More Women are Pursuing Engineering Degrees, but Vast Disparities Remain

Clemencia Cosentino, Mathematica Policy Research
Amlan Banerjee, American Society for Engineering Education

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Introduction

The underrepresentation of women in engineering continues to be a national problem. In 2013, women comprised about 12 percent of practicing engineers and 20 percent of engineering degree recipients, although they accounted for nearly 57 percent of degrees awarded in all fields (NSF 2015; AAUW 2015).[1] Disparities are even more striking for some ethnic groups: Black and Hispanic women account for fewer than 2 percent of engineers and women from underrepresented minority groups (URMs) account for only 3 percent of undergraduate degrees, although they comprise 18 percent of the general population (AAUW 2015).

This lack of diversity in engineering education and the profession is a national problem, as it may hamper the creativity and synergies in teamwork that lead to the innovations needed to increase productivity and foster new discoveries. It also signals a missed opportunity—the opportunity for women to contribute to a workforce that is projected to suffer from severe shortages (unless these shortages are addressed through immigration or global outsourcing) (PCAST 2013). From an equity standpoint, observed disparities also signal lack of opportunities for women to benefit from high paying engineering jobs.

In this paper, we rely on the existing literature and our own analysis (described at the end) to present an overview of (1) women's preparation for, and interest in entering engineering studies, and their representation (2) in engineering education programs, (3) among engineering degree holders, and (4) in the engineering workforce.

1. Female high school graduates are prepared to study engineering, but are neither well exposed to the field nor likely to enter college interested in engineering

Girls are likely to complete high school having taken advanced mathematics, but not engineering courses.

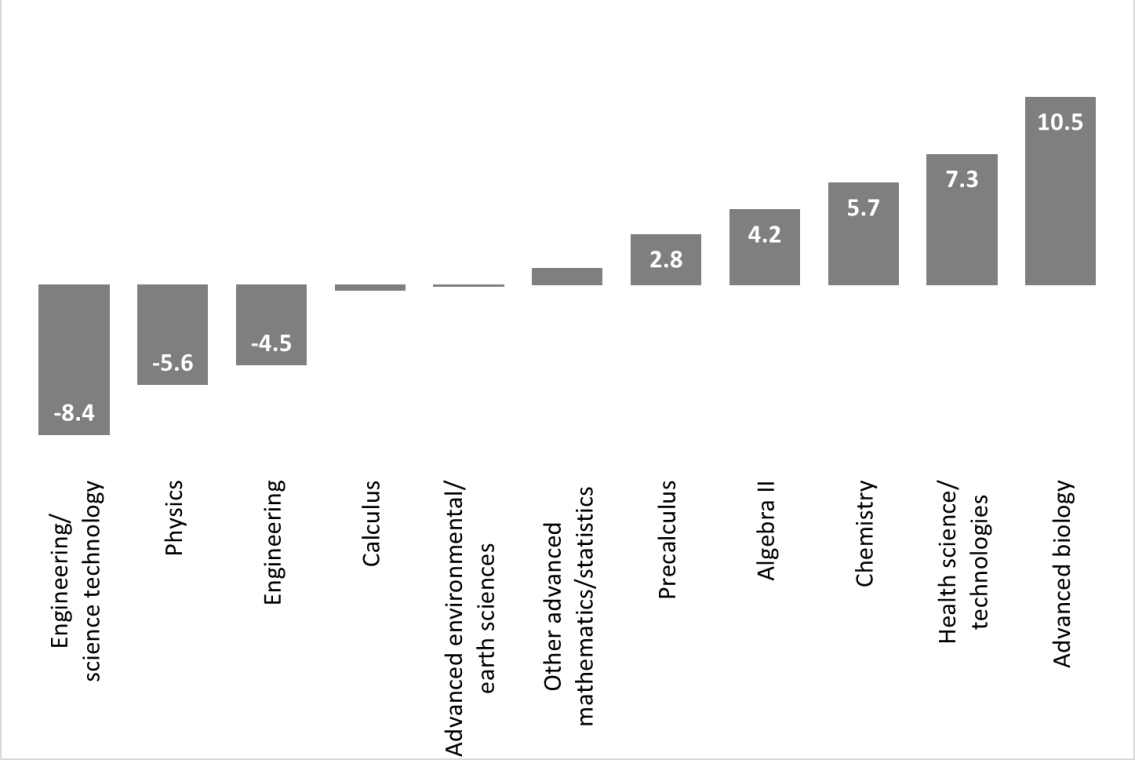
Despite not being as likely as boys to enjoy math and science[2], girls are as likely or more likely than boys to earn high school credits in advanced mathematics courses (such as precalculus and calculus)

[1] Women comprised 21 percent of degrees in engineering in 2012 (NSF 2015) and 19 percent in 2013 (AAUW 2015). The estimate provided is an average.

[2] Girls are less likely than boys to (a) report liking math (53 percent of girls versus 59 percent of boys) or science (59 versus 70 percent) or (b) indicate that math or science is one of their favorite subjects (43 versus 50 percent for math

needed to pursue studies in engineering (Cunningham et al. 2015). However, girls are less likely to have taken courses in engineering or engineering/science technologies in high school; the same is true of physics and computer and information science. In contrast, they are more likely than boys to have earned credits in other advanced science and health-related courses, namely, biology, chemistry, and health science (Figure 1).

Figure 1. Difference in the percentage of female versus male high school graduates who earned credits in science, technology, engineering, and mathematics (STEM) courses



Source: Cunningham et al. 2015. Analysis based on the 2009 National Assessment of Educational Progress (NAEP) High School Transcript.

Women are less likely than men to enter college intending to major in engineering.

Among first-year college students, women are less likely than men to indicate that they intend to study engineering. A recent analysis by the American Association of University Women (AAUW) suggests that the gender gap in field of intended studies is largest in engineering compared to other STEM fields. Men are three times more likely than women to report intending to major in engineering (6 percent of women versus 19 percent of men) (AAUW 2015). In other words, 1 out of 5 men versus 1 out of 17 women enter college intending to pursue their studies in engineering. This holds by ethnicity as well, although the size of the gender gap within ethnic groups differs.

and 34 versus 48 percent for science). This finding generally holds for all ethnic groups, although the size of the differences vary. For example, 55 percent of black female high school graduates versus 64 percent of black males reported liking mathematics.

2. Women's enrollment in engineering education is growing

The number and share of women enrolling in engineering programs of study has increased over time.

Overall, the number of women enrolling in engineering bachelor's degrees grew by 77 percent over the past decade (2005 to 2014), while increasing by 11 percent in master's degrees and 37 percent in doctoral degrees over the same time period (Figure 2.a.). However, due to increasing enrollment among men, the share of women in engineering bachelor's degree programs grew modestly by 4 percentage points between 2005 and 2014, and remained unchanged in master's and doctoral programs (Figure 2.b.). Consequently, as of 2014, women constitute about 21 percent of bachelor's, 23 percent of master's, and 25 percent of doctoral students in engineering.

Figure 2.a. Growth in enrollment among full-time female students

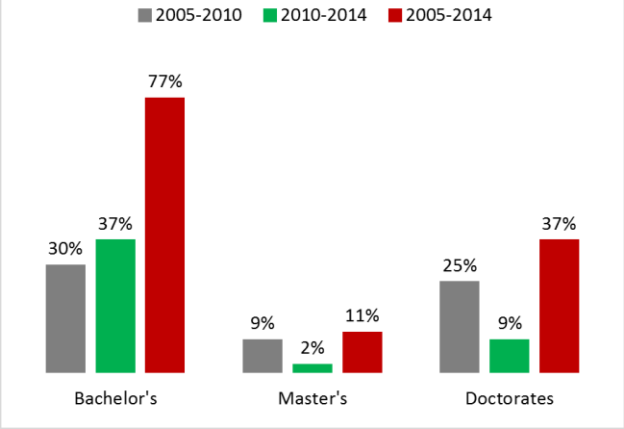
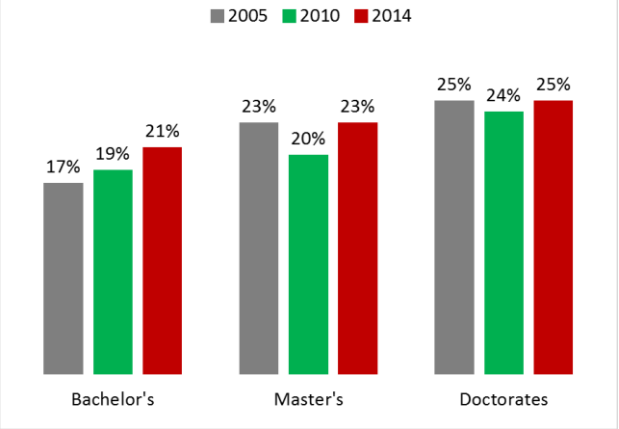


Figure 2.b. Women as a share of full-time enrollment

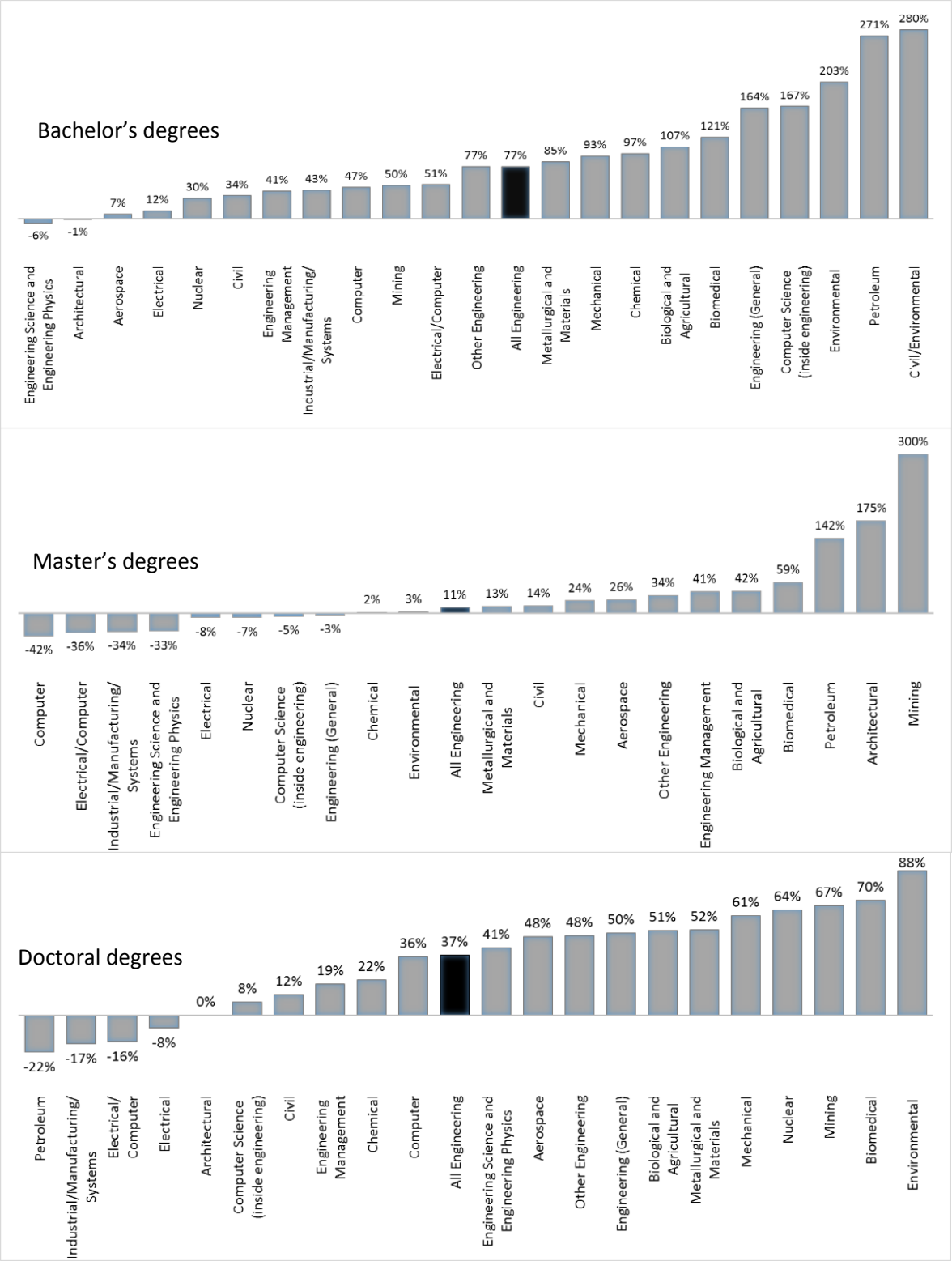


Source: Authors' analysis of ASEE profile surveys of universities.

Women's enrollment grew in nearly all engineering-related bachelor's degree disciplines.

In engineering bachelor's degree programs, the largest growth in women's enrollment is observed in disciplines where women are well represented in the baseline year of 2005 (defined as having a share of women that is above the national average for the given program). These fields include environmental, biomedical, chemical, biological/agricultural, and metallurgical/materials engineering. Computer science and mechanical engineering, two disciplines that had low representation of women in 2005, also experienced significant growth over time; in these cases, the small baseline numbers likely resulted in large percentage increases. With some notable exceptions, these findings hold for master's and doctoral degrees, although growth in women's enrollment in these degrees was not as marked as with bachelor's degrees. Indeed, in some fields—such as electrical and industrial/manufacturing—women's enrollment in graduate programs declined between 2005 and 2014 (Figure 3).

Figure 3. Growth in female enrollment (2005-2014)



Source: Authors' analysis of ASEE profile surveys of universities.

Some disciplines enjoy growth in women's enrollment across bachelor's, master's, and/or doctoral degrees.

Between 2005 and 2014, women's enrollment grew across bachelor's, master's, and doctoral degrees in two disciplines—mechanical and mining engineering. Women's enrollment also grew in bachelor's and master's degrees (in biomedical and petroleum engineering) and in bachelor's and doctoral degrees (in environmental and biological and agricultural engineering). Many other disciplines experienced growth in the representation of women only in bachelor's degrees (Figure 3).[3]

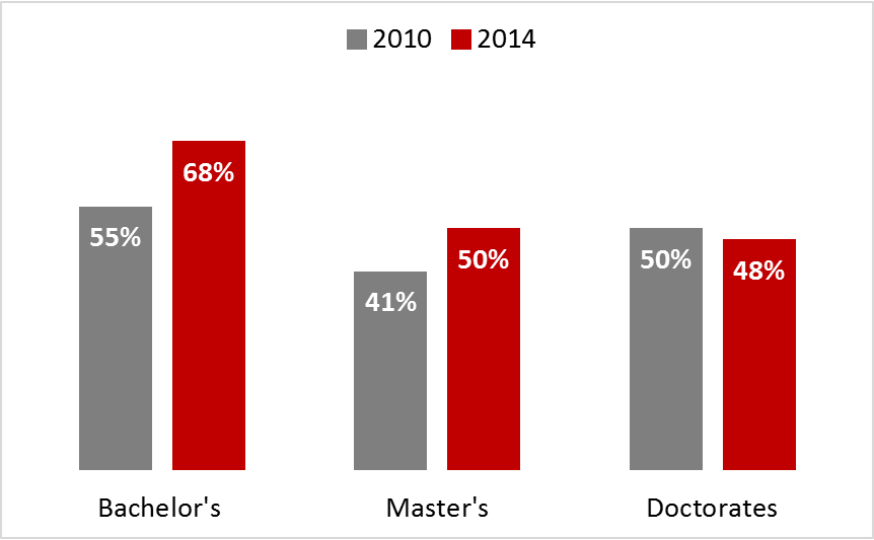
3. Once they enroll, women are as likely as men to graduate

Overall, women who enroll in engineering are as likely to graduate in engineering as their male counterparts, but continue to be underrepresented among engineering degree holders due to low participation of women in engineering studies (Cosentino and Deterding 2009).

As of 2014, women are as likely as men to graduate in most undergraduate engineering disciplines.

The parity index of female to male graduation in engineering improved over time across most disciplines at the undergraduate level (Figure 4). In 2010, the parity index was below 1 in ten disciplines, indicating that women were less likely to complete their degrees than men. By 2014, this was true only in seven disciplines. In fact, some of these disciplines experienced significant improvements in the parity index (engineering (general), electrical/computer, and architectural engineering), while two experienced significant drops (engineering management and engineering science and physics).

Figure 4. Percentage of engineering disciplines with a parity index of 1 or greater



Source: Authors' analysis of ASEE profile surveys of universities.

[3] These findings should be interpreted with caution as they are based on a sample that represents doctoral degree granting institutions, but not necessarily master's or bachelor's degree grantee colleges and universities.

At the graduate level, women achieved graduation parity in several disciplines in master's programs, but not in doctoral programs.

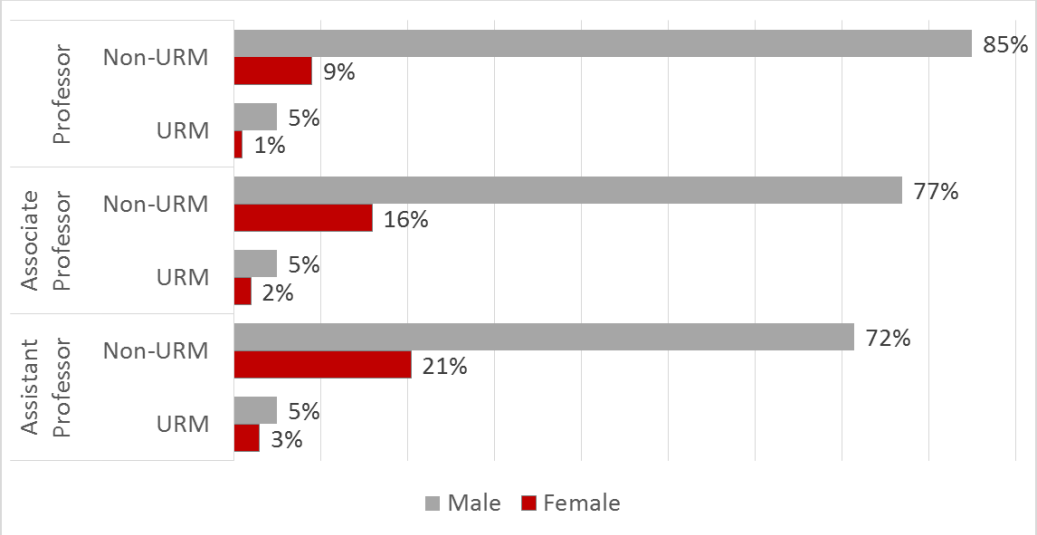
In master's programs, findings suggest a small improvement over time, as the number of disciplines showing a parity index under 1 declined from 13 to 11 disciplines (Figure 4). Improvements are not observed in doctoral programs, however. In fact, in these programs, disparities increased in some fields (such as computer, mechanical, and electrical engineering) and extended to fields in which there were no disparities at baseline (such as chemical and general engineering).

4. Women are less likely than men to enter academia or remain in the engineering workforce over time.

Very few women engineers—and particularly URM women—join academia.

As of 2013, women make up only 23 percent of assistant professors, 17 percent of associate professors, and 9 percent of full professors in engineering. With time, and assuming women are promoted as fast as men, the share of women will likely grow among associate and full professors. But even if this is the case, it is unlikely to increase by much given the low numbers of women engineers in academia. Even more striking is the share of URM women in academia—3 percent of assistant professors, 2 percent of associate professors, and one percent of full professors in engineering (Figure 5).

Figure 5. Percentage of engineering faculty by gender, ethnicity, and academic rank



Source: AAUW 2015.
Note: Estimates for 2013.

Most engineering graduates enter the engineering workforce, but women are less likely to be retained than men.

Based on 2010 data, about 65 percent of women (and men) holding engineering degrees obtain jobs in engineering after graduation, but with time women are more likely to drop out of the profession

than men. Consequently, 30 to 35 years after first getting a job in engineering (in their 50s), women are half as likely to be working as engineers as men (19 versus 39 percent among men; AAUW 2015).

Inspire, educate, and mentor in a nurturing environment

To summarize, this paper shows that important progress has been made in preparing women to study engineering and in increasing their representation in engineering programs of study. Women are likely to complete the mathematics and science courses needed to pursue a degree in engineering, and the number of women enrolling in engineering has grown drastically. In addition, those women who pursue engineering studies are as likely as men to complete them. However, women are still unlikely to enter college intending to pursue a degree in engineering and continue to be severely underrepresented in engineering education programs, academia, and the profession.

The recent AAUW study—*Solving the Equation* (2015)—reviews the literature to provide a detailed analysis of potential explanations for the underrepresentation of women in engineering (and computer science). The authors conclude that the solution to this problem lies in "create[ing] environments that are truly welcoming for women." This is true. But findings from this analysis suggest that this solution needs to be complemented with an active approach to engaging girls early to expose them to a wide range of engineering fields and work opportunities and to inspire them to pursue a career in engineering. Reaching down to K-12 education to provide this exposure will be just as important as ensuring that the right environment is fostered in K-12 and awaits them both in higher education and in the workforce.

Data

This analysis is based on the ASEE profile surveys of universities. The ASEE profile survey is a voluntary, web-based survey administered in the Fall of every year to all (530) colleges and universities in the United States offering at least one full-time graduate engineering program or ABET accredited undergraduate engineering program. The data needed for this analysis are available since the 2004-2005 academic year. We report the 2004-2005 year as the baseline year and approximately five-year intervals thereafter (2009-2010 and 2013-2014 as the most recent year available). For the years used in this analysis, an average of about 65 percent of institutions responded to the survey. With a response rate of 90 percent, findings are representative of doctoral degree granting institutions in the U.S., but may not generalize to smaller master's degree granting institutions (nearly 50 percent responded) or baccalaureate institutions (40 percent responded). All results reported are statistically significant at the .05 level.

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