

**AC 2010-788: WOMEN IN BIOMEDICAL ENGINEERING: CURRENT STATUS
AND A REVIEW OF POTENTIAL STRATEGIES FOR IMPROVING DIVERSITY**

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Women in Biomedical Engineering: Current Status and a Review of Potential Strategies for Improving Diversity

Abstract

The percentage of women in biomedical engineering is higher than in many other technical fields, but it is far from being in proportion to the US population. From the bachelors to the masters to the doctoral levels, the proportion of women in biomedical engineering decreases significantly, which is evidence of a leaky pipeline. In addition, the percentage of women faculty members at the assistant, associate and full professor levels remain disappointingly low even after years of improved recruitment of women into biomedical engineering at the undergraduate level. Even more alarming, as we show with a new summary analysis of publicly available data, the percentage of women undergraduates in biomedical engineering has been decreasing nationwide for the most recent three year span for which national data are available. In this paper, we review the barriers to women's success in biomedical engineering and suggest strategies for overcoming these obstacles, i.e., for fixing the leaky pipeline.

Introduction

The lack of gender diversity in all engineering disciplines is an important national problem. As noted at the Summit on Women in Engineering¹, “we simply need people with the best minds and skills, and many of those are women.” Furthermore, the literature suggests that a more inclusive workforce is more innovative and more productive²⁻⁴. In academia, the educational benefits of diversity are significant⁵. Students with the most classroom experience with diversity are more engaged in learning and self-report more gains in critical thinking, problem solving and self-confidence⁵. Similar benefits have been found in graduate medical and law school environments⁶. Also, multiple lines of evidence suggest that experience with diversity reduces unconscious bias against women⁷⁻¹⁰.

In biomedical engineering, anecdotal evidence suggests that the field is inherently appealing to women, especially in comparison to the more traditional disciplines such as mechanical and electrical engineering. We are also a younger discipline, which implies fewer institutionalized impediments to diversity and diversity initiatives. We are more connected to the biological and medical sciences, which have greater gender equity than engineering sciences. The unique challenges to gender equity in biomedical engineering are the flip side of these advantages. First, the inherent appeal of biomedical engineering to women can foster complacency about diversification and lack of attention to the real problems of attrition and, sometimes, discrimination. Second, as a younger discipline, we have fewer senior women role models. Third, the interdisciplinary nature of our discipline contributes to the leaky pipeline since at all levels – BS, MS and PhD – highly trained women may be recruited into medicine and the biological sciences where they perceive the intellectual challenges to be similar but the barriers to their success, such as isolation, less daunting.

Current Status of Women in BME

Although gender diversity is poor in engineering as a whole, the BME discipline has historically been attractive to women. The fraction of those receiving BS degrees in BME who are women is approximately 40% (Figure 1), which is second only to environmental engineering according to the most recent data from the ASEE¹¹. BME also has the highest fraction of women receiving PhDs in engineering (~30%; Figure 1). Unfortunately, gender diversity of the faculty is not as good. On

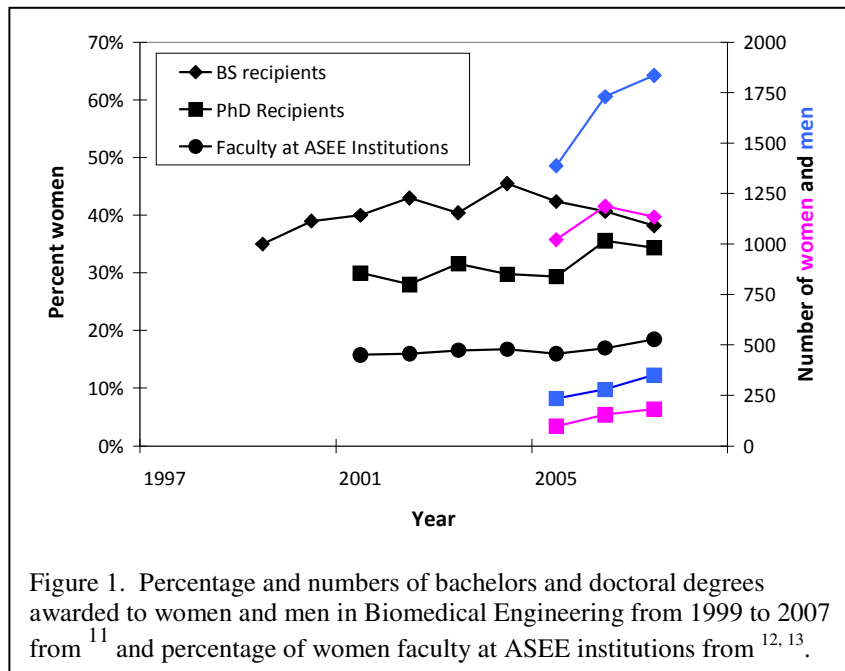


Figure 1. Percentage and numbers of bachelors and doctoral degrees awarded to women and men in Biomedical Engineering from 1999 to 2007 from¹¹ and percentage of women faculty at ASEE institutions from^{12, 13}.

average, for faculty at all levels, women comprise less than 20% at ASEE institutions^{12, 13}. Looking at the absolute numbers for the last three years, two different reasons for the decreases in percentage are apparent. From 2005 to 2006, the numbers of men and women obtaining BS degrees increased, but the number of men increased more than the number of women. In contrast, from 2006 to 2007, the number of men earning degrees again increased but the number of women decreased (Figure 1). Thus, BME attracted more men but fewer women.

Given the perceived growth in our field over the last 3-5 years, this last statistic is perhaps the most disheartening. Why are fewer women graduating with BME undergraduate degrees now and how can we reverse the trend? Also, if a relatively stable increase in women obtaining PhDs in BME does not increase the number of women faculty in BME, what will?

Potential Barriers and Strategies for Improving Diversity in BME

As succinctly reviewed by Handelsman et al.¹⁴, the barriers to success for women in science and engineering are (1) the pipeline, (2) the departmental climate, (3) difficulties balancing family and work and (4) unconscious bias. Strategies for overcoming these obstacles include: more effective K-12 outreach programs¹⁵, curricular reform¹⁶ and undergraduate mentoring programs¹⁷; improving the climate in our departments, institutions and national societies through mentoring programs¹⁷⁻²⁰ and workshops²¹ and by working together to support the diversity of the student body, faculty and society membership; providing access to high profile role models¹⁹ who are successfully balancing work and family and promoting best practices^{22,23}, through which we can help all faculty members more successfully balance work and family demands; and, finally, by educating leaders in our field about unconscious bias^{8,23-27} so that we can begin to lessen the consequences of gender schemas for women in BME.

Conclusions

While the percentages of women obtaining BS, MS and PhD degrees in biomedical engineering are higher than nearly any other engineering discipline, graduation rates are not monotonically increasing over time, and past increases in graduation rates have not led to significant increases in the percent of women in faculty positions in our field. The obstacles to reaching gender equity in STEM disciplines are daunting and likely play a role in the continuing relative absence of women at all levels in BME. However, the benefits of diversity are substantial – both for students in BME and society at large. Actively pursuing strategies to remove or reduce the barriers to women's success in BME will promote a more diverse workforce in BME disciplines, which may in turn create a more productive workforce.

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