should be appealing to both boys and girls, because engineers work with both things and people. But this obviously isn’t so. Women do not flock to engineering colleges clamoring to get in, but men do.

Therein lies the challenge—correcting a misunderstanding about what engineers do that results in an inability to attract representative numbers of individuals from all sectors of our population. Even though engineering is in dire need of diversifying to reflect the richness of our rapidly-changing demographics, and even though we are a nation in which women preferentially attend college and students of color are the large majority in many K–12 schools, we fail to attract either to attend engineering schools in quantity.

To meet the need for an adequate, diversified, educated engineering workforce by 2020, engineering colleges and the engineering profession must adapt now to ensure that engineering is appealing to people from all walks of life—young people, to be sure, but also the people who influence their early academic choices. Teachers, counselors, parents, and society at large must embrace the idea that engineering is a helping profession and that, to a large extent, it shapes the health and welfare of people everywhere, as well as the health and welfare of our planet.

The Myth

Over the past decade, the TEAMS Program at the University of Colorado (CU) Boulder has engaged thousands of girls and boys in grades 3–12 in weekly hands-on, standards-based engineering lessons and activities that inspire discovery and innovation. As custodians of engineering education in this early stage of the value chain, the same questions emerge year after year among K–12 students: Must engineers love math? Can I be an engineer (sometimes embedded in questions such as “can engineers have Mohawks”)?

The answer to the math question is no, engineers do not have to love math. They do, however, have to develop competent math skills and know how to use math concepts. Consider how different a child’s early perception of engineering would be upon hearing that she does not have to love math to imagine her future as an engineer. Perhaps she is a capable math student but does not particularly love it—any more than a budding physician might imagine loving organic chemistry. Sadly, a parent or educator may perpetuate the myth that she must love math to pursue engineering and dissuade her from preparing for an engineering future for fear that she will fail because she does not love the rigor of math.

In reality, not only can she become an engineer, but even if she at most likes math, she is likely to outperform her male counterparts in college and graduate school and earn a grade point average at or above the mean for her school (Lord et al., 2009). Love of math pales in comparison to her competent doing of math. And yet, that lack of love for math may be a show stopper for many, many girls. And boys. That’s one misunderstanding we can all help fix.

Although young women dominate the top deciles of U.S. high school graduates, they have a minimal presence among high school students who imagine pursuing careers in engineering (Sullivan, 2006). The persistent absence of a substantial female—and minority—presence in our male-dominated field, a long-recognized issue in higher education, has fueled the debate about gender equity, social justice, and professional diversification (Lord et al., 2009; Watson and Froyd, 2007). To increase the presence of women and underrepresented minorities in the engineering landscape (output), engineering programs must attract them in droves (input). And while we are at it, we should also focus more on first-generation college-bound students.

Among many environmental and cultural influences, poor self-efficacy (i.e., and nagging suspicion, common in females, of being unable to perform) low academic self-esteem, and early misperceptions of engineering influence a female student’s educational attainment and choice of career (Buchmann et al., 2008; NAE, 2008). The same is true for Latino, American Indian, and African American students, all of whom are also underrepresented in the engineering profession (Lord et al., 2009). These students don’t need “fixing” to find a home in engineering. But our system needs fixing, if we
expect to tap into the rich diversity of experience and perspective that today’s 3rd graders (the fall 2020 entering engineering class) could bring to our profession.

**Engineering and the Future**

Engineers want to be perceived by the public as members of an important, challenging, helping profession that contributes to society. However, many people have difficulty separating “engineering” from “science” and “technology” (NAE, 2011). An early lesson in the University of Colorado Boulder TEAMS Program, which reaches thousands of youngsters annually, is the importance of distinguishing between science and engineering, which we often characterize as follows: scientists explore the universe and investigate that which already is, and engineers create that which has never existed before. In essence, engineers create “stuff”—new knowledge, new things, new processes—that address the wants and needs of people and our planet. Young people are fully capable of understanding the difference.

According to the U.S. Census Bureau, by 2050, about half of the U.S. population will be nonwhite. This will mean that engineering solutions must meet the needs and desires of more diverse consumers (Sullivan, 2007). This will also mean that to maintain U.S. technological capability and capacity, the engineering profession will have to draw more heavily on individuals from underrepresented groups (NAE, 2011).

As we have seen, both adults and teens strongly associate engineering with mathematics and science skills much more than with problem solving, creativity, or having a positive impact on the world (NAE, 2011). Even though engineering is about doing things for the benefit of society, teens—and adults—rarely make that connection.

It is frustrating to have to remind the public that virtually every technology engineers design/create is intended to meet a societal need or desire and that most safety-related technologies—from airbags and the air traffic management system to food handling equipment and smoke detectors—were designed by engineers (NAE, 2011). The availability of clean drinking water is taken for granted, and the capability of loading more than 10,000 songs onto an iPod® is an expectation.

To offset the embedded (mis)perceptions about engineering and the engineering profession, something must change—and that change must be systemic and pervasive in our schools, homes, and culture. The question facing us now is how we can undo centuries of unintended ignorance about engineering and initiate systemic change.

Technology is pervasive in the lives of teenagers: 62 percent of 12 to 17 year olds use the Internet to read about current events or politics; 48 percent shop online; and 75 percent have cell phones (Lenhart et al., 2010). The disconnect between our nation’s young people, who are using technology at an increasing rate and those who are looking for opportunities to be agents of change at the forefront of creating technologies is astonishing. As long as young people do not know much about engineering or have a skewed view of what it means to be an engineer—or even who belongs in the profession—we cannot expect them to seriously consider careers in engineering (NAE, 2011).

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However, our goal of drawing on a diverse citizenry will not be realized as long as minority women and men—and women of all ethnicities—continue to reject engineering futures. So how can we prepare and recruit a talented population representative of our nation’s rich demographic makeup into the engineering fabric? For starters, we must change the messages that pervade our society about engineering, who engineers are, and who they should be.

**Changing the Conversation**

*Raising Public Awareness of Engineering* (NAE, 2002) and *Changing the Conversation* (CTC) (NAE, 2008) have provided a pathway toward enlightening students, parents, and teachers about the creativity and inspiring nature of engineering. They also address the importance of informing the public about opportunities afforded by engineering and encouraging K–12 students to pursue futures in engineering.

Even though the number of women in higher education is skyrocketing, a shocking 1.6 percent of them complete undergraduate degrees in engineering (NSB,
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2010; Snyder et al., 2009). This statistic reflects a broken K–16 educational system that is not poised to serve our nation’s—or our planet’s—future.

If we can take the information learned through the CTC study and implement strategies throughout our industry and educational system to inform and increase awareness of a positive image of engineering, we might, slowly, but eventually, realize a shift in students’ thinking about engineering futures. Only then can we expect an appreciable change in who and how many choose to pursue engineering futures.

**Implementing an Engineering Messaging Campaign at the University of Colorado Boulder**

Beginning in 2008, the CU College of Engineering and Applied Science overhauled its recruiting and marketing materials to capitalize on the CTC messages and preliminary taglines and married them with the whimsical, stylistic graphics created by the WGBH Engineer Your Life (EYL) (http://www.engineeryourlife.org) campaign to create postcards, flyers, and web-based tools that resonate well with younger audiences and adults. The communications materials make use of fun, funky fonts; bold, vibrant colors; and gender-friendly colors (even some flowers); and images of people interacting with technologies to highlight the relevance of engineering for young people.

These strategic, contemporary designs, coupled with well-messaged words on flyers about engineering events have stimulated interest among female and minority students to take a look at—and ultimately attend—our engineering college, thus substantially expanding participation. Attendance at both Diversity Sampler, a minority student-focused recruiting event (Figure 2), and Women Explore Engineering day, a one-day program for high school girls, quadrupled this year alone.

Concurrently, in late 2008, we combined EYL designs with images of our diverse engineering students in their lives beyond academics and CTC messages to create “messaged” recruiting postcards (Figure 3).

Although it is impossible to determine the exact impact of changing our messaging to be more engaging and relevant, our enrollment of women engineering students in fall 2009 and 2010 increased sharply—from our five-year average of 19 percent to more than 24 percent. At the same time, enrollment of minority students was up 67 percent in 2010 over our prior five-year average and is on target to be even higher for 2011. Anecdotal evidence also suggests that the recruiting pieces and consistent theme of “Be an Engineer” catch the eye of college-bound teenagers and positively impact recruiting outcomes.

Feedback suggests that the CTC messages and taglines effectively inform audiences that engineering is a fun, rewarding career about helping others and shaping our planet.

**FIGURE 2 “Messaged” flyer for the CU Boulder Diversity Sampler activity.**

**FIGURE 3 “Messaged” recruiting postcard that combines EYL designs and images of engineering students outside the classroom.**
and that it deserves further consideration as a personal pursuit. Teachers and parents frequently tell us that they wish they'd known engineering was that interesting and could go back themselves and become engineers.

Messaging materials continue to be refined at CU Boulder, and the CTC messages continue to drive all aspects of our recruiting—every letter, every presentation, every poster, every program flyer. Our initiative has been greatly improved by the addition to our team of a graphic designer who has given the messages a youthful, society-focused look.

The CTC messages encapsulate who we are as engineers and how we view the role of engineering in the world. CTC has not only changed our conversation but has literally changed us. Every bit of recruiting material from our college—including presentations by deans—is augmented with the CTC messages and/or taglines and is designed to “hook” young people on the giving back aspect of an engineering future. And, in so doing, we as deans are also energized by the messages we deliver.

The four messages that tested best in the Changing the Conversation (NAE, 2008) study are:

- Engineers are creative problem solvers.
- Engineers make a world of difference.
- Engineering is essential to our health, happiness, and safety.
- Engineers help shape the future.

The seven preliminary taglines are:

- Turning ideas into reality
- Because dreams need doing [which tested best across genders]
- Designed to work wonders
- Life takes engineering
- The power to do
- Bolder by design
- Behind the next big thing

Internal communications at CU Boulder have also changed significantly. For example, attendance at our undergraduate Women’s Manufacturing Workshops
tripled this year after we implemented a new recruiting flyer that combined the EYL template, CTC findings, and (shamelessly) flowers (Figure 4). We like that outcome!

Fun, well-messaged flyers inviting current engineering students have helped to increase attendance at myriad community events. But our goal isn’t just fun. Our hope is that these efforts to build community will ultimately improve retention of our engineering students.

Conclusion

The engineering community can, and must, figure out how to market our profession to attract talented, well prepared women and underrepresented minorities. Ultimately, this will change the engineering landscape and help sustain U.S. capacity for technological innovation, interest young people in engineering careers, and improve technological literacy (NAE, 2008). The CTC report and the engineering profession have issued a call to action to help change perceptions of engineers. However, it will take all of us—educators, professional engineers, industry, government, and researchers—working together to make that change a reality—and we need results now.

It’s time for years of public misperceptions about engineering to be unraveled and to put in place strategic, consistent practices to change the future of engineering in our nation. We can start by asking ourselves if it is time to change the conversation in our own organizations.

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