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## *Literature Review*

# **Discrimination against Women in the Field of Engineering**

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*Julia Weber, University of Dayton*

### **Introduction**

This article focuses on the position of women in the field of engineering, specifically why the field is male-dominated and why this condition should change. When I state the field is male-dominated, I am addressing both the proportion of men in the field in comparison to women and discrimination towards women in the workplace.

Throughout this article, I will be focusing on women in the field of engineering. I will look into why the field is so male-dominated (Chu, 2005; Hunt, 2016; Ramirez & Wotipka, 2001) and how this has begun to change over time (Hill, Corbett, & St Rose, 2010; Morgan, 1992; Ramirez & Wotipka, 2001; Scandura & Ragins, 1993; Torre, 2014). Additionally, I will look into whether or not women within the field ever feel as though they are discriminated against for their gender, or if they feel they are treated equitably in comparison with their male counterparts. I will be looking at this topic through a feminist framework. Relevant themes of feminism in the underrepresentation of women in engineering include “who benefits and who is harmed, critically examining assumptions and presumptions that create injustice, and creatively and energetically working for our dreams of what could be” (p. 34) in the field of engineering (Riley, Pawley, Tucker, & Catalano, 2009). Research in feminism, as far as sex discrimination in the workplace, indicates that sex discrimination is *immune to challenge* (Thornton,

2006). Looking at this topic through a feminist lens will highlight the gender inequality in the workplace of engineers.

Through this research, I have concluded that many factors account for the lesser proportion of women in the field of engineering- and in similar science and math related careers. Overall, I hope to show that an increased number of women in fields of engineering would be beneficial to society. This societal change would help bridge the gap between men and women when it comes to treatment in the workplace. Ultimately, projects could look into how the number of women in the field of engineering can be increased. Also, this topic could potentially be looked at through a different framework, such as a phenomenological lens, looking into how women think about stereotypes in this profession. Overall, there are many gaps in literature that future researchers could delve into, as the research I conducted seems to be a popular topic in current literature.

The reasons why women have been, and continue to be, a minority in the field of engineering and how this can be changed have been addressed differently in recent years (see for instance, Hunt, 2016; Shahala, Agogino, Bailyn, et al., 2007; Torre, 2014). Many authors view this subject differently, as many different reasons for the lack of women in engineering are identified in different publications, such as a large number of female exits, a shortage of female mentors, and preexisting biases and stereotypes, among other reasons.

### **Female Exits**

One reason as to why there are fewer women with engineering jobs than men is that a large number of women exit the field, finding other jobs. According to Jennifer Hunt (2016), “a lack of mentoring and networks, or discrimination by managers and coworkers, are the more promising of the existing explanations for excess female exits” (p. 23). This conclusion was reached by the finding that a lack of promotional opportunities and family-related issues were proportional between the male and female populations in the field. Hunt indicates that these reasons are still statistically significant; however, she finds they are not the biggest driving causes of female exits from engineering. Ultimately, as the numbers of females in the profession are lower, this perpetuates itself further, because fewer females in the professions means a lower number of female mentors, which is a major factor in why females leave male dominated fields (Hunt, 2016; Scandura & Ragins, 1993).

Margarita Torre (2014) opposes other researchers, explaining that the reason for female exits from traditionally male dominated fields is a “scar effect” (p. 1). Torre explains that there is a scarring effect of previous work in female fields by women, which drives them to leave male dominated fields. She found that women who had experience in a more female heavy field were more likely to leave a male dominated field after trying it out. This scar effect “hinders women’s opportunities in the male sector and ends up increasing the likelihood of exit” (Torre, 2014, p. 1). This view accounts for the female exits in the profession as a driving cause of the numerical minority of females in a different way than other researchers.

### **Female Entries**

In addition to focusing on the exits, I looked into whether or not there are fewer female entries into the field of engineering. Some research focuses on the reasons there are fewer females in engineering before even gaining jobs in the field. Donna Shahala, Alice Agogino, Lotte Bailyn, et al. (2007) find that women are very likely to face discrimination in the workplace, indicating that this could account for some exits. In addition, “women who are interested in science and engineering careers are lost at every educational transition” (Shahala, et al., 2007, p. 2). Not only are females exiting the field due to reasons once they have acquired a job, but they are changing their paths before even getting into it. For example, “as they move from high school to college, more women than men who have expressed an interest in science or engineering decide to major in something else” (Shahala, et al., 2007, p. 2). The same also reigns true in the transition into graduate school; the number of women in the field declines more and more as time in the educational system goes on (Hill, Corbett, & St Rose, 2010; Shahala, et al., 2007). Ultimately, the number of women graduating with an engineering degree is smaller, proving that factors at the workplace are not the only factors causing the numerical minority of women in engineering.

### **Stereotypes and Bias**

Additionally, there are preexisting biases that account for the difference between the numbers of men and women in the field. Men and women are equally capable of performing in engineering; however, “most of us carry prejudices of which we are unaware but that nonetheless play a large role in our evaluations of people and their work” (Shahala, et al., 2007, p. 3). This plays into the main focus,

because ultimately people could be less likely to hire a woman over a man with the same qualifications for this reason. People hold preexisting biases, whether they are aware of them or not.

Evidently, there is a greater rate of female exits from undergraduate engineering majors than that of men (Jones, Ruff, & Paretti, 2013; Rubineau, Cech, Seron, & Silbey, 2011). Jones, Ruff, and Paretti (2013) explain, “The culture of engineering departments and negative stereotypes of women’s engineering and mathematical ability have been identified as factors that inhibit women’s entry into engineering and cause them to leave the major” (p. 471). A woman’s decision to become an engineer is largely influenced by her skills in math and science (McIlwee & Robinson, 1992). As a result, negative stereotypes about their capability in these subjects lead to women doubting themselves and deciding to pursue a different career path.

### **Female Exits in Comparison to Men**

Other research finds that the answer lies in the comparison of the exit rates of women to that of men. Fewer men leave the field because “men lose more future earnings by leaving engineering than do women” (Rubineau, Cech, Seron, & Silbey, 2011, p. 1). A study found that although women who stay in engineering generally make less than men who stay, for the most part men who leave the field make substantially lower than both men and women who stay (Rubineau et al., 2011). While researchers agree that fewer women entering the field of engineering is a reason for the numerical minority, there is debate as to why there are larger exit rates at an undergraduate level.

According to a study conducted by Carolyn Morgan, another major factor that leads to the underrepresentation of women is the fear of resentment from their colleagues (Morgan, 1992). This is a psychological cause, as women have this fear embedded in their mind. This is a major barrier to women’s participation in science and engineering at all levels.

### **Sex Discrimination**

Brush (1991) has found that “Universities and corporations have not dismantled the structural barriers that effectively deny rewards to women, ranging from the SAT to promotion systems that conflict with family life or allow women to rise no further than a glass ceiling” (p. 416). This indicates that a lack of reward for women

in technical fields, engineering included, is a factor in female exits from these majors at the university level. Brush (1991) explains that the leaders of these institutions need to make changes that would pull women into the field rather than pushing them into it.

Many researchers agree that sex discrimination is one of the major reasons the number of women in engineering is much smaller than that of men (Jones, Ruff, & Paretto, 2013; Hunt, 2016; Beasley, & Fischer, 2012; Shahala, Agogino, Bailyn, et al., 2007). Beasley and Fischer (2012) indicate that stereotype threat causes women to leave engineering, meaning that the expectation that they will be judged as less capable than men in the field causes women anxiety and drives them away. This stereotype threat is one driving cause as a result of discrimination. Additionally, sex discrimination in the workplace causes women to feel inadequate (Beaton, Tougas, Rinfret, & Monger, 2015). This feeling of inadequacy could be a factor that drives women to leave the field. These psychological results of sex discrimination are highlighted by researchers as major reasons engineering is such a male dominated field.

Taking this view in a slightly different direction, Bastalich, Franzway, Gill, Mills, and Sharp (2007) explain, “Within the engineering workplace culture ‘women’, or anyone who fails to conform to strict codes of masculine conduct, is cast as an ‘outsider’ or ‘foreign’” (p. 397). Therefore, women exit the field, because they do not fit in with the masculine expectations (Bastalich, Franzway, Gill, Mills, & Sharp, 2007).

There is other research supporting Bastalich, Franzway, Gill, Mills, & Sharp’s concept of the masculine conduct expected in engineering, taking this idea in a different direction. According to Powell, Bagilhole, and Dainty (2009), “In ‘doing’ engineering, women often ‘undo’ their gender” (p. 411). Ultimately, female engineers are conforming to their workplace expectations and becoming more masculine. This research suggests that women who do remain in engineering conform to fit a masculine role, leading to an environment that is hostile towards women (Powell, Bagilhole, Dainty, 2009). If women are not comfortable with giving up their femininity, they may decide to leave the field for one believed by society to be more appropriate for females.

## **Change Over Time**

Although women are still a numerical minority in the field of engineering, over time the number of women in the field has increased (Hill, Corbett, & St Rose, 2010; Morgan, 1992; Ramirez & Wotipka, 2001; Scandura & Ragins, 1993; Torre, 2014). According to Morgan (1992), “In 1960... less than 1% of the engineers employed in the United States were women. Since that time, women have made progress. ... By 1988, they represented ... 4% of engineers” (p. 228). These numbers are still very small, but they are climbing. Although numbers of women are increasing in the field, this is a slow process, and it is important not to assume there is more inertia than what actually exists (Ramirez & Wotipka, 2001). We cannot just leave this issue to fix itself; something needs to be done to make women in engineering more comfortable in both the university and the workplace.

## **Discussion**

There is much debate in current literature regarding the reason for a numerical minority of women in the field of engineering. There is a large focus on both the entry and exit of women into the field, as there are fewer women than men who enter (Shahala, Agogino, Bailyn, et al., 2007) and a larger proportion of women who exit the field (Hunt, 2016). Different researchers account for these differences in both entry and exiting of women engineers in different ways. Fewer women enter the field as a result of a greater number of exits at academic transitions (Shahala, Agogino, Bailyn, et al., 2007), and negative stereotypes of women’s mathematical and engineering ability (Jones, Ruff, & Paretto, 2013). The greater number of female exits can be accounted for by a lack of female mentors within the field of engineering in general (Hunt, 2016; Scandura & Ragins, 1993), discrimination by male counterparts (Hunt, 2016), pre-existing biases (Shahala, Agogino, Bailyn, et al., 2007), and a “scar effect” (Torre, 2014). In addition, the number of women in engineering has been in an upward trend (Scandura & Ragins, 1993; Torre, 2014; Ramirez & Wotipka, 2001), but there is still a long way to go before there is equality in the workplace for female engineers.

After conducting this research, I concluded that it would be of value for future researchers to look into how the proportion of women in engineering and other STEM fields could potentially be increased. There is a large amount of research on why the difference between men and women in science and engineering fields exists, but not as much on how this could be changed in the future. What could be

implicated to ensure a larger number of women in these fields? Would changes made back in the schooling system be more helpful in increasing the proportion of women than changes made in the workplace? Why aren't any changes being made currently? Additionally, looking at this issue through another lens other than feminism, such as a phenomenological, ethical, or psychological framework could be of value in literature. Researchers could delve into how female engineers are affected psychologically by discrimination in the workplace and by negative stereotypes.

Ultimately, my research aims to prove that more women in the field of engineering would be beneficial to society. Feminists today focus largely on issues like the wage gap and creating equality in the workplace, and increasing the number of women in the field of engineering would be taking a step forward in this regard, as women are underrepresented in the field. Through my research, I found that literature has highlighted sex discrimination and negative stereotypes against women as major reasons for the lesser number of women in engineering. According to Carolyn Morgan (1992), "negative stereotypes of women scientists and engineers may be removed as the societal need for them becomes crucial" (p. 234), comparing this societal change to the change in the view of working mothers after World War II. If the negative stereotype against women engineers were eliminated, there would be more gender equality in engineering workplaces and in the university, and the number of women in these professions would likely increase.

It is clear that a society free of negative stereotypes and sex discrimination would be more ideal than the society we are a part of today; people would not be driven away from careers for this reason anymore. Women looking into engineering would no longer face this obstacle when choosing a career. As stated by Stephanie Blaisdell, "The time has come to change society's perception of women in science and engineering" (Blaisdell, 2006, p. 170).

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