Best Practices for Attracting Girls to Science and Engineering Careers

by Cindy P. Veenstra, Ph.D.

When I pursued my undergraduate studies, there were few women in my math degree program at Ohio State University. When I recently returned to pursue and complete my doctorate degree in industrial engineering at the University of Michigan, I thought the female-to-male ratios would be much different—that half the class would be women. Unfortunately, I had a misunderstanding of the reality of engineering education with respect to women participating in it. Considering my success in an engineering career in technology-based industries, I found this very surprising.

This article discusses the current participation of women in engineering degrees and recommends best practices for attracting more young women to science and engineering careers.

Just the facts

In the ASQ Education Division's just-published book, *Advancing the STEM Agenda: Quality Improvement Supports STEM*, I listed the statistics related to the percentage of women graduating with an associate or bachelor's degree at a U.S. college or university.[1, 2]

- Women earn 59% of all associate and bachelor's degrees.
- Women earn 44% of all associate and bachelor's degrees in science, technology, engineering and mathematics (STEM).
- Women earn 43% of all associate and bachelor's degrees in the natural sciences.
- Women earn only 18% of all bachelor's degrees in engineering.
- Women earn only 14% of all associate's degrees in engineering technology.

We do not have a uniform problem with women earning degrees in STEM. It is only in engineering and engineering technology that there is a major disconnect with U.S. women pursuing degrees (and therefore careers) in engineering.

Women choose the degrees they are interested in. For example, some are interested in pursuing careers as doctors or as biological researchers, so they earn a degree in biology (58% of all bachelor's degrees in biology).[3] In engineering, women earn 37% percent of all bachelor's degrees in biomedical engineering and 43% of all environmental engineering degrees. However, they earn only 12% of the bachelor's degrees in mechanical.[4]

Besides personal interest by students, some of these engineering programs are considered more "friendly" toward women students, especially when they have a high percentage of women faculty members and a student-focused culture.

We need more women in engineering to ensure innovation. It is widely recognized that economic growth is driven by innovation and engineering know-how. We also need the diversity of engineering problem solving that women bring to engineering.

Research has shown that less than 10% of all engineering graduates transfer into engineering. They matriculate into engineering as freshmen. Several studies have also shown that women persist and graduate in engineering at the same rate as men.[5, 6] These facts lead to the conclusion that we must interest more girls in engineering majors in their middle school and high school years.

Some best practices

The research has been substantial and some of the best practices that have come out of this research are summarized below.

1. Start early in inspiring all children to consider careers in STEM. K-12 outreach summer programs for girls play an important role in inspiring them to pursue science and pre-engineering in middle school and high school and to consider STEM careers. For more information on this, see my list of favorite K-12 outreach programs at http://www.veenstraconsulting.com/links.

2. K-12 teachers often have no training to discuss engineering and engineering careers. Prepare teachers to teach engineering in middle school and high school. Ohio Northern

University's innovative bachelor's program addresses this issue.[7] Provide professional development programs that help science teachers to be more effective in teaching science and pre-engineering. An example of this is the Western Wisconsin STEM Consortia.[8]

3) The groundbreaking research of the National Academy of Engineering's "Changing the Conversation" project has led to new best practices.[9] This research showed high school students related more to messages of vision, such as "engineers are creative problem solvers." High school girls related best to the messages, "Engineers make a world of a difference," and "Engineering is essential to our health, happiness and safety."[10]

This is much more visionary than the usual message that high school students receive from counselors and engineers that they will be good engineers since they are good in math and science. For girls, in particular, this last message is a turn-off, because it does not address improving society, a core value espoused by girls that figures prominently in their decision to elect for a career in engineering.

Engineering programs, such as the one at the University of Colorado, have incorporated this new messaging into recruitment efforts and have increased the "engineering college's ability to attract more diverse students, particularly women and minorities."[11] See the innovative website, "Engineers: How Are You Changing the Conversation?" at http://www.engineeringmessages.org for more information.

4) Once students are attending engineering college, provide mentoring such as the "Women in Science and Engineering" programs and residential colleges focused on STEM.

5) For all students, provide strong advising that supports each student. Once a college admits a student, it has the social responsibility to support that student so she is successful in her STEM major.[12] Too often, students are not given the support they need and the student changes her major or drops out of college. Better process improvement of student support activities leads to an improved quality in STEM education and improved student retention.

2012 ASQ Advancing the STEM Agenda Conference Provides Presentations on Attracting Girls to STEM and Providing Support for Improved Persistence in STEM

The *2012 ASQ Advancing the STEM Agenda in Education, the Workplace and Society Conference*, co-sponsored by the ASQ Education Division and the University of Wisconsin-Stout, will continue last year's focus on presenting peer-reviewed conference papers that showcase research and best practices on inspiring girls and women to pursue STEM careers on July 16-17.These papers include the following:

- ***The STEPS Difference: 16 Years of Attracting Girls to Careers in Science, Technology, Engineering and Mathematics*** by Brenda S. Puck and Wendy R. Stary, UW-Stout. (Our congratulations to UW-Stout on its 16th anniversary of the STEPS program!)
- ***Identification of Strategies that Overcome Barriers to Women and Minorities in STEM*** by A.A. Ilumoka, Ph.D., University of Hartford.
- ***Inspiring and Engaging the Next Generation in STEM through PLTW and REAL*** by Cordelia Ontiveros, Ph.D. and Elena Alvarez, California State Polytechnic University, Pomona-College of Engineering.
- ***Dual Enrollment: A STEM/Engineering Initiative*** by Tecca Larrick, Kent State University-Tuscarawas.
- ***Creating a Pipeline: An Analysis of Pre-College Factors of Students in STEM*** by Erica Harwell and Derek A. Houston, University of Illinois at Urbana-Champaign.

Note that our presenters will come from universities all over the United States. Visit our conference website to view our national keynote speakers, workshops and other presentations that focus on improving STEM Education and partnerships between industry and universities.

References

1. National Science Foundation, "Women, Minorities and Persons with Disabilities in Science and Engineering," National Science Foundation, 2012, http://www.nsf.gov/statistics/wmpd/tables.cfm.

2. Cindy P. Veenstra, “Introduction,” in Cindy P. Veenstra, Fernando F. Padró and Julie A. Furst-Bowe (eds), *Advancing the STEM Agenda: Quality Improvement Supports STEM,* ASQ Quality Press, 2012.

3. National Science Board, “Science and Engineering Indicators 2012 (Appendix Table 2-18),” National Science Foundation (NSB 12-01), 2012. http://www.nsf.gov/statistics/seind12/.

4. Michael T. Gibbons (2011). “Engineering by the Numbers.” *Profiles of Engineering and Engineering Technology Colleges*, 2011, http://www.asee.org/papers-and-publications/publications/college-profiles/2010-profile-engineering-statistics.pdf

5. Matthew W. Ohland, Sheri D. Sheppard, Gray Licktenstein, Ozgur Eris, Debbie Chachra, Richard A. Layton, Persistence, “Engagement and Migration in Engineering Programs,” *Journal of Engineering Education*, 2008, Vol. 97, No. 3, pp. 259-278.

6. Matthew W. Ohland, Catherine E. Brawner, Michelle M. Camachob, Richard A. Layton, Russell A. Long, Susan M. Lord and Mara H. Wasburn, “Race, Gender and Measure of Success in Engineering Education, *Journal of Engineering Education*, 2011, Vol. 100, No. 2, 225-252.

7. Kenneth Reid and Eric T. Baumgartner, “Toward a New Paradigm: A Bachelor of Science Degree with a Major in Engineering Education,” in Cindy P. Veenstra, Fernando F. Padró and Julie A. Furst-Bowe (eds), *Advancing the STEM Agenda: Quality Improvement Supports STEM,* ASQ Quality Press, 2012.

8. Kevin Mason, Charles Bomar, Petre Ghenciu, Mike LeDocq, Carolyn Chapel, Jerrilyn Brewer and Jerry Redman, “SySTEMically Improving Student Academic Achievement in Mathematics and Science,” in Cindy P. Veenstra, Fernando F. Padró and Julie A. Furst-Bowe (eds), *Advancing the STEM Agenda: Quality Improvement Supports STEM,* ASQ Quality Press, 2012.

9. National Academy of Engineering, “Changing the Conversation: Messages for Improving Public Understanding of Engineering,” Committee on Public Understanding of Engineering Messages, 2008, http://www.nap.edu/catalog.php?record_id=12187.

10. Ibid.

11. National Academy of Engineering, “Engineers: How Are You Changing the Conversation?” http://www.engineeringmessages.org/.

12. Cindy P. Veenstra, “A Strategy for Improving Freshman College Retention,” *Journal for Quality and Participation*, January 2009, http://www.veenstraconsulting.com/storage/docs/JQP%20article.pdf.

Cindy P. Veenstra, Ph.D., is a principal consultant for Veenstra and Associates, which conducts research on engineering education, especially as it applies to access and retention of disadvantaged students and systems thinking that supports disadvantaged students in engineering college. She is an ASQ Fellow and an ASQ-certified reliability engineer. She is the 2012 chair of the ASQ Education Division and co-conference chair for the 2012 ASQ Advancing the STEM Agenda in Education, the Workplace and Society Conference. She often tweets for the Education Division at @ASQ_EduDiv and can be reached at cindy@veenstraconsulting.com.