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Becoming Engineers: Exploring Gender, Choice and Intersectional Identities Among Women in Undergraduate Engineering

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BECOMING ENGINEERS: EXPLORING GENDER, CHOICE AND INTERSECTIONAL IDENTITIES AMONG WOMEN IN UNDERGRADUATE ENGINEERING

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Abstract

Women's participation in engineering remains one of the areas in American higher education in which gender inequality remains particularly pronounced. Much has been written about the chilly climate, unwelcoming occupational practices, and significant social barriers in engineering, which cause women to exit the field. Yet recent literature also suggests that woman's minority status results not only from their attrition, but also from their relatively slow movement into engineering majors. In this sense, it is important that we begin to ask not only why women leave engineering, but also what reasons those women who actually pursue engineering as a college major, provide for doing so.

My dissertation attempts to address this gap in knowledge by asking how women form preferences and aspirations for engineering degrees. I rely on qualitative research methods, which consist of 35 in depth interviews with undergraduate engineering students, as well as a textual analysis of recruitment materials targeted towards young women to encourage them to become engineers. The key findings from this study demonstrate that an intersectional approach can help enhance our understandings of multiple identities such as gender, race, and social class and how they impact women's choice of major and experiences in their pursuit of engineering. My findings also demonstrate that institutions can create frameworks for how students approach the choice of college major that can allow for alternative gendered processes to emerge. I also find that how women approach the choice and pursuit an engineering majors strongly relates to gendered understandings that operate in schools and families about the purpose of college and professional goals. In addition to shedding light on social interactions and structures that influence college major choice, this research also illuminates how postfeminist narratives operate at the organizational level among recruitment materials to create contradictory and problematic gendered narratives to encourage women to become engineer

Chapter 1: Introduction

Over the last fifty years, women have made dramatic gains in American society in terms of their educational and occupational achievements. After battling male dominance for decades, women have now gained key positions in government and the paid labor market. They go to college in greater numbers than men while also earning better grades and graduating at higher rates (DiPrete and Buchmann 2013; Rosin 2012). However, gender inequality still remains extremely pronounced, particularly in college major selection. As statistics indicate, women earn 57 percent of all bachelor's degrees overall. However, they earn approximately 80 percent of degrees in fields such as education and 77 percent in psychology, but only 19 percent in engineering (National Center on Education Statistics 2015).

The issue of disparities in college major choice represents one of the most significant forms of gender inequality in higher education. The disparities are problematic for a number of reasons. For one, the distribution of women and men into different fields and professions fuels occupational gender segregation, which is the leading cause of the gender gap in earnings today. Many science, technology, engineering and math (STEM) fields are lucrative and women are missing out on the potential for high compensation if they are underrepresented (Bradley 2000; Shauman 2006). Yet even beyond this, the dearth of women in STEM also represents the loss of human capital that can enhance scientific and technological progress (Blickenstaff 2005). Diverse groups from different backgrounds are often able to design products and solutions that better represent all users (Glick et al. 1995). Furthermore, diverse teams improve solutions and outcomes in technological products and research, as compared to more homogenous teams (Hong and Page 2004). Finally, as the United States seeks to cultivate a highly trained workforce to maintain America's competitive edge and meet future challenges, drawing women into STEM is one potential strategy to do this.

This topic of women's low participation in STEM continues to garner attention from scholars across academic fields who have examined this issue from various lenses and perspectives. While some focus on various STEM disciplines, a handful of scholars study engineering specifically, as women have been historically underrepresented in this field. Much of this work demonstrates that engineering poses a number of gendered obstacles for women because it is male dominated and commonly understood as masculine and male-identified (Cech et al. 2011; Hunt 2010; Fouad and Singh 2011; McIlwee and Robinson 1992). Women in engineering struggle to prove their suitability in the profession and they must often prove their competence to their mostly male peers. They face doubts about their abilities even when they are well qualified. Furthermore, many encounter obstacles in a professional culture that values hands on skills and technical competencies, particularly because women are often socialized differently and do not gain these experiences at home (Faulkner 2007; McIlwee and Robinson 1992). As they progress to the workforce, balancing a career and motherhood also presents substantial hurdles and many are not given opportunities to advance in their careers. As a result, women leave the engineering workforce in large numbers (Fouad and Singh 2011). Studies also demonstrate that women with similar educational and professional backgrounds in engineering face substantial wage gaps relative to men (Cech 2013).

Despite the fact that we have gained a better understanding of these issues there are still many areas that need exploring in relation to women's participation in engineering. In fact, much of the research on this topic suffers from significant limitations. One of these is that most researchers have focused on the persistence of those individuals who have already chosen to enter engineering, while neglecting the factors that influence how and why students pursue an undergraduate engineering degree to begin with (Xie and Shauman 2003). As scholars have

demonstrated, women are taking as many math classes as men and performing equally well in them (Hyde et al. 2008). They are also persisting at the same rate in obtaining STEM degrees as men, but are far less likely to chose a number of STEM fields (Xie and Shauman 2003). This means that in order to increase women's representation in fields such as engineering, it is necessary to focus on encouraging women to become engineers alongside efforts to improve the educational and workplace climates. This will require more theorizing and analysis of why women avoid engineering for other STEM fields and liberal arts majors, but also perhaps even more importantly why the relatively few women who study engineering do so.

Another limitation is that much of the research has focused exclusively on white women. Research simply has not paid enough attention to how women from different racial and ethnic groups chose engineering and experience the educational and workplace climates in this profession. We cannot make sense of gendered experiences, without considering how they are also racialized. As feminist sociologists have argued, research needs to incorporate intersectional frameworks that ask how multiple dimensions of identity interact to create mutually reinforcing categories that produce differential outcomes and experiences (Collins 2000; Wingfield 2007).

Finally, another gap in the existing literature is that much of the research on the topic of women's underrepresentation in engineering relies on quantitative methodologies at the exclusion of other methods. While incredibly informative, our knowledge on the topic can be enhanced by utilizing diverse methodological approaches to shed light on the issue in novel ways. In a similar vein, much of the literature on women in engineering is also largely uninformed by sociological feminist frameworks and gender theory. Incorporating these theoretical frameworks can expand our understandings about how issues of underrepresentation are perceived, framed and researched, as well as the implications of current conceptualizations of

women's underrepresentation as a problem (Beddoes 2011; Pawley 2008). The purpose of this dissertation is to focus on filling some of these gaps. I provide three separate articles in an attempt to begin to address these issues.

The first article focuses on understanding why and how women chose engineering as a college major. While much has been written about the chilly climate, unwelcoming occupational practices, and significant social barriers in engineering, which cause many women to exit the field (Cech et al. 2011; Fouad and Singh 2011; Mcilwee and Robinson 1992; Seymour and Hewitt 1997), research has paid insufficient attention to issues surrounding the choice of an engineering major. If women selected engineering at the same rate as men, the gender gap could be significantly reduced. Furthermore and of crucial importance, is that the numbers of women matter. Often, an influx of women can transform the image of engineering as masculine to more gender diverse. Furthermore it can improve structural conditions of engineering that impede women's progress (Lagesen 2008). This article attempts to address this by examining the process by which women chose to study engineering through the use of in depth interviews with young women. Until we begin to understand the reasons around why women select the majors they do, we will never be able to fully address gender inequality in higher education.

The second takes an intersectional approach to understanding the experiences of Black women in undergraduate engineering education. Too often research on women in engineering implicitly assumes a racial and ethnic homogenization of women, which obscures important differences among women. Black women make up 1 percent of those who earn degrees in engineering (Yoder 2016) and their views and perspective are often neglected. This article focuses on better understanding how they navigate engineering education and the specific barriers they face as a result of multiple identities.

Finally, taking seriously the need to enhance the literature on women's participation in engineering by engaging with theoretical frameworks in sociology (Beddoes 2011; Pawley 2008), the third article of this dissertation focuses on analyzing the messages that are marketed towards young women to become engineers in outreach campaigns. As educators, advocates and national science bodies recognize the need to recruit women to the field, outreach programs have grown tremendously in the United States. Few however, have analyzed their content and the larger narrative package that these campaigns present to the public. This article responds to calls for more multi-disciplinary approaches to better understand the implications of the construction of gender in engineering. In doing so, it attempts to consider how outreach programs can leverage their strengths while also ensuring that they address cultural and structural factors that shape women's experiences with engineering.

References

Beddoes, Kacey. 2011. "Engineering Education Discourses on Underrepresentation: Why Problematization Matters." *International Journal of Engineering Education* 27(5): 1117-1129.

Blickenstaff, Jacob Clark. 2005. "Women and Science Careers: Leaky Pipeline of Gender Filter?" *Gender and Education* 17(4): 369-86.

Bradley, Karen. 2000. "The Incorporation of Women into Higher Education: Paradoxical Outcomes." *Sociology of Education* 73(1): 1-18.

Cech, Erin, Brian Rubineau, Susan Silbey and Caroll Seron. 2011. "Professional Role Confidence and Gendered Persistence in Engineering." *American Sociological Review* 76(5): 641-666.

Cech, Erin. 2013. "Ideological Wage Inequalities?: The Technical/Social Dualism and the Gender Wage Gap in Engineering." *Social Forces* 91(4): 1147-1182.

Collins, Patricia Hill. 2000. *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment.* New York and London: Routledge.

Crenshaw, Kimberle. 1993. "Mapping the Margins: Intersectionality, Identity Politics, and Violence against Women of Color." *Stanford Law Review*. 43(6): 1241-1299.

DiPrete, Thomas A. and Claudia Buchmann. 2013. *The Rise of Women: The Growing Gender Gap in Education and What It Means for American Schools*. New York: The Russell Sage Foundation.

Faulkner, Wendy. 2007. " 'Nuts and Bolts People' Gender-Troubled Engineering Identities." *Social Studies of Science* 30(5): 759-792.

Fouad, Nadya A. and Romila Singh. 2011. Stemming the Tide: Why Women Leave Engineering. Retrieved May 30th, 2017 at: (https://energy.gov/sites/prod/files/NSF_Stemming%20the%20Tide%20Why%20Women%20Leave%20Engineering.pdf).

Glick, Peter, Korin Wilk, and Michele Perreault. 1995. "Images of Occupations: Components of Gender and Status in Occupational Stereotypes." *Sex Roles* 32(9-10): 565-582.

Hong, Lu and Scott E. Page. 2004. "Groups of Diverse Problem Solvers Can Outperform Groups of High-Ability Problem Solvers." *Proceedings of the National Academy of Science* 101(46): 16385-16389.

Hunt, Jennifer. 2010. "Why do Women Leave Science and Engineering?" *International Labor Review* 69(1): 199-226.

Hyde, Janet S., Sara Lindberg, Marcia C. Linn, Amy B. Ellis, and Caroline C. Williams. 2008. "Gender Similarities Characterize Math Performance." *Science* 321(5888): 494-495.

Lagesen, Vivian A. 2008. "A Cyberfeminist Utopia?: Perceptions of Gender and Computer Science among Malaysian Women Computer Science Students and Faculty." *Science Technology & Human Values* 33(1): 5-27.

McIlwee, Judith S. and Greg J. Robinson. 1992. *Women in Engineering: Gender, Power, and Workplace Culture.* Albany: State University of New York Press.

National Center for Education Statistics. Digest of Education Statistics. Retrieved March 15, 2015 at: https://nces.ed.gov/programs/digest/d15/tables/dt15_318.50.asp.

Pawley, Alice. 2008. "What Counts as "Engineering": Toward a Redefinition." Pp. 59-85 in *Engineering and Social Justice* edited by Caroline Baillie, Alice Pawley and Donna Riley. West Lafayette: Indiana: Purdue University Press.

Rosin, Hannah. 2012. *The End of Men: And the Rise of Women*. New York: Penguin Books.

Seymour, Elaine and Nancy M. Hewitt. 1997. *Talking About Leaving: Why Undergraduates Leave the Sciences*. Boulder, Colorado: Westview Press.

Shauman, Kimberlee A. 2006. "Occupational Sex Segregation and the Earnings Occupations: What Causes the Link among College-Educated Workers?" *Social Science Research* 35(3): 577-619.

Wingfield, Adia Harvey. 2007. "The Modern Mammy and the Angry Black Man: African American Professionals' Experiences with Gendered Racism in the Workplace." *Race, Gender and Class* 14(2): 196-212.

Xie, Yu and Kimberlee A. Shauman. 2003. *Women in Science: Career Processes and Outcomes*. Cambridge, Massachusetts: Harvard University Press.

Yoder, Brian L. 2016. "Engineering by the Numbers ": American Society for Engineering Education. Retrieved March 22, 2015 at: (https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf).

Chapter 2: Becoming Engineers: Exploring Women's Pathways Towards an Engineering Major

Introduction

Since 1982, women have been outpacing men in terms of college completion. Women now earn approximately 57 percent of all college degrees, but fields of study remain strongly segregated by gender. Yet in some fields, women still remain severely underrepresented. For example, in engineering women complete only 19 percent of undergraduate degrees (National Center for Education Statistics 2015). Much has been written about the chilly climate, unwelcoming occupational practices, and significant social barriers in engineering, which cause women to exit the field (Cech et al. 2011; Hunt 2010; Kemelgor et al. 2000; McIlwee and Robinson 1992; Sandler et al. 1982; Seymour and Hewitt 1997). Indeed, attrition rates in STEM majors and workplaces have been cause for alarm for policy makers, educators, and business leaders for decades, with the metaphor of a leaky pipeline introduced in the 1980s to describe the way in which many talented women leave science, technology, engineering and math (STEM) degrees and careers (Berryman 1983). A common area of research from scholars across disciplinary fields such as sociology, psychology, economics and education is why students, and in particular women and minorities, leave science and engineering for other professional fields. (Cech et al. 2011; Chen and Soldner 2013; Fouad and Singh 2011; Holland and Eisenhart 1992; McIlwee and Robinson 1992; Seymour and Hewitt 1997)

Recently however, amidst women's increased gains in education, social scientists have taken a renewed look at the issue of women's low participation rates in STEM fields. For example, in their book *Women in Science: Career Processes and Outcomes*, sociologists Xie and Shauman (2003) conduct a systematic examination of gender differences in science career trajectories throughout the life course to better understand how US youth are selected into and

out of such fields. One key conclusion from the study is that women's retention in STEM is now similar to that of men and has improved over time, but far fewer choose STEM majors and professions. In terms of engineering specifically, scholars have found similar results. According to one study by Lord and colleagues (2009), from entry to undergraduate graduation, women are as persistent as men in terms of completing an engineering baccalaureate. In light of this, a central argument these scholars make is that while it is important to recognize that there are serious gendered institutional barriers that pose obstacles to women's advancement in engineering, women's relatively slow movement into these fields requires close and renewed attention.

To be sure, researchers have sought to understand college major choice and the segregative gender patterns that characterize higher education. This topic too has fueled a vast body of research (Charles and Bradley 2009; Davies and Guppy 1997; Eccles 1994; England and Li 2006; Jacobs 1995; Jacobs 1996; Turner and Bowen 1999). Yet despite the significant breadth and depth of this literature, it suffers from some limitations that restrict the usefulness of its findings. One such limitation is that much of this research is performed using quantitative methods using large scale datasets and closed-ended surveys that do not allow us to understand the nuance behind how such decisions are made. Often these studies regress major choice on gender including independent variables such as academic achievement, attitudes and coursetaking. While such research is clearly very valuable in documenting trends regarding college major choice, it does very little to understand the process behind how such decisions are made. Furthermore, because women are not uniformly underrepresented in all STEM majors, it does not allow for us to further probe their differential representation across different STEM fields.

In this article, seeking to address these shortcomings I ask what we might learn by approaching the topic from a different angle. First, instead of focusing on why women leak from the pipeline and why women avoid engineering, the question I pose is why do some women pursue it as a college major? I ask how and why some women chose engineering, when so many do not. In order to gain insight on this topic in a novel way, I ground this study in the theoretical tradition of symbolic interactionism. Symbolic interactionists theorize human behavior as reflexive identity performances, rather than as automatic and unthinking responses to environmental stimuli. Such an approach supposes individuals are influenced by cultural contexts and cues that influence how they make meaning in their everyday lives (Blumer 1969; Goffman 1959; Mead 1934; Stryker 2008; West and Zimmerman 1987). Using qualitative in depth interviews with 35 women, I demonstrate how the choice of a college major in general is shaped by cultural understandings and institutions that encourage young people to express themselves as individuals. Within this framework, many women who are talented in math will likely never study engineering because they have only limited information about it as a career possibility. As I show, my respondents chose to study engineering because of the academic environment and pivotal experiences with teachers and families that enabled their entrance into the field. Finally, I demonstrate that the gendered expectations espoused in families that work to push women towards this field.

Previous Literature

A great deal of scholarship has focused on the topic of the stark gender segregation that characterizes college majors. Scholars studying this phenomena note that the segregation of women in men into different fields declined dramatically particularly after 1960, when women began to integrate many formerly male strongholds such as law, medicine and business. Yet after

1990, progress stalled, despite the fact that women's college completion rates surpassed those of men. As some scholars demonstrate, for college majors to become gender integrated, approximately one third of men, or all women, would need to change their majors to other fields (England and Li 2006) Women earn 85 percent of degrees in fields such as nursing, 80 percent in education, and 77 percent in psychology. However some fields are characterized by particularly low numbers of women such as engineering and physics where women earn only 19 percent of degrees (National Center for Education Statistics 2015). Scholars, Xie and Shauman (2003) who have looked specifically at women and science fields, find strong gender disparities exist among high school students in their intent to declare a STEM major. They determine that the probability of choosing a STEM degree is 60 percent less for females than for males. Previous research dedicated to analyzing the choice of a STEM majors indicates that some of the most significant factors affiliated with entering a STEM field are often a student's academic preparation and their attitudes to math and science.

Academic preparation has captured the attention of quantitative researchers for decades. One line of research and reasoning for example has been to assess disparities in coursetaking and achievement between women and men in high school and college predict the gap (Benbow and Stanley 1980; Fennema and Sherman 1977; Pinker 2005). The thinking goes, that if women underperform relative to men, either as a result of nature or nuture, then many will not go on to study STEM. However, such theories have largely been discounted by recent trends in educational attainment among girls. While there were significant gaps between boys and girls in the past, since the 1990s, they have narrowed and largely disappeared (Hyde et al. 2008; Xie and Shaumann 2003) To date, on average women now earn better grades in math than boys and earn similar scores to boys on standardized tests (Hyde et al. 2008). Even where gaps still exist (such

as in physics coursetaking), most researchers show that they are far too modest to explain the large gender gap in general in STEM major choice (Morgan et al. 2013; Xie and Shauman 2003).

Attitudes towards math and science also influence the choice of a major and many studies seeking to understand women's low representation in STEM majors as a consequences of negative attitudes and experiences towards math and science. Shelly Correll (2001, 2004) for example finds that women leak out of the STEM pipeline in high school as a result of harmful gender beliefs about math as masculine that influence their perceptions of their math competencies net of their actual ability as compared to men. Jacquelinne Eccles (1994; 2007; 2011a; 2011b) has also been particularly influential in understanding attitudes towards STEM and developed her expectancy value model to describe the process. It is still extremely influential in the literature today. Eccles maintains that women hold future plans of becoming mothers and helping others, which they view as conflicting with the demands and values of STEM careers. She also contends that over time women make decisions about careers based on their subjective evaluation of their performance and the feedback of important socializers. As she describes, women must expect and believe they can be successful in STEM subjects and they must be interested and see value in them as well. Often, however, they are conditioned to have less confidence in math and science as a result of parental and school influences.

Indeed, research has looked in the topic of parents and teacher influence seeking to understand how they influence young women's career paths with respect to STEM. Many of these take younger children as their focus. For example, studies have shown that teachers tend to overrate male students' math abilities and view women's more negatively (Fennema et al. 1990; Jussim and Eccles 1992 McKown and Weinstein 2002; Sadker and Sadker 1994). Furthermore, existing research shows that parents are active in gendering their children toward culturally

defined gender norms. For example, beginning with kindergarten aged children, Bleeker and Jacobs (2004) find that parents are more likely to purchase math and science toys for their sons than daughters, even when many of the girls they studied were significantly more interested in math and science than the boys. They further demonstrate that the toys and opportunities parents provide influence their children's later involvement in math and science. Yet in contrast, while not focused specifically on STEM, some research finds that that parents from varied background celebrate gender atypical interests for girls. Emily Kane (2006) finds that parents offer their daughters, but not their sons, both feminine and masculine themed toys with many approving of girls taking on tomboy-typed interests.

Recently some have made a somewhat different argument in light of women's improved performance in math by looking at women's interests in certain profession (Cheryan 2012; Diekman et al. 2010; Cheryan et al. 2015). As Sapna Cheryan argues (2012), women are underrepresented in certain majors STEM majors because of stereotypes affiliated with them that act as gatekeepers to screen women out. As she demonstrates, fields like computer science and engineering are affiliated with various forms of masculinity that make it unappealing to women who view it as incompatible with their sense of femininity. A key tenet of her argument is that if women could see the feminine qualities in engineering practice such as it's social relevance or were allowed to comfortably express a feminine persona, more women would chose it as a major.

Finally, research also details how cultural ideologies which encourage gendered self expression is central to how young people choose majors and leads to occupational gender segregation. A number of sociologists argue that in wealthy industrial countries women are encouraged to indulge in gendered conceptions of their sense of self and embrace majors that are

identity-based. Those that are viewed as feminine often tend often tend to be in fields such as English, education or even event planning, rather than masculine typed majors such as engineering or physics (Cech 2013; Charles and Bradley 2009; Hamilton 2013; Mullen 2014).

While informative, much of this research has significant limitations. First, much of this research is done using statistical methods or performed using experimental designs, which does not allow for a thorough understanding of the how the process of selecting certain STEM majors occurs. The research therefore identifies trends but cannot reveal the meaning behind those choices. The trends commonly identified demonstrate women's negative attitudes to math, their anxieties about math, the harmful transmission of gender stereotypes that are prevalent in schools, and the way that parents and teachers actively discourage women from STEM. While these studies are enormously important in bringing the critical attention to these issues they deserve, there is a tendency for a master narrative about women to emerge based on these findings. Because such studies do not allow us to understand the exceptions, we tend to lean towards somewhat one-sided images of women. Also, because they rely on quantitative methods that operationalize gender as being a man or woman, it often unintentionally, contributes to an overreliance on these types of ideas as fixed, rather than as gender as something performative and dynamic.

There is no doubt that notions of engineering as masculine are widely held. Cultural ideologies of men as more skilled at math than women are also dominant. However, sociologists have demonstrated variations in gendered attitudes and norms in recent decades. As Hillary Levey Friedman (2013) shows, parents from a variety of social classes often make choices to enroll their daughters in either competitive dance, or more masculine coded pursuits such as competitive soccer or competitive chess to ensure that they will have certain skills for their

professional futures. She finds that the latter two categories are used strategically by upper middle class families who want their daughters to cultivate skills that will make them successful in hegemonically masculine professional cultures and careers.

In terms of STEM specifically, others argue that there is contextual variety in school environments and among classrooms that can mitigate negative gender stereotypes about women's math abilities (Legewie and DiPrete 2014; Riegle-Crumb and Humphries 2012). Legewie and DiPrete (2014) show for example that gender beliefs across schools vary impacting the gender gap in declared STEM majors. As they demonstrate in schools with a strong STEM curricula, women are 25 percent more likely to study STEM.

Thus, while dominant cultural understandings and arrangements related to gender often deter women from engineering and reproduce gender inequality, there are possibilities for resistance and transformation. Symbolic interactionists argue that individuals are not simply units that respond to forces beyond their control, but are active and reflective agents shaped by interactions and different ways of thinking and reflecting on events (Mead 1934; Stryker 1980). As feminist sociologists further point out, we need to seek out examples of how gendered scripts can be "undone" or remade (Deutsch 2007; Risman 2004:). Accordingly, while this article recognizes the dominant gender ideologies that can and do deter women from engineering, it seeks to better understand why how and why some women resist them to study engineering.

Data and Methods

The data from this study come from thirty-five in-depth, semi-structured interviews with women who were studying engineering at a large public university in the southern United States, which is the flagship in this state. In order to develop a sample I utilized several techniques. I first began by interviewing one woman I knew through a personal contact. She then helped me to

develop further contacts through her friends and acquaintances and her involvement in the student group the Society for Women Engineers at this university. I conducted the first interview in 2012 and continued interviewing students until November of 2016. Throughout this time period in order to increase my sample and obtain a range of respondents in terms of major, social class and race, I also attended different engineering events such as those for women in engineering, Black students in engineering, peer mentors in engineering and in engineering classrooms to ask students to participate. I also sent emails out to student listserves and utilized snowball sampling. I interviewed 19 white women, 12 Black women, 2 Latina women, 1 bi-racial (black and white) woman and 1 Asian women. I also interviewed ten men (8 white and 2 black) studying engineering. While I do not include quotes from these men in this analysis, these interviews did provide context for the findings in this article. Additionally, I did not place any restrictions on these women to be in any particular year or phase of the program. However, I only interviewed one sophomore. The rest were juniors or seniors. I also did not track these women through the program. Studies demonstrate that attrition or switching to another major is highest in the first two years of engineering degrees and thus it is unlikely that many switched their major after their junior or senior year. I also had sporadic contact after the interviews with some of them, and all of these women were still in engineering or had recently successfully graduated. Because the purpose of the study is to understand the how the choice of an engineering major occurs, rather than track switchers versus non-switchers, I do not consider this to be a limitation. It may be that a woman switched out of engineering after the interview but whether or not one choses engineering or stays in engineering, while equally important, are in many ways separate issues. Finally, I also included one woman who had very recently graduated

and begun working because she expressed interest in being interviewed, as she considered her story to be noteworthy.

The interviews lasted between one and two hours and were conducted at coffee shops or other locations chosen by the respondents located primarily on this campus. I did not compensate the respondents but did offer to buy them anything they wished to eat or drink if we were in a coffee shop. In the interviews information was collected about respondents' demographic and family background information either through a short written survey or by simply asking them the questions located on the survey at the end of the interview. A particular focus of the interview was why these women had chosen engineering but I also included questions designed to probe about their experiences with the academic and social climate in engineering at this university. Students were asked to discuss in detail the story of why they had declared an engineering major and I asked about whether or not they had considered anything else, whether they had changed majors along the way, and how satisfied they were with their decision. I probed for them to describe how teachers, peers and parents played a role. I assigned pseudonyms to all my interviewees in order to preserve confidentiality.

In order to code, I utilized a constructivist grounded theoretical approach as detailed by Charmaz (2014). All transcripts were analyzed looking for commonalities and differences and I went through three stages of coding: line by line coding, focused coding and axial coding. Line by line coding is a step where the researcher is tasked with reading through the transcript and staying close to the data to create preliminary codes. In this step, I began to reveal broader themes (which on their own were largely unsurprising) such as the fact that the decision is often made in high school and that influential others such as teachers and parents are involved in a number of ways. Focused coding was a next step to used to more finely classify the categories

and connect findings between interviews. This step allowed me to start seeing more nuance and revealed what I consider deeper insights into the topic. For example this began to reveal *how* schools, teachers and parents are involved. What finally emerged in axial coding is that the larger context in which women live is one in which structures are in place let them explore career choices on their own as individuals. In this situation, many women who would be qualified will likely never consider engineering. The women in my study however benefited from an academic environment in high school that made engineering a possibility, while also being influenced by their parent's input and steered by their families' beliefs about gender.

Overview of Women's Pathways to Engineering

The majority of women I interviewed explained that that they had reached the decision at some point in high school (71 percent) Most also explained that they approached the major with an open attitude, meaning that if they determined along the way that it was not for them, they were prepared to find something else. As Nita stated,

> I came across computer science and I was like ok this is cool. Then the first year of college I actually liked it so I stayed.

Caroline, who was prepared to study environmental science explained,

> Like I said initially I just wanted to research and study coastal sciences and work on oceanography and do lab work and I came in here and had a ton of extra credit hours….so I was like, well why don't I just pick two majors. I'll pick something else I enjoy and give that a shot.

Her second major soon became biological engineering, which she then retained while dropping the one in environmental science. This article demonstrates that women talk about and conceive of their choice of major in a highly individualistic fashion. Often they are encouraged to achieve academically or finish school successfully, attend college and eventually find a job, but few are given very detailed information and direction about what that job might be and they are

considered the experts on what they want and should do in college. Within this larger cultural context, what ultimately pushed these women towards engineering was their various interactions in schools with teachers and STEM subjects. Additionally, as I will argue pivotal experiences of how gender operates in the family also facilitated women's entrance into engineering. My research strongly suggests that although women are able to choose from a range of options, and many qualified women could study engineering, many likely will not do so without similar interactions and interventions.

The Role of Schools

Consistent with quantitative research, these interviews revealed that the coursework that young women take in high school, as well as their attitudes towards math and science impact their choice of college major. Yet there was a great deal of complexity about why they chose engineering specifically and how schools influence the role of gender in educational outcomes. The majority of women I interviewed spoke of high school as a seminal time where they or someone else recognized their talent or aptitude in math and science. It is in middle school and then increasingly in high school where students have choices to take different classes, have a variety of teachers for different subjects, and begin more seriously begin to consider their strengths and interests.

In the accounts that these women shared, high schools, however, function under the assumption that students are well poised, independent, and informed about what they will study in college. In terms of the choice of college major, schools themselves offer very little specific guidance towards the choice. In fact, as I probed to understand how women actually decided on an engineering major, it became clear for almost all of the women I interviewed, regardless of social class and race, or whether they went to a public or private school, schools are primarily

focused more on shepherding students to graduation or getting them into certain colleges and finding scholarships, than on providing students information about what they might study.

Paula, a upper class black woman who had gone to a top performing public high school with a strong math and science focus illustrated this point well. She had done very well in math and really enjoyed her science classes, so when I asked her if she had ever talked to a counselor about what her options might be she told me,

> Well um we had counselors but in my senior year, we just went to them to get help guiding us to college but it wasn't really focusing on "Oh what do you want to do with your life?" You tell them what you want to do and they help you pick the colleges that they think you can get into with your grades.

Sara who told me she went to a large public high school explained,

> Once a year the counselors would come around and be like here is your schedule. And we were like ok cool. Um, I mean there was this one counselor who actually did end up getting me a scholarship that she applied me for and that was nice. But the counselors at my school tried to focus more on the kids that had potential but didn't know where to go and what to do and didn't have the money to pay for ACTs. I feel like they gave those kids a lot of attention.

Gabby, an upper class white woman who went to a reputable private school stated,

> We had career days and you could go and talk to who you wanted to from certain professions. We did have counselors but I never talked to them about it.

Few students I interviewed had ever talked with counselors about specific college major choices or professions. A few had taken career-planning classes, but of those who had, most were disappointed by these efforts as they found the information provided quite vague. Only one had had the opportunity to job shadow a doctor and a forensic scientist, which led her to decide that she did not want to do either of these jobs and that computer science might be a better option. This meant that the majority of women were expected to research careers, determine which one they believed would fit with who they were, and select a college major that aligned with these self-conceptions as individuals, rather than engaging in any type of formal career

counseling. In effect, the structures of American high schools insulate students from important information about careers and professions. Respondents describe contemplating what they might study in college by reflecting upon classes they enjoyed at school, which was often a process of evaluating different subject areas within STEM. Math and science are broad subjects required for a number of degrees and can lead to many possible career fields. Biology and engineering can both technically be considered STEM, yet as statistics demonstrate on average women earn 50 percent of degrees in biology but only 19 percent in engineering (National Science Foundation 2017). As scholars also note, universities have expanded academic programming dramatically with more choices than ever and they promote the idea that students must find their passion and do what they love. Even if math and science fits that bill, there are a number of majors affiliated with STEM proficiencies from which students may chose. For example at the university where this study was conducted there are 13 math and science majors and 11 engineering majors. Furthermore, these majors also have concentrations, allowing for further specialization and increasing the possibilities for what one can study. So while clearly the decision to enter engineering is linked to one's achievement and exposure to math and science in high school, I was curious to know how respondents settled on this particular field. Why did some chose engineering rather than say, chemistry or pre-medicine? I also was interested in why they had not chosen other professional paths in the liberal arts.

Three women in my sample (who were studying biological and chemical engineering) were planning on pursuing health professions upon graduation (two had plans for medical school, while one said she was applying for physician assistant's school) but most had rejected the idea of a health profession in high school. A number indicated that a health care field seemed like an obvious choice at first. Some explained that they had grown up on TV shows that

featured doctors (Grey's Anatomy and House were some mentioned). Yet, when asked there were several reasons for ruling health professions out. As Jennifer put it,

> Well, I thought about being a doctor and I thought about pharmacy too but well the doctor thing just makes me queasy. I couldn't do it and pharmacy well I thought about that but you are behind the same counter everyday. Also, engineering appealed to me more than those fields because in 4 or 5 years you are done and you are working.

Crystal described how math was her strongest subject,

> Ok, in high school I was like I am going to be a doctor, I am going to be a lawyer. All those things that you want to be in high school. But once I got into junior and senior year I realized I really was not that good at biology so being a doctor was out. I was also not that good at English. I mean I could argue with my parents you know, but I couldn't stand up in front of a crowd and do that so being a lawyer was out. But I loved science and I loved math. I mean math was really my strongest subject. So I had to find something with math.

A number also discussed how they narrowed their choice around certain STEM subjects and often for very subtle reasons. When I asked Samantha about this she told me, that she loved chemistry, but not biology and this had motivated her to study chemical engineering. As she said,

> In biology you have to memorize a lot of stuff. You don't understand why it is, it just is. At least with chemistry you have a why, you have a concept, you have a when and you have a how. All those Ws are answered, with biology you don't and I feel like biology is just, it's just lazy. It does all the work and you have to remember it.

When I asked another woman who was majoring in chemical engineering if she had ever considered studying chemistry, she implied that a chemistry degree would not be rigorous enough.

> No, I never considered just plain chemistry. It was too plain for me. Same with biology. I never would have come for a sole biology degree. I considered biochemistry but I guess it was the math that really leaned me to engineering.

To contextualize these quotes a bit, in the United States, girls now take as many math classes as boys in school (with the exception of physics) and studies demonstrate that on average

they earn similar grades in their coursework. At the same time, existing research often shows that cultural ideals early in the life course often deem men to be men as more skilled in math, which leads them to avoid STEM fields in general. Yet in my sample, regardless of race, the majority claimed that they had felt comfortable and supported in math, as well as science, classes in high school. What was important for them, was how to translate their passion for these subjects and find a major or career. For the overwhelming majority regardless of race, teachers also appreciated their work, commitment and intelligence. In fact, it was often shocking for some of these women to enter engineering in college to then be confronted by assumptions about their suitability for engineering because they were women (and this was particularly true for black women). Sapna Cheryan (2012) has argued that as women's academic achievement has surpassed boys in school, doing well in math in school has shifted from being deemed masculine to feminine. Others have argued that gender stereotypes about math achievement may be different in advanced classroom environments and schools with strong STEM coursework and programs, which mediate their effects on women (Legewie and DiPrete 2014). I certainly found evidence of this among my respondents. While many recognized cultural biases about men's superior performance in math, and many noted that engineering was seen as masculine, they talked of being shielded from this in their high school classrooms and often by their families. As they explained, they sat in classes with boys and girls, performed well and were encouraged by their parents. Feminist sociologists demonstrate that gender norms are shifting, allowing for more possibilities for women to embrace what are often culturally understood as masculine pursuits (Deutsch 2007; Kane 2006; Friedman 2013; Risman 2004). Unlike masculinity for men, there are multiple ways to expressive femininity for women that are encouraged in schools and families. (Kane 2006; Legewie and DiPrete 2014; Friedman 2013). As Sara told me,

> So I went into LSU with petroleum engineering as my declared major. I was looking for something challenging. It's kind of weird I guess but a lot of people expected me to do something hard. I was also the valedictorian of my high school and so there was no way I would do something like business or marketing or something social science. I was supposed to do something great!

Interestingly, Brown was not only the valedictorian but the co-captain of the cheerleading team and on homecoming court. She also took woodworking as an elective. As the only girl, she built a Victorian dollhouse that was three feet tall, while her male peers crafted baseball bats and canoe paddles. Here she described being able to embrace aspects of culturally defined traditional femininity and masculinity successfully in school. The key for these women, however, is that they had to discover engineering as a possible path among many competing subjects in school in order to pursue it.

Teachers

When talking about experiences in schools, women discussed the ways teachers influenced their decision-making. Some research finds that teachers steer women away from math and science (Sadker and Sadker 1994) but again, in asking the question of why women choose engineering, I was curious about whether teachers could also create specific environments for women to select an engineering major. In recounting their choice of a major, 18 (50 percent) women spoke about teachers as contributing to their choice of major. In going through their accounts, three different narratives emerged regarding how this happens. Teachers play a role by acting as inspirers, recognizers or seed planters. The majority of women spoke of teachers in the interviews describing them as inspirers. The inspirers were teachers that women looked up to and the ones they saw as passionate about their subjects. Women also found that they communicated the subject matter well and motivated students. Additionally, some women found that inspirers were harsh or demanding, pushing them to the limits to achieve excellence.

As a result many embraced science and math subjects, which then lead them to engineering. For example, Paula said,

> So in high school I took this class called environmental science and I really loved it. My teacher was this woman and she was just so quirky. She was in a rock band and did all this stuff and had all these cats. She was hilarious and just a sweet lady. I just really loved her and her class because we talked about the issues that are going on with the environment and the earth and it just really bothered me and so I thought about pursuing environmental science, but I felt like they were just doing more research instead of actually changing the problems so I just did more research and was like engineering, they are actually changing things by making things better, they have a huge impact on the world around them so I felt like I should do that.

Beyond writing a recommendation letter for her to go to college, however, Paula never discussed any of her potential career plans with this teacher.

Others discussed teachers as recognizing their talents, which was something that also influenced college major choice. As one biological engineering major Melissa told me,

> I had a few really good teachers. I mean my biology teacher in freshman year definitely inspired me. She wanted me to go the biology route. When I went in (to high school) I had no idea what I wanted to be. I had no I idea what I wanted to do in college or what career I wanted to have. So she saw potential in me and like she saw my ability to do biology and really get fascinated by it. She let me start volunteering at a wildlife center with her. So she was really probably one of the most influential teachers I had because she believed that I could do something.

Recognition however can occur when teachers push students in different ways that act as a catalyst for women to reconsider their aptitudes. As respondents explained, their views about their abilities in math could shift even in high school. As one other respondent recalled,

> When I started senior year I didn't like math, I didn't like chemistry, I didn't like physics and I never really studied for it because I had no interest, but um there was this assignment in class. A teacher had told us to answer this one question and there was this girl who always got good grades. Every time in everything, and she couldn't answer the question and I was like ok, let me try to answer this question. So I tried to answer the question and I was the only one who knew it and she didn't know it. After that I started to think-I have to get ahead, if she didn't know that question and I did then I have potential. So that was good and it really involved that teacher and her.

A third effect that teachers had on students was to plant the seed for an engineering major. For this to be the case a teacher had to specifically advise women to consider engineering as a career. Jan was one respondent who had benefited from all the three types of teacher effects, but her teachers had also planted the seed which was important for her actual choice.

> My senior year of high school, I had a calculus teacher who was all about math and engineering. She was always encouraging us in terms of suggesting engineering and asking us about whether we had considered this or that profession. She was the first teacher who asked us to write our resumes. If you were applying to a college, she said, "what would you put, what would you want to be?" She was the first person who really pushed us to think that way and that was the class I had with my best friend where we both had her and we were all like, we are going to be engineers because we were so inspired by her. She was a tough teacher, but she was an excellent teacher.

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What is striking again however upon close inspection of their accounts is the fact that while half of my sample women saw teachers as influencing their choice, only six were ever given any specific information about how they might link their talents and enjoyment of STEM subjects to potential majors, such as engineering. As Madeline told me, she had a wonderful science teacher in high school who was an inspirer and a recognizer. In her words,

> She encouraged me to follow my dreams and go to college but she did not say 'hey, go look at this program.

Madeline initially chose a degree in biochemistry after looking through the course catalogue and selecting it because it would allow her to take "fun" classes. Unfortunately, it provided dim employment prospects in her case. After working at a retail store for two years after graduation, she came back to college and completed a chemical engineering degree and at the time of the interview had just begun a career at a large petrochemical plant. When teachers told respondents they should consider studying engineering, all were open and amenable to the idea. For my respondents, once the seed had been planted, this set them on the path to becoming engineers.

Why do teachers not provide more information about engineering or careers in STEM to students who they recognized as talented and who they inspired? Some research finds that the American teachers are not very well informed about what engineers do (Cunningham and Knight 2004; Cunningham et al. 2005). Again, engineering is just one field among many STEM professions young women can chose from. Engineering is also not a common course offering in schools as is chemistry or calculus. Furthermore, many have argued in recent years that the professional responsibilities of teaching have intensified, adding increased tasks to their workloads. Both of these factors may prohibit them from engaging in planting the seed for an engineering career. Perhaps because career decision-making is considered to be a deeply personal decision best made by individuals, teachers do not view this as their role. Finally, existing research demonstrate that academic fields themselves carry gendered connotations (Blosser 2017; Mullen 2014; Thomas 1990). Because engineering is strongly gender typed as masculine with virtually no television shows or media personalities that provide role models, it may be that teachers do not see this as appropriate for women, or that it simply does not occur for this reason for teachers to suggest it to women. It may also never occur to women to pursue it for similar reasons, if no one suggests it. In reflecting upon this, I refer to this as gender inertia. If external forces such as teachers, schools, and parents do not intervene in ways that place engineering on young women's radar screen, many will likely continue on in an existing gendered state. This means many women will follow traditional gendered career pathways considered appropriately feminine (for example studying math to become a math teacher instead of engineering, studying chemistry instead of chemical engineering, planning on a medical field instead of engineering, or pursuing something in the liberal arts instead of STEM in general).

Parents' Professions

Parents' professions are important in the choice of an engineering major. The women interviewed were disproportionally the children of engineers or parents who were employed in STEM fields. Within my sample, ten of the respondents had a father who was an engineer, three had a mother who was an engineer, and two had both. Another two said they had aunts who were engineers and one mentioned a cousin. At least six others said they had parents who were working in some type of professional or vocational STEM field. Yet for the majority of women, regardless of their parents' occupation, the choice of what to study in college was still often left to them to make themselves. A central assumption of American parents is that children are considered best equipped to decide and will naturally discover what they are best suited to. However, having an engineer as a family member meant that women had resources to draw upon when they began pondering a college major. It meant that they could observe their parents' or family members' jobs, as well as their satisfaction with heir work to get some ideas. Because ideas about women and work have also shifted dramatically, most families were happy if their daughters decided upon engineering. Yet in their descriptions, their knowledge about engineering was still very abstract and often uninformed. In almost every interview, women said they knew very little about what those parents actually did. In terms of parents' occupations I found pronounced divides among parental professions with respect to race. One black woman had a father that was an engineer but her case was somewhat different than most in my sample. She was from an upper class family in Nigeria and her parents had also given her three choices of a major: law, medicine or engineering and sent her abroad to complete this degree. Of the black women from the United States only one had an aunt who was an engineer and she explicitly told me her aunt was special in a sense because she was one of the first black women

to graduate with a chemical engineering degree from this university. Otherwise none had a mother or father who was an engineer. Though the sample is small it is important to point out the potential significance of this finding for black women who may have very little information about engineering through their family networks. Historically engineering as a profession provided pathways for working class men to reach the middle class but this has not been the case for African American men. As historian Amy Slaton (2010) has found, aspects of curricular admissions and criteria in engineering have historically worked against proportionate black involvement in engineering programs. She points out that this has kept the number of African Americans in the profession very low particularly as compared to other occupations.

Gender in Families

Different environments at home can expand gender roles to encompass engineering as a college major. A common theme across respondents was the way that gender operated in the family primed them to consider engineering. While some played with toys which are often considered to be for boys at home, some also worked on science projects with their parents, or tinkered with their fathers and brothers. Many mentioned that their families took steps to foster an in interest in science and math oriented classes and activities, which often continued until they graduated from high school.

As Elisa told me,

> You know I was not consciously interested in engineering in high school but when I think back, one of the science school projects I did when I was in middle school was to see which kind of windmill, I guess thin or whatever you want to call it, works better and um me and my dad we built it and we tested it. I always think back to that. I mean I liked it but at that time I did not think oh, I should do something like this as a career.

She went on to say,

> I mean I was going to study theater. I did drama camp and took all these theater classes but then my senior year I just didn't really see myself doing that somehow and I was also

> good at all my classes. I mean I was in AP calculus my senior year and it just never occurred to me that I should be focusing on what I was actually really good at. That never crossed my mind until my dad was like, you know, you should look into engineering.

Her story is illuminating because it demonstrates the importance of keeping doors and opportunities open. The attainment of an engineering degree is one that requires students to be prepared through coursework. Engineering programs tend to have prerequisites of advanced math classes. If Elisa had chosen to take fewer math classes because drama was her passion or eliminated opportunities to engage in STEM activities, she may have unwittingly limited her chances of entering engineering.

Daughters in families where mothers and fathers were divorced also sometimes talked about being given more freedom to explore with their fathers. As Jewel said,

> My dad would rebuild computers for the family. We rebuilt my grandma's computer. I remember I had shown interest in that versus dolls. I enjoyed rebuilding hardware…. So also my parents are divorced and I always hung out with my dad because my mom was in Kentucky and I went there on major holidays and summers and winters. I think with my dad too has always at least tried to spark that interest. I mean to me it seems like it was so important that he said like "hey this is an option, like don't rule it out." I really think if my dad had said to me you can only play with Barbies or you can only do this and this, I do not know if I even would have considered engineering.

Jewel said in college as she had considered different specializations within her major such as oil and gas, she was hesitant, but her dad had continued his advice to her to keep an open mind and try things. There were those, however who said their parents never exposed them to any building toy or science projects, but some had enabled an interest in engineering through activities. For example, four Black women I interviewed had parents who had enrolled them in engineering summer camps. Another attended a high school with a specific engineering focus to gain exposure to the profession. All of them said that it was pivotal in their choice and solidified their decision to study engineering. Yet in the interviews there was often an important second factor that related to families that led these women to engineering beyond toys or the activities

they did at home that related to both social class and gendered logics espoused in families. In the interviews, respondents were concerned with finding a major that combined their interests with the ability to find a secure job, largely as a result of their parents' views and social class positions. Because they all liked math, and had discovered engineering, the field aligned well with these aspirations.

When describing their plans for the future, there were variations by social class, which impacted the ways in which women viewed job security. For women from upper middle class where both families were educated professionals, most described their parents as supportive of liberal feminist ideas (though none described their parents as feminists) that promote the notion that women should be develop a personally satisfying professional career and have equal opportunities and rights to men. Their parents wanted their daughters to have opportunities in school and consider entering male dominated fields of work if they wanted to. These women were concerned about the development of a professional career, and while issues of money were important they were less central to their accounts. As Angela said,

> You know I work hard here because I appreciate my education. I mean my parents paid for my high school (at a private school) and I think it was well worth it. My grandparents are paying for my college education and that is such a great gift and I am not going to throw it away. I want to make them proud. I want to make them feel like their investment is paying off and I can do this. I also have a lot of family role models. All the women in my family are powerful professional women. My mom is an attorney and I mean my aunts are engineers were doing this stuff when it was way harder. One has a PhD in electrical engineering. I mean they were the ones paving the way back then. So if they can do it so can I.

Carol who was from an upper middle class family stated,

> My mom told me if your going to pick a major pick something you are going to be interested in, don't pick something like mechanical engineering just because you make a lot of money or business just because you think the job market is steady right now. So in high school I did Advanced Placement art. I got a 5 on the AP art exam. I was so into that and I that is what I wanted to do but I was also deterred from this for several reasons also because of my mom. I mentioned that she is an electrical engineer. She is also a very

> good artist. But her father told her through school he told her look, you are very good at art and she really wanted to do art but he was like look you can't make money doing that and so even though she came out saying oh she would like to go back and do art if she could do it all over, she still said she wouldn't because she had more enjoyment out of doing it as a hobby rather than as a job where you have stress because you don't know what your next step is in terms of finances. So her saying that also helped me maybe figure it out a little bit. Like maybe I don't want to go into that kind of field and that definitely had an influence on my decision.

There were also those from middle class families lower on the hierarchy, such as Sara whose parents both had college degrees but had limited resources because they had ten children. Her account was more strongly influenced by the need for economic mobility. As she told me,

> Yeah and I mean just growing up I just never got to do what I wanted and I just want to be able to do what I want with my money. You know they say that money doesn't solve problems but it kind of does. You know, you can pay electricity and bills and everything with money and that does solve problems.

Women from working class families were also focused on the practicality of the degree and the independence if could offer them. They often mentioned that it was very appealing because it did not require graduate training (which many said was too expensive and lengthy) in order to get a well paying job. Furthermore, they saw enormous opportunities for advancement and varied jobs in a generally tight job market. As Salina whose mother was a cosmetologist and dad was a barber said,

> I thought it would be a good major to be able to provide for a family and to be independent. So when I found out about it, it seemed really good because my mom always told me you don't want to have to depend on a man. You have to be able to make it yourself. When I heard about engineering, and the job outlook, I definitely thought about that.

Karrie who had a two year old son to provide for said this,

> My mom mostly wants me to make a lot of money, which probably sounds bad but at this point they (my family) are all putting forth effort to get me to graduate because my mom gave everything up to take care of us. So she is like whatever you need we are going to do this so you can do more than I did. She is pretty much pushing me on that. Like the first thing she wanted to know when I told her I can do computer science, she was like

> what can you do with that and I was like there are so many options. I can do this, this and this.

Sometimes working class women also compared how they understood the purpose of coming to college, as compared to other women they knew.

> My mentality is that I can party for four years and then spend the rest of my life working as hard as I can and then struggle to pay bills and have maybe the bare minimum. Or I can spend 4-5 years working my butt off and then get this degree, get a great job, and coast and enjoy life. I just think though that in our society women are told to express their personality and do certain stuff and because of that the mentality has been that they don't have to pursue a career, like I'll just go do hair or whatever."

The majority explained that their parents would be supportive of them choosing another major or switching to something else they enjoyed if they "had a plan" for getting a job after graduating. Nevertheless, women were careful to weigh the practicality of any college major degree according to their parents' expectations as well as their own. At times some women described how their parents even subtlety intervened to push back against certain choices they saw as less pragmatic. As Rebecca explained,

> I actually considered doing piano and going to college for piano but my dad said he wouldn't pay for college if I did that. Actually, I think he said he wouldn't pay for me to go away to college and at the time we were living in Marion and I would have gone to Mid State University and I did not want to do that at all, so I decided on chemical engineering and came here."

Mary told me this,

> My mom is a math teacher, and she is really into STEM because she knows that is the future. I mean if we (this respondent and her sister) were to tell her we were going another route she would start to tell us you are not going to have a job. Life is going to be really hard for you. You are going to have to depend on a man and you don't want to do that. My mom would always preach to me and my sister about that…She always talked with us starting in elementary school like saying some majors are not worth going to college for. She said, I am not paying for you to go college if you major in this and this because it's not worth it, you might as well go to a trade school. She does not believe in coming to college for like history or nothing, she was like if you switch to something like that, you might as well drop out.

Finally, Alecia who was considering biology said this,

> My dad is an engineer and he talked me into it and it took him a while. He just kept telling me it would open up so many doors for me. Like he said if I just got a biology degree or a chemistry degree I could be stuck somewhere, but if I got a biological engineering degree I could get a job right out of school, but if I didn't like it, I could always do something else.

As these statements point out, at times parents had their ways of nudging their daughters toward engineering. These women described how their parents rejected ideas about traditional femininity that assumed they would go to college to find a mate who would support them or pursue a so-called "easy" major, rather than get a degree to achieve economic security. If engineering helped them achieve this, most expressed enthusiasm for engineering and claimed their parents were fully behind their choice of this degree.

Conclusion

The interviews analyzed here with thirty-five women studying engineering from diverse backgrounds, illuminate how and why they chose to study engineering. As the interviews demonstrate, of those women who enjoy math and science and are confident in their abilities, many are unaware of the numerous possibilities they may have in college. Structures such as schools often treat college major choice as an individual decision left to students to make on their own and this is limiting how women decide. One implicit assumption that operates in schools and among parents is that young people will somehow "naturally" find a career that fits them. As Jennifer who decided on her major in high school put it,

> You know, it turns out I was actually lucky. I made a blind choice for engineering but I made the right choice!

In fact, it was somewhat surprising throughout the study that a decision of what to study in college, which can have a profound influence on one's future, is often made with so little information.

Within this framework, teachers and the ways in which they interact with young women can play a seminal role in disrupting segregation patterns among college majors. Students choose majors based on their experiences with subjects they take in school and the teachers they have for those classes. In fact, women who are inspired by their teachers in math and science classes, often then search for careers that they might find that relate to the subject. Perhaps if they had more information on those options, the numbers entering fields like engineering would increase. When teachers recognized women for their talents in science, many often begin to take seriously different possibilities for majors in STEM in college. When teachers actually talk to women about engineering specifically, they plant a seed that can set women on a path towards this major. As my findings demonstrate, if the goal of policy makers, educators and others is to encourage more women to study engineering, then schools and teachers are an important resource that is often neglected. For those interested in changing occupational segregation patterns among majors, then more science and math programming that is taught in a way that is exciting and interesting to young women in schools coupled with specific career counseling and training for educators about professions is necessary. Many of these women also went to schools where they interfaced with teachers who inspired them and several (though not all) had access to advanced math and science course offerings. For those who are not as fortunate to attend such schools, engineering may remain an elusive future career. Furthermore, while these women found supportive teachers, this may not always be the case. In this respect, it is critical that teachers receive more information and training about the ways in which cognitive biases operate around women's math achievement and the ways in which these biases can be racialized. Because high school is a formative time for women to consider engineering, teachers wield enormous influence in this respect.

Families also serve as an important institution that can push women towards engineering and expand conceptions of gender for young women. Having a parent who is an engineer provides exposure to young women even if it is a father. However, this means that only a slim number of women benefit from this exposure. Indeed, this finding points to the fact that many talented women likely lack the guidance and information at home to make informed career plans about fields like engineering because they do not know any engineers. Engineering is widely considered masculine, even if only implicitly, and this can act as a gatekeeper to screen women out (Cheryan 2015). Counterexamples have been shown to be important in combating such ideas (Banaji and Greenwald 2013). Crime Scene Investigation (CSI) and National Crime Investigative Service (NCIS), which are television shows that have female leads as forensic scientists, for example, are credited with helping to increase the number of women in forensic science (Houk 2009). Women I interviewed also grew up watching television series about female doctors who inspired them and often led them to at least consider medicine. Yet there are very few television shows or films that portray engineers, much less female engineers. For women from underrepresented groups, it may be particularly important to expose them to practicing engineers and what they do, if they do not have parents or relatives in engineering due to a legacy of institutional racism in the profession.

How ideas about gender operate home is important as well, and parents shape what occupations their daughters choose. Popular media and outreach campaigns communicate the need for pink Legos or special building toys for girls in early childhood to encourage women to engineering. Yet the women in this study often played with the same toys their brothers did or were offered a range of toys and activities that were gender typed as “boy” and “girl” toys by their parents. Furthermore, as one said, her father’s attitude was simply about not ruling things

out and keeping options open. His daughter was a cheerleader in high school but also rebuilt computers with him and later would study chemical engineering. Some of the respondents never played with building toys at all, but their parents continually exposed their daughters to a broad range of options such as engineering summer camps and STEM schools. Most said their parents promoted the idea that women were good at math, countering common stereotypes of boys as more gifted in these areas. Some talked about how their parents emphasized the importance of taking advanced classes, including math throughout high school, even if their daughters had other feminine typed interests. Indeed, there were women who decided in their senior year of high school to chose engineering, which means that keeping the path open, through both continuing to take math and science coursework and activities is important.

Finally, one issue often neglected in the research literature is that a family's view on the purpose of going to college matters in terms of what women chose. I had many respondents who were high school cheerleaders, ballet dancers, drama stars, artists and piano players. A number of them laughed telling me they might have pursued one of these paths but the need to be self-sufficient and find a stable job (often impressed upon them at home) intervened. Because they also enjoyed math, they never fully closed the door on the possibility of a major that would allow this, such as engineering.

In sum, this research expands the literature on the topic of college major choice and women's underrepresentation in engineering by demonstrating the importance of taking into account how interactions and institutions shape the choice of an engineering major. In doing this it emphasizes that attitudes about engineering as a major are shaped by embodied experiences and the ways that individuals make sense of them that occur throughout the life course. There is of course no magic bullet, but small micro-interactions, here and there can make a difference

Finally, my hope is that this research also challenges dominant narratives that become prescriptive and too often generalize all women as less confident in their math abilities or generally somehow less inherently interested in engineering. As I saw, there are women who love math and are diverse in their interests and experiences, which are fluid and strongly influenced by important people and institutions throughout their lives. When their talents were recognized and they had information about engineering they responded positively to studying and pursuing engineering. Furthermore, these women did not fit into one typology or description but many were interested in engineering for various reasons. While all of the women I interviewed loved math and science, some were also interested in helping professions. Others talked more narrowly about problem solving and the fun of thermodynamics. Some like clothes and fashion, while others could not care less about their hair or makeup. Most of them embrace some elements of traditional femininity while also gleefully defying it. All of my respondents had families who supported them in doing this. Finally, the majority of them are willing to overlook engineering's masculine identified image in terms of choosing it, if they know about it and it enables financial security and potentially economic mobility.

References

Banaji, Mahzarin R. and Anthony G. Greenwald. 2013. *Blindspot: Hidden Biases of Good People*. New York: Delacorte Press.

Benbow, Camilla P. and Julian C. Stanley. 1980. "Sex Differences in Mathematical Ability: Fact or Artifact?" *Science* 210(12): 1262-1264.

Berryman, Sue E. 1983. *Who Will Do Science? Minority and Female Attainment of Science and Mathematics Degrees: Trends and Causes*. New York: The Rockefeller Foundation.

Bleeker Martha M. and Janis E. Jacobs. 2004. "Girls and Boys' Developing Interests in Math and Science: Do Parents' Matter?" *New Directions for Child and Adolescent Development.*106: 5-21.

Blosser, Emily. 2017. “Gender Segregation Across Engineering Majors. How Engineering Professors Understand Women’s Underrepresentation in Undergraduate Engineering.” *Engineering Studies.*9(1): 24-44.

Blumer, Herbert. 1969. *Symbolic Interactionism*. Englewood Cliffs, New Jersey: Prentice-Hall.

Cech, Erin, Brian Rubineau, Susan Silbey, and Caroll Seron. 2011. "Professional Role Confidence and Gendered Persistence in Engineering.” *American Sociological Review* 76(5): 641-666.

Cech, Erin. 2013. "The Self Expressive Edge of Occupational Sex Segregation." *American Journal of Sociology* 119(3): 747-789.

Charles, Maria and Karen Bradley. 2009. "Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries." *American Journal of Sociology* 114(4): 924-976.

Charmaz, Kathy. 2014. *Constructing Grounded Theory. Second Edition.* London: Sage.

Chen, Xianglei and Matthew Soldner. 2013. "Stem Attrition: College Students' Paths Into and Out of STEM Fields. Statistical Analysis Report." National Center for Education Statistics.

Cheryan Sapna. 2012. Understanding the Paradox in Math-Related Fields: Why Do Some Gender Gaps Remain While Others Do Not? *Sex Roles* 66(3-4): 184-190.

Cheryan, Sapna, Victoria C. Plaut, Caitlin Handron, and Lauren Hudson, 2013. The Stereotypical Computer Scientist: Gendered Media Representations as a Barrier to inclusion for Women. *Sex Roles* 69(1-2): 58-71.

Cheryan Sapna, Allison Master, and Andrew N. Meltzoff. 2015. “Cultural Stereotypes as Gatekeepers: Increasing Interest in Computer Science and Engineering: Diversifying Stereotypes.” *Frontiers in Psychology* 6: 1-8.

Correll, Shelley J. 2001. "Gender and the Career Choice Process: The Role of Biased Self-Assessments." *American Journal of Sociology* 6: 1691-1730.

Correll, Shelley J. 2004. "Constraints into Preferences: Gender, Status, and Emerging Career Aspirations." *American Journal of Sociology* 69: 93-113.

Cunningham, Christine and Meredith Knight. 2004. “Draw an Engineer Test: Development of a Tool Investigate Students’ Ideas about Engineers and Engineering. *Proceedings of the 2004 American Society for Engineering Education Annual Conference and Exposition*. Salt Lake City, Utah, June 20–23. Washington, D.C.: ASEE.

Cunningham, Christina, C. Lachapelle, and A. Lindgren-Streicher. 2005. Assessing Elementary School Students Conceptions of Engineering and Technology. Proceedings of the 2005 American Society for Engineering Education Annual Conference.

Davies, Scott and Neil Guppy. 1997. Fields of Study, College Selectivity, and Student Inequalities in Higher Education. *Social Forces* 75: 1415-1436.

Deutsch, Francine M. 2007. "Undoing Gender." *Gender & Society* 21(1): 106-127.

Diekman, Amanda B., Elizabeth R. Brown, Amanda M. Johnston, and Emily K. Clark. 2010. "Seeking Congruity between Goals and Roles: A New Look at Why Women Opt out of Science, Technology, Engineering and Mathematics Careers." *Psychological Science* 21(8): 1051-1057.

Eccles, Jacquelynne. 1994. "Understanding Women's Educational and Occupational Choices: Applying the Eccles Et Al. Model of Achievement-Related Choices." *Psychology of Women Quarterly* 18: 585-609.

Eccles, Jacquelynne S. 2007. "Where Are All the Women? Gender Differences in Participation in Physical Sciences and Engineering." in *Why Aren't More Women in Science? Top Researchers Debate the Evidence*, edited by S. J. Ceci and W. M. Williams. Washington D.C.: American Psychological Association.

Eccles, Jacquelynne S. 2011a. "Understanding Women's Achievement Choices." *Psychology of Women Quarterly* (35): 510-516.

Eccles, Jacquelynne S. 2011b. "Gendered Educational and Occupational Choices: Applying the Eccles Et Al. Model of Achievement-Related Choices." *International Journal of Behavioral Development* 35: 195-201.

England, Paula. 2010. "The Gender Revolution: Uneven and Stalled." *Gender & Society* 24(2): 149-166.

England, Paula and Su Li. 2006. "Desegregation Stalled: The Changing Composition of College Majors, 1971-2002." *Gender & Society* 20(5): 657-677.

Fennema, Elizabeth and Julia Sherman. 1977. "Sex-Related Differences in Mathematics Achievement, Spatial Visualization and Affective Factors." *American Educational Research Journal* 14: 51-72.

Fennema, Elizabeth, Penelope L. Peterson, Thomas P. Carpenter, and Cheryl A. Lubinski. 1990. Teachers' Attributions and Beliefs about Girls, Boys, and Mathematics. *Educational Studies* 21: 55-69.

Fouad, Nadya A. and Romila Singh 2011. Stemming the Tide: Why Women Leave Engineering. Retrieved May 30th, 2017 at: (https://energy.gov/sites/prod/files/NSF_Stemming%20the%20Tide%20Why%20Women%20Leave%20Engineering.pdf).

Friedman Levey Hillary. August 6th, 2013. "Soccer Isn't for Girly-Girls? How Parents Pick the Sports Their Daughters Play?" in *The Atlantic*.

Goffman, Erving. 1959. *The Presentation of Self in Everyday Life*. Garden City, NY: Anchor Doubleday.

Hamilton, Laura. 2014. "The Revised Mrs: Gender Complementarity at College." *Gender & Society* 28(2): 236-264.

Holland, Dorothy C. and Margaret A. Eisenhart. 1992. *Educated in Romance: Women, Achievement and College Culture*. Chicago: University of Chicago Press.

Houk M. 2009. Is Forensic Science a Gateway for Women In Science. *Forensic Science Policy & Management: An International Journal* 1(1): 65-69.

Hunt, Jennifer. 2010. "Why do Women Leave Science and Engineering?," *International Labor Review* 69(1): 199-226.

Hyde, Janet S., Sara Lindberg, Marcia C. Linn, Amy B. Ellis, and Caroline C. Williams. 2008. "Gender Similarities Characterize Math Performance." *Science* 321: 494-495.

Jacobs, Jerry. 1995. "Gender and Academic Specialties: Trends Among Recipients of College Degrees in the 1980s." *Sociology of Education* 68: 81-98.

Jacobs, Jerry. 1996. "Gender Inequality and Higher Education."*Annual Review of Sociology* 22: 153-185.

Jussim, Lee, and Jacquelynne S. Eccles. 1992. Teacher expectations II: Construction and Reflection of Student Achievement. *Journal of Personality and Social Psychology* 63: 947-947.

Kane, Emily. 2006. " 'No Way My Boys Are Going to Be Like That!' Parents Responses to Children's Gender Nonconformity." *Gender & Society* 20(2): 149-176.

Kemelgor, Carol, Brian Uzzi, and Henry Etzkowitz. 2000. *Athena Unbound: The Advancement of Women in Science and Technology*. Cambridge, United Kingdom: Cambridge University Press.

Legewie Joscha and Thomas DiPrete. 2014. "The High School Environment and the Gender Gap in Science and Engineering." *Sociology of Education* 87(4): 259-280.

Lord, Susan M., Michelle Madsen Camacho, Richard A. Layton, Russell A. Long, Matthew W. Ohland, and Mara H. Wasburn. 2009. "Who's Persisting in Engineering? A Comparative Analysis of Female and Male Asian, Black, Hispanic, Native American, and White Students." *Journal of Women and Minorities in Science and Engineering* 15: 167-190.

McIlwee, Judith S. and Greg J. Robinson. 1992. *Women in Engineering: Gender, Power, and Workplace Culture.* Albany: State University of New York Press.

McKown, Clark and Rhona S. Weinstein. 2002. "Modeling the Role of Child Ethnicity and Gender in Children's Differential Response to Teacher Expectations." *Journal of Applied Social Psychology* 32: 159-184.

Mead, George H. 1934. *Mind, Self, and Society.* Chicago: University of Chicago Press.

Morgan, Stephen L., Dafna Gelbgiser, and Kim A. Weeden. 2013. "Feeding the Pipeline: Gender, Occupational Plans and College Major Selection." *Social Science Research* 42(4): 989-1005.

Mullen, Ann. 2013. "Gender, Social Background, and the Choice of College Major in a Liberal Arts Context." *Gender & Society* 28(2): 289-312.

National Center for Education Statistics. Digest of Education Statistics. Retrieved March 15, 2015 at: https://nces.ed.gov/programs/digest/d15/tables/dt15_318.50.asp.

National Science Foundation. Women, Minorities, and Persons with Disabilities in Science and Engineering. Retrieved May 5, 2017 at: https://www.nsf.gov/statistics/2017/nsf17310/digest/about-this-report/.

Pinker, Stephen. 2005. "The Science of Difference: Sex Ed." *The New Republic*, February 14th.

Riegle-Crumb, Catherine and Melissa Humphries. 2012. Exploring bias in math teachers' perceptions of students' ability by gender and race/ethnicity. *Gender & Society,* 26(2): 290-322.

Risman, Barbara J. 2004. "Gender as a Social Structure: Theory Wrestling with Activism." *Gender & Society* 18(4): 429-50.

Sadker, Myra and David M. Sadker. 1994. *Failing at Fairness: How America's Schools Cheat Girls*. New York: Scribner.

Sandler, Bernice Resnick, Lisa A. Silverberg, and Roberta M. Hall. 1996. *The Chilly Classroom Climate: A Guide to Improve the Education of Women*. Washington, DC: The National Association for Women in Education.

Seymour, Elaine and Nancy M. Hewitt. 1997. *Talking About Leaving: Why Undergraduates Leave the Sciences*. Boulder, Colorado: Westview Press.

Slaton, Amy. 2010. *Race, Rigor, and Selectivity in U.S. Engineering*. Boston, Massachusetts: Harvard University Press.

Stryker, Sheldon. 2008. "From Mead to a Structural Symbolic Interactionism and Beyond." *Annual Review of Sociology* 34(1): 15-31.

Thomas, Kim. 1990. *Gender and Subject in Higher Education*. Bristol, PA: Open University Press.

Turner, Sarah W. and William G. Bowen. 1999. Choice of major: The Changing (Unchanging) Gender Gap. *Industrial and Labor Relations Review* 52: 289-313.

West, Candace and Don Zimmerman. 1987. "Doing Gender."*Gender & Society* 1(2): 124-151.

Xie, Yu and Kimberlee A. Shauman. 2003. *Women in Science: Career Processes and Outcomes*. Cambridge, Massachusetts: Harvard University Press.

Chapter 3: How Black Women Experience Undergraduate Engineering on a White Campus

Introduction

Sociologists who study women's experiences in engineering have long noted that women contend with gendered institutional structures, cultures and practices, which pose obstacles to their success (Cech et al. 2011; Dryburgh 1999; McIlwee and Robinson 1992). Despite having made inroads into other male dominated majors and fields, to date women remain severely underrepresented in engineering. Women now earn approximately 57 percent of baccalaureate degrees, but comprise only 20 percent of students who complete an undergraduate degree in engineering (Snyder et al., 2016).

Yet, much of the research on the topic of women in engineering implicitly assumes a racial and ethnic homogenization of women in engineering education and workplaces, which obscures important differences among women. For example, even the statistics offered above, do not reveal the fact that Black women in engineering comprise only 1 percent of those who earn degrees (Yoder 2016). Indeed, in most of the scholarly research that focuses on gender and engineering, white women are taken as a default category in understanding women's experiences. Little consideration is given to the implications of the intersection of race and gender on women in engineering education.

Seeking to address this gap in the literature, this article reports on interviews with twelve Black women in undergraduate engineering at one university in the southern United States. In it, I examine how both race and gender come together to shape their experiences as engineering students. A key focus of this study is to pay careful attention to how their narratives compare to those of white women in engineering.

Background

In their seminal study on women in engineering, sociologists McIlwee and Robinson (1992) examined a group of young women and men who became engineers in the 1970s and 1980s at two universities in California. Their study, which makes no mention of race, utilized both surveys and interviews and focused on the experiences of women both in college, as well as the professional careers they pursued thereafter. These scholars discover that women must come to terms with being in the minority in a competitive and grueling major in which their ability to succeed is often questioned. In their study, they document how some found modest success in college, as many entered with a strong foundation in math and worked hard, which was valued by professors and peers. However, after graduation, women faced particularly difficult obstacles. These authors describe the prevalence of a culture of engineering, which required fascination with technology, an expertise in tinkering, and aggressive displays of confidence, even though such competencies were often rarely necessary for much of the work required. According to McIlwee and Robinson, as the result of gender role socialization and gender stereotypes, women have more difficulty performing such norms of interaction and doing so in a convincing manner. A pivotal finding from their study is that women's membership in engineering is often precarious as a result of their gender, rather than their abilities. They face more challenges in proving their competence than what is required of men.

McIlwee and Robinson's initial insights have been further researched and examined to better understand how women fare in engineering education, as well as various workplaces and sectors. For example, sociologist Heather Dryburgh (1999) (whose study also makes no mention of race) has studied women's experiences at one college of engineering in Canada. Using Erving Goffman's (1959) concept of impression management she attempts to understand how women

adapt to the engineering culture in their academic studies. Goffman, a seminal figure in sociology, theorized that human behavior is analogous to a dramaturgical performance and developed the concept of impression management. In his work*, The Presentation of Self in Everyday Life*, he describes impression management as the use of a wide range of behaviors and actions aimed at eliciting a desired response from another individual. Dryburgh argues that women must often undergo a difficult transition period to becoming engineers once they enter the university. However, through impression management, female students attempt to build solidarity with their mostly male colleagues by earning extraordinary grades and projecting self-confidence in order to assuage any doubts about their abilities. Furthermore, she finds that women often come to deny or even downplay subtle sexism they begin to encounter in their training in order to be accepted. In sum, Dryburgh shows how women become professionally socialized into engineering by aligning themselves with masculine norms and behaviors.

In another stream of research, some studies have examined Black students' experiences (with few making mention of gender) at primarily white institutions (Beasley 2011; Feagin and Sykes 1995) with some focusing specifically on those that pursue STEM degrees (Fries-Britt et al. 2010; Harper 2010; Maton et al. 2012; Strayhorn 2012; Strayhorn et al. 2013). One line of inquiry in such research is to investigate successful programs that assist Black students with strong secondary backgrounds in adapting to and succeeding in STEM fields through student orientation programs, summer bridge programs, research opportunities, mentoring programs, and living-learning communities (Maton et al. 2012; Strayhorn 2012). Others document high performing Black students' experiences, describing how they report experiencing racial antagonism from fellow students and professors (Beasley 2011; Fries-Britt et al. 2010; Harper 2010). Western culture has historically tended to promote and celebrate monolithic images of

white men as those who hold the superior intellect needed to become scientists and engineers (Eglash 2002; LaFollette 1988) and these images work to depict black students as outsiders as a result. When Black students enter fields such as STEM, many describe a loss of confidence that ensues as a result. They also face enormous burdens and pressures to continually prove themselves to peers and faculty as a result of these widely held beliefs about their fit, roles, and competency in STEM (Beasley 2011; Fries-Britt et al 2010).

Recently there have been a handful of studies on the experiences of minority women in STEM, many of which also attempt to emphasize how they persevere and succeed in STEM (Carlone and Johnson 2007; Hanson 2009; Johnson 2011; Ong 2005). Carlone and Johnson (2007), for example have performed longitudinal ethnographic research on this topic drawing on a sample of Latinas (4), Black women (4), American Indian women (3), and Asian American (4) women in a variety of STEM majors. They show how recognition from others is one of the most important elements of cultivating a scientific identity and that faculty can often work to either promote or derail minority students. Ong (2005) similarly has tracked a group of minority women through their physics education African American (1); Latinas (4); Chicanas (3); Filipina Americans (2) calling particular attention to the many strategies they rely upon in order to persevere despite the barriers they encounter. She describes in great detail the process by which light skinned women of color "fragment" their identities often attempting to pass as white in an effort to blend in and eschew discrimination.

Though these studies have yielded useful insights, they are not without their limitations. For example, it is rare to find a sample that does not place different racial and ethnic groups of women together. While this is often sometimes necessary to create a sample, these decisions can obscure important differences.

Another limitation in this research is that it assumes that all STEM fields are more similar than different. Yet engineering education scholars argue that engineering should be considered distinct, as it varies dramatically in its epistemologies, its practices, and the manner in which it trains its students. As existing research demonstrates, engineering is considered to be rooted in science and mathematics like many STEM fields, but it places an emphasis on its practicality and its technical core (Downey and Lucena 1997; Pawley 2009) As Pawley (2009) argues, engineering educators demarcate engineering from other STEM fields, by claiming that engineers solve "real" problems and "make things" such as artifacts found in the human environment.

Engineering students are also educated with the goal of producing a disciplined, knowledgeable and powerful person in terms of engineering problem solving. Downey and Lucena (1997) describe the educational landscape in engineering in the following way:

> Knowledgeable students have gained control over technology in a way that is unavailable to other persons, whether human or corporate. Through the logical and precise actions of identifying and solving problems in mathematical terms, each student has, by definition, succeeded in extending the realm of human control to include technology, transforming technology into a tool for human use. The stereotypic engineer is this and nothing else (p. 134).

As such studies demonstrate, engineering as a discipline places a high value on presenting oneself as a confident self-assured, can-do individual.

Furthermore, as opposed to other STEM fields, engineering does not require further graduate training for professional opportunities. Grade point averages are often of extreme importance to students who need them to compete for internships and future jobs (Downey and Lucena 1997). Students in engineering are aware of pressures to keep their grades up to be competitive for employment opportunities.

As this review of the literature points out, a closer examination is needed that considers intersecting identities such as gender and race, while also considering engineering separately from other STEM fields. In this article, seeking to address this gap, I examine the implications of race-gender intersections of twelve Black women in engineering to contribute to contemporary discussions about how they experience the engineering educational climate. As I will argue, black women experience unique challenges beyond that of white women and for most their adaptation strategy is more about survival rather than acceptance.

Data and Methods

This study is qualitative and is based on 12 in depth interviews conducted between 2014 and 2016 with women who self identified as Black at a primarily white public research university located in the southern United States. All women were sophomores, juniors and seniors currently studying various engineering majors. At this college, in 2016, women made up 19 percent of those earning degrees, while black women made up 1 percent of those who completed engineering degrees.

The purpose of this study was to discover first and foremost the pathways that these women had taken into engineering and why they had selected the majors they had, but it was also an opportunity to offer a critical investigation of how they experienced the atmosphere of engineering education and how they were navigating their way through the major. This paper is based on the second topical area.

All the interviewees identified as Black women, but three were of African descent. Two of these women had moved to the United States between the ages of 2 and 5, and attended public schools, and described themselves as both African and American. Another had begun an engineering degree at age 16, coming directly from Nigeria to this university and identified as

African. These women ranged in age from 19 to 23 years old. There are a total of eleven different engineering majors at this university and respondents came from different areas. In this study, two respondents were studying chemical engineering, one industrial engineering, one electrical engineering, one petroleum engineering, three mechanical engineering, one biological engineering and three were in computer science (which at this university is located in the college of engineering). These interviews were conducted as a part of a larger research study with engineering faculty (23 interviews) and students (45), which included nineteen white females, two Latinas, one Asian female, one bi-racial female (Black and white). I also interviewed eight white males and two black men. I do not include quotes from participants who are not Black women in this study, but the information influenced my analysis and challenged me to think about differences and similarities.

I obtained my sample of Black women for this study through several strategies. It began with the help of my husband who is a mechanical engineering professor at this university. He introduced me to an undergraduate Black female student who worked in his lab and she agreed to be interviewed. She then helped me recruit three additional participants. I utilized snowball sampling (Esterberg 2002) as well, asking respondents if they knew of anyone I could interview which allowed me to recruit four additional respondents. I was also in contacted with the Dean of Diversity in engineering, who sent an email out to an email list of women of color stating that I was conducting a study and that women should reach out to me if they wished to participate, offering my email. I received the remaining respondents from this email. All interviews were strictly confidential and I rely on pseudonyms to conceal the identities of my respondents.

The interviews were semi-structured and based on questions that probed the reasons these women had chosen engineering as a major, asking them to describe the pathways they had taken

to get to this point. They also focused on how race and gender shaped their experiences as engineering students. I audio or video recorded all of the interviews and transcribed them verbatim.

In order to code the interviews I relied on a constructivist grounded theoretical approach as outlined by Charmaz (2014). Charmaz describes this process as constituting of multiple coding steps. The first is one in which the researcher begins to organize data by characterizing it through short descriptions about what is happening by summarizing the point the interviewee was making. The next step consisted on focused coding, in which an interpretation is made about the common themes and patterns found across respondents. The final step is known as axial coding, which requires the researcher to theorize about the relationship between these categories. The results of this final step are included in the findings below where I argue that Black women face additional burdens to adapting to engineering cultures beyond that of white women of similar abilities. Furthermore, they adapt somewhat different coping strategies. When white women face challenges, they attempt to gain solidarity with male students and bond with other women in fields where there is a critical mass. Black women who are successful face a more isolating climate that requires them to be more resourceful in terms of individualistic coping mechanisms.

I think it is important to note that there were limitations and barriers in this research that likely influenced the results. I am white and this made it difficult for me to recruit respondents, who I believe were skeptical of whether they would want to meet with me to discuss issues surrounding their experiences in engineering as Black women. I sensed that in the interviews some women felt comfortable talking about their experiences, but I also sensed a real discomfort in others when I asked questions about how their race impacted their experiences. Popular

comedian and journalist Trevor Noah recently interviewed former President Barack Obama shedding light in an interesting way on this issue. In the interview he asked the President how he dealt with speaking honestly about race and being black, when interacting with white people (who were obviously the majority of his colleagues in American politics, as well as his constituents). His question was meant to find out how the President spoke his mind and shared his views frankly about the fact that Black Americans are disadvantaged because of a legacy of racism in the United States, while at the same time not alienating white people who may not be able to understand such disadvantage. In Noah's view, this is a difficult topic to straddle, because

> If you are a white person speaking about race, you are just a person who is interested in race, but if you are a person of color speaking about race and racial injustices, people start to respond with the idea of 'oh, the black person thing started again. [1]

In a similar way, some of my respondents seemed careful about how much and what they should say without "that black person thing" starting, in which I might view them as complaining about problems that should be issues of the past in purported "post-racial" America. What if I discounted what they told me? What if I simply dismissed them as black women complaining about imagined problems? Few knew my husband, and many were in different majors, but for some this may have colored their ideas about whether or not I was trustworthy. If my racial status was shared with these women, I believe I could have obtained more interviews and that respondents would have talked more freely and comfortably.

These issues were of great concern to me. In all of my interviews, I briefly explained that in my view, that there was a history of pervasive and ongoing racism in our country that still very much impacts our educational and public institutions. I also explained that I thought it was

[1]This interview aired on The Daily Show on December 12, 2016.

important for more open discussions on race in the higher education and particularly in engineering, where such issues are not usually addressed because these disciplines are seen as technical and objective, and thus bias-free. Furthermore, I told all respondents, I was doing the research because Black women were an under-researched group that deserved more attention, and I planned to use the information for my dissertation and academic publications in an effort to draw awareness to their experiences. I also emphasized that all information was confidential.

This study is qualitative and its purpose is not to generalize these experiences to all Black women in engineering. Qualitative research does not have this as its overarching goal. Instead, the strength in a study like this is that it helps us to theorize and make visible how intersecting identities can cause some Black women to feel marginalized in engineering educational settings. Unlike survey research, the value in these interviews is that they allow for careful consideration of particulars of their stories rather than on a variable center approach, which regresses performance, graduation rates, or satisfaction with the educational climate on race and gender and other independent variables. As race scholars, Feagin and Sykes (1995) suggest,

> Most assessments of the state of African American students in predominantly white (and historically Black) colleges and universities (HBCUs) have relied heavily on numbers, such as enrollment rates, grade point averages, and graduation rates. Yet a deeper examination of the experiences of Black students in these places requires something more than numbers gathered in school records and surveys or in classroom testing. We need to listen closely to what Black American students tell us about what happens to them and how they feel, act and think (p. 91).

Guided by this insight and taking seriously the need to expand such research to engineering education and other male dominated majors and professions, this study relies on a small sample that allows for rich data to illuminate how influential identity markers intertwine, so we can begin to consider how these identities shape their experiences in engineering education.

Findings

Throughout the interviews many respondents spoke enthusiastically about engineering as college major. All of the respondents perceived of themselves as being "math and/or science people," and this influenced their selection of engineering. Most also spoke with pride about the fact that they had been admitted to this university, as it held prestige in this state as the flagship. It is generally regarded in the region as producing high quality engineering graduates. For a number of them, it was also well resourced in comparison to other in state universities, particularly compared to other Historic Black Colleges and Universities, that many had considered. In these interviews, however, the women spoke of challenges they faced as Black women in engineering. Much like in previous studies of women in engineering, I find that Black women are also making adjustments to the engineering culture but in ways that are gendered and racialized. In contrast to white women, their strategy is not to gain the respect of others per se, but to survive and to graduate.

Coming to Terms With Being The Only One

One issue that was prominent in the interviews was the discomfort that these students felt at being the only black woman in their classes or at student meetings and events. Feelings of isolation among women have long been an issue in the literature on the topic of women in engineering. Yet my respondents expressed this in ways that were much more acute than those of that I heard from white women. Indeed many talked about it in ways that induced feelings of discomfort, anxiety and sensitivity, which white women did not appear to share to the same degree, if at all. One way in which this is apparent has to do with the varying demographics among the majors in engineering. Engineering is made up of different disciplines, majors and workplaces that exhibit somewhat different norms and cultures. Furthermore, as women have

made gains in the workplace and higher education, some engineering majors have seen dramatic increases in the relative numbers of women in them. For example, biological, chemical, environmental and industrial engineering have garnered a critical mass of women. However women are severely underrepresented in fields such as mechanical, electrical, petroleum and computer science. Critical mass is an important concept introduced initially to understand women's presence in male dominated organizations and professions and it is still influential today. It posits that once a threshold level of women is reached, a dynamic process begins in which their situation in that field improves often involving increased access to resources and social networks (Some put the numbers needed for this at 15 percent of the total; Etkowitz et al. 1994). One argument affiliated with critical mass is that it allows for differences between women to blend into the background so they might unite and find common ground (Kanter 1977). In terms of undergraduate women in science and math fields, some studies have found a "strength in numbers" effect (Lagesen 2004), whereby when more women enter a field, it undergoes a shift from being deemed masculine to more gender diverse. When this happens women report feeling more comfortable in their chosen majors and feel more at ease overall (Lagesen 2004; Margolis and Fischer 2002).

Yet in talking about their experiences, simply having more women in their programs did little to cultivate a sense of belonging among my respondents. As Jeannette in chemical engineering explained,

> When I go into my classes and I just don't see anyone that I can immediately identify with because sometimes I literally am the only one. It's so difficult. I don't think that people realize how much that matters and how having greater representation makes you feel more connected to the class, and then you like learning. When you can connect you start to feel like, well I guess we are all in this together. I mean it should not be awkward for me to talk to something who is sitting next to me, but here it is. That is the one thing about this program, they need to mix it up here… it just helps the environment.

Haley was a biological engineering senior, and despite the fact that women make up 50 percent of the students, she also felt very much alone.

> You know everybody is pretty friendly in biological engineering, they are all cool. For the most part the faculty is nice, but still I would have to say that what I do not like about engineering, is that a lot of the times I am the only black female in my class. It never really bothered me but this semester, I just kind of started to notice it more. Sometimes, I just look around and I am like oh man. But it doesn't stop me. It's just a big wake up call. I mean some people get so uncomfortable with it but I am like oh well, oh well-what can I do?

For Haley this led her to question her place in engineering. Yet she, like others, did not talk about proving herself to others through exceptional grades or self-confidence, as studies of white women have found. Instead, she placed more emphasis on persisting in engineering by convincing herself that she belonged. She told me she had gotten through being the only one, by telling herself repeatedly no one was going to take her tests for her so why should it matter what anyone thought. Is she passed a class, she could check that box and move on.

As both of these quotes point out, when we consider women as a homogenous group, as critical mass theory often does, we often miss out on other important markers of identity such as race that have tangible impacts on women's experiences. In both of these majors, a sizeable number of women have enrolled and are completing these degrees. However as Haley points out, "greater representation" does not just mean women, but requires diversity efforts to go beyond this identity.

Respondents also talked about majors where women were represented in smaller numbers. As Paula Russell in mechanical engineering explained,

> Right now, I am literally the only black person, well let's see, actually the only black woman in my all of my classes this semester and I was last semester too. I don't really talk to the white women. There are usually 5-7 black guys. So I guess they have each other. I mean they can form their own group and it just seems easier for black guys to connect with other people. I just feel like it's easier for them to mesh with everybody. So

> this means for me, there is really a huge disconnect between me and my classmates. I don't know how to describe it but I just don't like being looked like, like I am a different person. The problem is that I just hate feeling like an other, you know?

The issue being a token that Paula describes, in and of itself, is not surprising given the research on women's experiences in engineering. McIlwee and Robinson (1992) talk of how women in engineering are often regarded as Os in a world of Xs.[2] The Os are often socially isolated and are highly visible and become tokens that are seen as representatives of the group. Yet, in thinking about the analogy of Xs and Os, Black women describe themselves as foreign and thus completely outside the realm of letters. They are distinct from the Xs (the white men) and also not really related to the Os (the white women). Paula's statement in which she uses the word 'other' is an example of how these women describe their distance from their fellow students. In my interviews with white women in mechanical engineering (ten women), they too spoke of being in the minority, but a number talked about how there was a small group of female students that they connected with in order to adapt to the male dominated climate. For Black women, they spoke of how a racialized and gendered identity marginalized them in more distinct way in the classroom and the degree overall. Paula had many black friends on campus but few were in an engineering discipline. Her friendship groups were among other Black women in campus spread across different majors.

The issue of being the only one was discussed by the majority of my respondents, regardless of major. When I probed respondents to describe how this felt or how they experienced it, a common response is that it was difficult to fully explain. Kahlila, said it was like "shell shock" and could only describe it in this way,

[2] This is a reference to Kanter's analogy of Xs and Os in her book *Men and Women of the Corporation* 1977.

> Its like you really don't-you really cannot fully fit in no matter where you go. Like, you know, I have white friends, I have a lot of white friends. But, it's like I am sort of left out of stuff, but they don't see that. They don't understand some of the stuff of that I understand. And where we are from is very different.

Paula, for example, also discussed this when we talked about her involvement in the National Society for Black Engineers (NSBE). She found the meetings in which practicing engineers came to speak to the group about their jobs to be a motivational source, because it allowed you to meet Black people working in the field. Yet she emphasized to me how one meeting had stuck with her particularly because a Black female engineer who had completed a degree in mechanical engineering from this university came to speak to the group. She described it as seminal moment, saying that it was "very comforting," In her words,

> I just felt so much better seeing her. I thought, wow, she graduated in this program, I guess I can do it too.

This quotes point to the tendency in law and public policy, scholarship, and historical narratives to connect race with African American males, and gender with white females (Collins 2000, Crenshaw 1991, Davis 1981; hooks 1992). They resemble bell hook's (1992) observation that,

> No other group in America has so had their identity socialized out of existence as have black women. We are rarely recognized as a group separate and distinct from black men, or a present part of the larger group 'women' in this culture (p. 7).

Discussions persist in engineering about how to craft policies and offer solutions designed that are targeted towards women or minority students, rarely considering the ways these identities are interactive. The National Society of Black Engineers recently launched it's 1 of 10,000 campaign aimed at increasing the number of black engineers from 3620 to 10,000 in 2015, with no mention of gender. At the same time discussions continue which emphasizes the importance of increasing women's overall representation and diversifying teams and group work, as a way of creating a sense of belonging, rarely ever mentioning race (Blickenstaff 2005;

Dasgupta et al. 2015). Interestingly, existing research demonstrates that young black women often express a keen interest in studying STEM fields as compared to white women (Hanson 2009; O'Brien 2014). Recruitment efforts could capitalize on this by making efforts to increase the number not just women or Black students, but Black women in engineering. As these quotes suggest, increasing the relative numbers of Black women plays a role in making the environment more welcoming.

Unwanted Visibility

At the same time that women discussed the discomfort of being the only black women among their peers, they also discussed a heightened sense of awareness of their presence. They described this attention in ways that were both gendered and racialized. Patricia was one of these students. She was a tall, well-spoken, Black woman who wore a natural hairstyle and was studying mechanical engineering. When I asked here about her experiences in the programs she said,

> When you are the only Black woman in your class, one of the things that happens is that people notice you and they come up to you and they know you. Like when I am sitting down somewhere, people always say 'oh you are in my thermo class' but I have no idea who they are and well… it is just weird.

When I probed to ask if she could put into words why this was weird, she explained that the unwanted attention aroused a sense of angst. To be noticed everywhere made her uneasy. In her case, she had struggled with her coursework and also did not want to draw attention to herself and her performance. When I asked if she thought it might be the same for Black men, she said she said she was unsure, but she suspected being a Black woman, made her much more conspicuous. For Patricia, who was getting closer to graduation and talking more about the need to network, which many engineering students generally agree is an important skill in a competitive job market, this made her think twice about attending student events. She told me

about an American Society of Mechanical Engineering (ASME) meeting she wanted to attend. There would be students and some possibly employers and she thought it might be an excellent opportunity to meet some professional contacts. Yet as she explained it was being held at a mostly white bar and her appearance would also be striking, so she might be nervous and out of place while socializing. When I asked her, how she usually handled this, she said, if she wanted to go, she would have to find another Black woman engineering, even in a different major, and take her along.

Paula, who was a shy but friendly, tall, attractive young women with wide set eyes and long wavy hair also talked about how she attracted a lot of attention in mechanical engineering. As she told me,

> It's always so obvious that I am the only black woman around and I mean the guys don't ever say anything like 'hey you are the only black woman,' but you notice how obvious it is. I get random comments like, 'Oh, you change your hair so much' and sometimes they try to touch me. I have to be like, " Ok, stop touching me, just stop! I mean it's not that I have to blend in completely but I wish I just was not sticking out so much!

Such experiences reflect what some scholars describe as gendered racism, or racism that is experienced differentially by men and women and often influenced by historically racial stereotypes, beliefs and images (Collins 2000; St. Jean and Feagin 1998; Wingfield 2007). In this case, her quote suggests that she must contend with one of the dominant images of black women, which pervade American culture and lead to their increased sexualization. Collins describes the Jezebel as originating under slavery when Black slave women were labeled as sexually aggressive, as a means of justifying the widespread sexual assaults perpetuated on them by white men. To many students in engineering, dominant images of Black women, such as the Jezebel, are likely not consciously familiar and may seem innocuous. Yet, as scholars argue, the influence

of such lingering cultural ideas is not trivial and lead to subtle but uncomfortable interactions similar to what this young women describes (Collins 2000; Feagin 1991; Wingfield 2007).

In thinking about how these women might deal with being highly visible, it is helpful to think of Goffman's (1963) work on stigma. According to Goffman, an individual that possess a stigmatized identity, must adapt to a world filled with "normals" (or going back to the analogy of Xs and Os, the identity of an X). In this case, a stigmatized individual can deal with their isolation by either passing or covering tactics. If the signs of stigma are not visible, passing is when individuals try and hide this identity to appear as one of the "normals" or "Xs." As Ong (2005) found in her study of minority women in physics, ambiguously raced women attempt to pass by performing whiteness through their speech, or if possible, by not openly disclosing what their race or ethnicity is as a way of fitting into. Covering is when individuals try and displace the stigma by making it seem less important or attempting to downplay it. Much research demonstrates that female engineers become quite skilled social actors in this sense. For example, Miller (2004) has found that engineers working in the oil industry take great care in how they dress in order to be accepted. Her respondents talked of not carrying purses in the field to not look weak, or bringing heals and loafers to work so that one can alternate them appropriately for when one is in the office and the field. Women in masculine fields also may try to attempt to mask their bodies and their femaleness if they wish to attempt to minimize their gender identity as a way to fit in. In Traweek's (1988) study of physicists at the Stanford Linear Accelerator Laboratory, she observed only one female physicist ever wearing a skirt, and she noticed this on one single occasion. In my interviews with white women, some were aware of ways in which they could perform masculinity through their appearance to gain acceptance. One white woman told me that though she often wanted to she chose not wear dresses to class so as not to draw

attention. Another said the advice of older women in the field was helpful in determining what to wear so she could be taken seriously in her internship. However, for Black women, clothing or changes in speech cannot hide that the fact that they were highly recognizable, often because of their hair or skin color.

There were, however, some who mentioned that standing out because you were Black woman could confer advantages. Computer science junior Tricia had attended an all women's annual computer science conference (The Grace Hopper Celebration of Women in Computing) and been stopped by a recruiter who offered her a job. She explained to me that,

> Sometimes being a person of color you think, I won't get a job or an internship, but I try to turn that into a motivational thing if I can. You cannot let that boundary defeat you. I went to that conference I was telling you about for women in computer science and I was just walking and some lady noticed me and came up to me and said can you give me your resume and that's how I got my internship in New York.

Bias and Negative Stereotypes

Racial stereotypes often assume that blacks are less intelligent and hardworking (Feagin 2006) and Black students at primarily white institutions report difficulties as the result. As Fries-Britt et al. found in their study of Black students in physics, physics is considered the domain of white men and one that most assume requires extreme intelligence, which poses additional obstacles in which they have a higher burden of proving their suitability. Many in my study also spoke about it in a way that indicated they were affected by a unique combination of both sexism and racism, which made it difficult to know the separate contributions of the two.

Adeola a young Nigerian woman from Africa explained this in a way that was quite illuminating. Our interview was distinct from others because parents from upper class families in Nigeria. They had chosen her major and had offered three options of study for her: law,

medicine or engineering. They had sent her to a private primary school and had high expectations that she do well and study in either the United States or Great Britain.

Her father was a mechanical engineering and that even in her senior year she did not really like math or physics. However at some point she on an assignment for a class, she had put a great deal of effort into it and outperformed another woman who was known as the top achiever in math. At this point, engineering seemed like a viable goal. At the age of 16, she moved to United States and began her degree at this university. In our interview she expressed her confidence in her abilities in both math and engineering subjects, telling me the basic intro classes had been a repeat from high school and that she had understand and performed well in some of the difficult engineering gatekeeper classes. However, she had become aware of the way in which understandings of race is shaped by cultural norms. She told me she had "become" black in the United States and offered a poignant example,

> Back in Nigeria, I don't have to worry about what people think of me but here I have to worry about first impressions. You know, like how will this person see me or this person see me. Or what vision does this person have of me without talking to me, because if someone sees me I am simply black and there are a lot of preconceived notions.

When I asked what those preconceived notions were she said,

> She's black and in engineering…well I guess she's not smart and probably has a 2.0 GPA…and I've noticed that when you do say something smart, then people are just really surprised. You can see it on their faces. It's really disheartening, because I didn't really know that much about African Americans living here before, but coming here, I feel like I am one of them. I guess I have become one of them because I've been forcefully lumped in to that category with them. So now I feel like I go through their struggles even though I am not American. That weighs down on you a lot of the time.

For Adeola, she was unaware that such stereotypes even existed. She came from an upper class and highly educated family in Nigeria and she told me that being a black woman in engineering

was nothing out of the ordinary in her home country. It was a rude and painful awakening to have this identity hoisted upon her in the United States.

Charlene, an African woman who had moved to the United States at age two from Ghana and was studying petroleum engineering talked some about this as well. Referencing the competitive climate for jobs she explained that as she looked to the future,

> We all want to be graduating with our engineering degrees with um securing a job but sometimes you have in the back of your mind, maybe they are going to pick her because she is white and I am just black and they see her as more of an investment and you as more of a burden. So you have those little digs in your head and you go back and you question that a lot but at the same time, if you do have the qualifications and you can sell yourself it shouldn't be any problem, I guess.

Haley described a similar thought process, explaining how in an outreach camp she decided to do engineering because of the need for female engineers. As she described,

> When I went to the camp they did say there was going to be a high demand for female engineers and I mean it is still going on now so I think that is something that kind of pushed me towards this (engineering), and then I am a black female engineer so it's kind of like and you would think that would help you (pause) but sometimes I think it doesn't and I say that because of internships. I don't really know a lot of black females in engineering but it seems like there are not that many who have gotten internships as compared to everyone else. That is just something I have noticed.

It was unsurprising why these women had doubts based on our interviews. For example, Charlene described her interactions with fellow students and even professors. She told me of an incident with a professor in which he called her into her office,

> I had this professor and he made me come to him and was like I just want to tell you you that in the real world when your going to go to work you are not going to be respected because of your sex and your ethnicity. So he gave me the rundown and I was in shock because I never thought that, I mean I believed in equilibrium and kum-ba-yah. That's in the perfect world maybe, but unfortunately this is not utopia. I was in awe! I just didn't think of that. My ignorance level was at an all time high because I didn't know that people thought of it like that.

In classes she felt similar insecurities. As she told me,

> When you are in your classes you are a minority. So, as a woman, you are also a minority. As a black woman, you are an ultimate minority. As an African woman, like in my case, you are another minority on top of that. So the thing is, that if you have something to say, people look at you like oh my gosh! Especially if you get it right. Then they look at you like you did a trick or something. You have like this sense that you are an alien.

The notion of doing a trick is similar to Paula's statement in the previous section of being an "other". Being an alien threatens her sense of belonging and undercuts her potential to be a self-confident engineer, as dictated by the norms of the profession. Black women also talked frequently about these two identities coming together to impact how others viewed them, with many of them unsure about which was more salient, or if both contributed to others perceptions of them. Melissa in computer science described this as

> The guys in this major, a lot of them underestimate me. I don't know why, maybe it's because I am a woman, maybe it's because I am a Black woman. Maybe it's just because they just don't see too many of me. I don't know? I mean I am not one to show you that I know everything because I am not one to boast. I am not a boastful person- but they are, a lot of them are. They are always like "I've done this, I've done that. I can code this!" And I am like ok, great. When we get our grades back and they see that I have gotten a better grade than they have they are like-How did you do that? They are like you didn't even know this when we talked. I am like, well I studied.

Such interactions and impressions created insecurities. The ways in which these women discussed these issues suggests these women's vulnerability to stereotype threat, or the social-psychological confirming a negative stereotype about one's social group (Steele and Aronson 1995). The concept, which was developed by psychologists, Steele and Aronson (1995) demonstrates that when individuals are primed or made aware of stereotypes about their social group, it often negatively affects their performance on a given task, regardless of the individual's actual ability or belief in the stereotypes.

While I cannot say how negative stereotypes impacted these women's grades or actual performance or their internship opportunities, one thing that was clear in the interviews was extreme discomfort when they talked about it. These women clearly understood how they were perceived no matter what high school they had gone to or what grades they received along the way. This is also of immense importance in engineering, because it is a profession that values self-confident displays of knowledge. They are critical to proving oneself in the field and are emphasized very early in the professionalization process as a key to success (Downey and Lucena 1997; Dryburgh 1999; McIlwee and Robinson 1992). Black women have an extremely difficult burden and uphill challenge in this aspect as a result of entrenched stereotypes about their abilities and backgrounds.

Lack of Study Groups

Another issue that Black women discussed is the fact that they struggled with difficulties in forming study groups and personal connections with fellow students. Engineering is largely considered a weed out major and faculty generally assumes that those unable to handle the curriculum are unfit and should not persist (Downey, Hegg and Lucena 1993; Seymour and Hewitt 1997). Much research demonstrates that this aspect of the climate, often forces students to work groups as a means of making it through the degree and achieving success (Dryburgh 1999; Seymour and Hewitt 1997) In these groups, camaraderie often develops and working together on difficult tasks is often more beneficial and satisfying than working alone. For women, this is a challenge and often means adapting to working with an all male, or largely male group, which often means the dynamics may be tinged with sexism (Dryburgh 1999).

Yet for many black women in my study, they were unable to form study groups at all. Not finding study groups meant they were isolated socially but many also believed it also had an

influence on their actual grades. Janet, in electrical engineering found this dilemma to be quite frustrating.

> It is a given that the classes in engineering are going to be so hard but outside of that you have to deal with so much more that add stresses to already being an engineering major. Like it's always been difficult for me to find study groups. One time in my Circuits I class I got the number of everyone in class and I would text them and be like do you want to study together and they would just ignore my texts and it is so awkward seeing them in class after that. Then you often hear them talking to people, like hey we could meet here and study, or I've got the solutions to these problems so we can go over them before the test and just knowing that you are not invited is just terrible.

I asked her if she thought that white women had similar issues and she said, it was "super easy for white women" to find groups. As she described, she had a friend who was a white woman in her class who she saw studying regularly with some of the men who had ignored her texts. In her view this had been enormously helpful in allowing this woman to complete projects and homework, which in turn impacted her grades. She acknowledged that the guys did not respect this woman's engineering abilities, but she benefited nevertheless by being included in their group.

I also asked Janet if she ever studied with black men or knew if they faced similar difficulties. She said there were also not that many black men in her classes, but in her experience they were more likely to want to study on their own, or to be unable to meet her because of commitments with their girlfriends.

Kahlila also spoke to this challenges that she faced compared to white women when seeking help from classmates,

> There was this guy in computer science and we took every single class together and one of my things, as I said, I struggled in my gen eds (general education courses). So I ran into some difficulties in biology. So I went to him and I was like what are you doing? I need help. He was just not even studying and he would be fine and I was like what are you looking at, what are you doing, how do you do the stuff and he was like I just know it, I just know it, I just know it. But one of my other friends who is white asked him, what are you doing and he gave her a list of stuff, that he was doing. So I was like, what is the

problem, what was the difference- and well I think the only explanation is racism.

Emily: Did you ever say anything to him or confront him about it?

Kahlila: I mean no. People are people. I feel like it's pointless if it won't help, so I mean I asked and he said no, and regardless of the reason, there's nothing I can do about that. And really what did it do, honestly, it made me have to work a lot harder and I still got a good grade.

There were others who did not talk of negative interactions like those mentioned above but as a result of the negative stereotypes discussed in the previous section they were concerned about reaching out. Both Paula and Patricia were reluctant to even ask to study with others for fear they might expose that they were confused or struggling with the material. Patricia in mechanical engineering simply put it this way,

I am a minority in engineering and so I don't do the study group thing. I just never ask anyone oh, can I join your study group.

As Paula similarly explained,

I am uncomfortable reaching out to people to study. Being a black person in general, I would never want to openly admit that I am totally lost in class.

For these students, self-segregation was a defense mechanism they used to shield themselves from potential racist assumptions from others. Yet there were some women who had found ways to overcome this. Tricia discussed her isolation as the only one and how this influenced her,

Last semester was the first time I had an African American woman in one of my classes, which kind of makes you discouraged, but it kind of gives you the motivation to push through- you have to step out on your own, and find study groups. That's what I had to do, but I can say there are not any white guys in my group.

A number of respondents also discussed alternative ways for getting help with coursework. One of these was relying on supplemental instruction, which is a peer facilitated tutoring sessions offered to all students by this college in what they term "historically difficult classes." Some talked of other Black women and men they were in touch with, even some who

had graduated, that they asked for tips and information about professors, tests and projects. Others told me about meet-ups among student organizations that were open to all students in their departments or other resources on the university for honing students' study skills. In this sense, such opportunities that were accessible to all students and did not require an invitation made them a valuable resource. What was evident is that to get help, they had to be particularly resourceful, as they were often shut out of networks among students.

Such findings are important for engineering educators who are beginning to emphasize the need to cultivate professional, interpersonal skills among students as part of the curriculum, so that students go beyond the core of technical problems (Downey 2009). Black women may face enormous setbacks in this respect. If one key expectation in engineering is that students form relationships with one another through study groups and networks among colleagues, and Black women are unable to do so, this can severely interfere with their ability to fully participate and their educational experience may be diminished.

Managing Barriers and Overcoming Obstacles

In this final section, I raise the question of what can be done to improve the experiences of Black women at this university. It was something I asked respondents. Throughout such conversations, many talked about ways to adapt to the culture, rather than the other way around. As many explained, they realized that choosing a primarily white institution which meant that they were a minority and would have to work to fit in. The majority of respondents told me that the best advice they would give to other Black woman entering engineering would be to join a student organization for support.

The three women in computer science talked about being members of a group for women in computer science, as well as being members of NSBE. However, of the women in other

engineering majors, all of the respondents explained that NSBE was the group they felt most connected to, suggesting that their racial identity trumped their gender identity in this respect. Three of the respondents held leaderships positions in NSBE, while others said they attended meetings sporadically. NSBE was important because it provided an opportunity to build professional development skills, which gave many of these women a sense of purpose. It also provided a safe space and it offered a sense of community.

In terms of the professional development opportunities, three respondents spoke about the opportunity to serve on the leadership committee, which offered opportunities to coordinate the national conference. Janet, who felt marginalized and depressed as a result of being a black woman in electrical engineering, explained being involved in NSBE had helped her gain experience in coordinating and planning events, which she had found immensely enjoyable. Kelly also expressed the idea that NSBE had offered her an outlet beyond technical proficiencies to be involved in both volunteer work but also to connect with other similar students in her major.

NSBE also served a protective purpose for many because it offered a safe space where students could talk openly about their academic progress and struggles. If they were unsure about a bad grade or whether they suitable candidates for engineering, they were able to ask this question openly and get the encouragement they needed without the fear that others might negatively judge their abilities or see these doubts as evidence of Black women's lack of fit in engineering. Others, like Paula, found it encouraging to meet role models with similar racial backgrounds by attending meetings. A number of respondents also spoke about the ways the organization had allowed them to meet other Black engineers outside of this university, such as at the national NSBE conference. Of those who had attended, most said it was profoundly

impactful to be surrounded by room full of other Black engineers and again it opened up professional networking opportunities.

In terms of the faculty, students also discussed faculty members they liked and disliked but no respondent mentioned any of them as mentors. Furthermore, when asked, all of the women said they were not personally acquainted with any Black professors, male or female in engineering at this university. When asked about mentors or influential individuals who influenced their experiences, most spoke of classmates or staff members in the college rather than faculty. All of the women I spoke to in computer science adamantly expressed appreciation for a coordinator who as one told me "keeps me on her radar screen," sending emails about jobs and internships, talking to them in person if they found an opportunity that seemed applicable and relevant, and even getting to know them. This coordinator had made it possible for them to attend the Grace Hopper conference, which was an opportunity that they did not know existed and which two said they never would have been able to afford if not given a stipend.

Yet one interesting finding that surfaced in the interviews, however, is that students noted that faculty, both male and female, could be allies to women of color in important ways. As Haley explained, one her favorite professors had been from Southeast Asia. They were not close and she did not speak of his exceptional teaching skills per se. What impressed her instead were the messages he sent during class about who was competent. Haley said,

> Dr. Shakeer has been my favorite so far. What I really like about him is that I remember on the first day he said don't every doubt anybody because you just don't know what the person sitting next to you is capable of. This person next to you might be the president someday. That is just something that really stuck with me and I was like wow, you know that's true. In engineering there are a lot of professors who doubt students and I just felt like he was one of the ones who didn't, he didn't doubt students at all. He is not going to tell anyone, like you are not smart enough for engineering.

Finally, two students spoke notably about Research Experience for Undergraduates (REUs) opportunities they performed at other universities, in Colorado and Massachusetts. One described how this had expanded their horizons in terms of what opportunities where available in chemical engineering, as well as the types of people who were engineers. Another had found a influential mentor in Massachusetts through this opportunity. In their descriptions, this had been pivotal to building an identity as a scientists and bolstering their self -confidence. Such descriptions confirmed findings about the benefits of REUs to underrepresented groups in STEM (Hurtado et al. 2009), though at the same time, they raise questions about why students did not find this experience at this university but elsewhere.

Conclusion

Universities, such as the one where this study was conducted, are the first place in which students begin their pathway to becoming engineers. It is here where they begin to learn the core academic competencies necessary for success. However, engineering education is also where they learn about the professional culture. To date, a number of studies have been conducted that have sought to understand how women navigate the culture of engineering. However few have specifically addressed intersections of race and gender in such studies. In this paper, seeking to further our understanding of Black women's experiences in engineering, I ask how they perceive the climate at one primarily white institutions. As described, I find that at this primarily white institution, these women face different challenges to adapt to in order to succeed in their educational goals than those of white women.

When Black women walk into a classroom, meeting or engineering event they realize they are the only one they feel at unease. Even in majors were women have reached a critical mass, Black women report a desire to see greater representation of other Black women. My

respondents could not draw on the same impression management techniques of white women. Masking their bodies and attempting to pass as white are not available options. Projecting self-confidence was also not a coping mechanism for a number of them. Many are largely excluded from study groups or are too hesitant and fearful because of their racial identities to interact with colleagues. Many also spoke about the unwanted attention they garnered and expressed the hope that the college would work to increase the numbers of Black students, both women and men, who study engineering. Additionally, they spoke of painful experiences of suffering from negative stereotypes and interactions with other students and professors who doubted their abilities because they were black women.

Support structures and organizations like NSBE can help women to overcome these challenges and were critical to many of these women's success. Colleges of engineering should support and promote their activities and efforts. These women spoke of NSBE as a lifeline. Furthermore, scholars find that there is a "strength in numbers" effect, and my respondents spoke of their desire to see more Black students but also Black female engineers. In recruiting efforts, attempts should be made to increase the numbers of black women and not simply women. This can help to shift the image of who belongs in engineering and may help reduce perceptions among engineering students and educators that Black women are somehow outsiders and not made for engineering.

However, we should not conclude that it is up to individual students to adapt to engineering through their involvement in student groups or simply by increasing their numbers through outreach and recruiting. Indeed, perhaps the biggest takeaway from this study is that it is alarming that the majority of my respondents viewed their larger exclusion as the way things are, or as reality to be accepted and managed. Institutional change is therefore also necessary to

increase the participation and improve the experiences of Black women in engineering. Engineering programs often contend they support diversity but at the same time research continues to find that exclusionary norms exist for those who are not white and male. Too often, little critical introspection is given to changes, even small ones which be made

There are steps that can be taken. For example, in one of my interviews with faculty, a professor in chemical engineering discussed a policy in which he assigned study groups for a thermodynamics class. In his words, his advisor was a notable engineering educator who had made him aware of this issue. He also explained he was trying his best to ensure that women and minorities were not placed in groups without others who were also representative of their gender and race.

Another possible solution is to increase the presence of role models among the faculty and in other venues. One respondent in this study also mentioned that she had never seen a Black engineer as a guest speakers at general events offered in her major, or in courses where practicing engineers sometimes came to speak. She noted that Black engineers only seemed to come to NSBE meetings. In her view, changing this would make the major more feel more inclusive and it would also demonstrate to her mostly white male colleagues that Black engineers indeed existed and were out there doing engineering jobs. As social psychologists argue, when individuals are presented with counter-stereotypes (Black female engineers who are successful) they work to break down and challenge implicit biases we hold about Black women's suitability in engineering (Banaji and Greenwald 2013).

Finally, a number of scholars have called for engineering education to incorporate perspectives from feminism and the philosophy of science and technology into the curriculum and pedagogy in order to stimulate reflexivity and challenge the dominant norms of the field to

shed light on social injustice (Beddoes 2012; Pawley 2012; Riley 2011). In my interviews, students would sometimes mention how courses in the liberal arts in fields such as African American Studies or Women's and Gender Studies had given them an awareness and perspective on why they were facing some of the challenges they described. The engineering profession often claims that diverse teams would benefit its abilities to produce better technologies and innovative outcomes, than those with more homogenous members (Wulf 1998). Engineering educators should carefully consider how consistent this message is with what is actually happening on the ground at their universities.

References

Banaji, Mahzarin and Anthony Greenwald. 2013. *Blindspot: Hidden Biases of Good People*. New York: Delacorte Press.

Beasley, Maya. 2011. *Opting Out: Losing the Potential of America's Young Black Elite*. Chicago: University of Chicago Press.

Beddoes, Kacey D. 2012. "Feminist Scholarship in Engineering Education: Challenges and Tensions." *Engineering Studies* 4(3): 205-232.

Blickenstaff, Jacob Clark. 2005. "Women and Science Careers: Leaky Pipeline or Gender Filter." *Gender and Education* 17(4): 369-386.

Carlone, Heidi B. and Heidi Johnson. 2007. "Understanding the Science Experiences of Successful Women of Color: Science Identity as an Analytic Lens*." Journal of Research in Science Teaching* 44(8): 1187-1218.

Cech, Erin, Brian Rubineau, Susan Silbey, and Caroll Seron. 2011. "Professional Role Confidence and Gendered Persistence in Engineering." *American Sociological Review* 76(5): 641-66.

Charmaz, Kathy. 2014. *Constructing Grounded Theory: A Practical Guide through Qualitative Research 2nd Edition*. London, England: Sage Publications.

Collins, Patricia Hill. 2000. *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment.* New York and London: Routledge.

Crenshaw, Kimberlee W. 1991. "Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist

Politics " Pp. 57-80 in *Feminist Legal Theory: Readings in Law and Gender* edited by K. Bartlett and R. Kennedy. San Francisco: Westview Press.

Crenshaw, Kimberlee W. 1992. "Whose Story Is It Anyway? Feminist and Antiracist Appropriations of Anita Hill " Pp. 402-40 in *Race-Ing Justice, En-Gendering Power: Essays on Anita Hill, Clarence Thomas and the Construction of Social Reality* edited by T. Morrison. New York: Pantheon.

Dasgupta, Nilanjana, Melissa McManus Scircle, and Matthew Hunsinger. 2015. "Female Peers in Small Work Groups Enhance Women's Motivation, Verbal Participation and Career Aspirations in Engineering." *Proceedings of the National Academy Sciences.* 112(16): 4988-4993.

Davis, Angela. 1981. *Women, Race & Class*. New York: Random House.

Downey, Gary. 2009. "What Is Engineering Studies For?" *Engineering Studies* 1(1): 55-76.

Downey, Gary, Shannon Hegg, and Juan Lucena. 1993. "Weeded Out: Critical Reflection in Engineering Education." Paper presented at the American Anthropological Association Annual Meeting Washington D.C., Washington DC.

Downey, Gary Lee and Juan C. Lucena. 1997. "Engineering Selves: Hiring in to a Contested Field of Education " in *Cyborgs & Citadels: Anthropology Interventions in Emerging Sciences and Technologie*s edited by G. L. Downey and J. Dumit. Santa Fe, New Mexico: School of American Research Press.

Dryburgh, Heather. 1999. "Work Hard, Play Hard: Women and Professionalization in Engineering-Adapting to the Culture." *Gender & Society* 13(5): 664-682.

Eglash, Ron. 2002. "Race, Sex, and Nerds: From Black Geeks to Asian American Hipsters." *Social Text* 20(2): 49-64.

Esterberg, Kristin G. 2002. *Qualitative Methods in Social Research*. Boston: McGraw Hill

Etzkowitz, Henry, Carol Kemelgor, Michael Neuschatz, Brian Uzzi, and Joseph Alonzo. "The Paradox of Critical Mass for Women." *Science* 266(5182): 51-54

Feagin, Joe R. 2006. *Systemic Racism*: *A Theory of Oppression*. New York: Routledge.

Feagin, Joe R. 1991. "The Continuing Significance of Race: Anti-black Discrimination in Public Places." *American Sociological Review* 56(1): 101-16.

Feagin, Joe R. and Melvin P. Sikes. 1995. "How Black Students Cope with Racism on White Campuses." *The Journal of Blacks in Higher Education* 8: 91-97.

Feagin Joe R. and St Jean. 1998. *Double Burden: Black Women and Everyday Racism*. New York: Routledge.

Fries-Britt, Sharon, Toyia K. Younger, and Wendell D. Hall. 2010. "Lessons from High Achieving Students of Color in Physics." *New Directions for Institutional Research* (148): 75-83.

Goffman, Erving. 1959. *The Presentation of Self in Everyday Life*. Garden City, New York: Doubleday-Anchor.

Goffman, Erving. 1963. *Stigma: Notes on the Management of Spoiled Identity*. Englewood Cliffs, New Jersey: Prentice Hall.

Hanson, Sandra. 2009. *Swimming against the Tide: African American Girls and Science Education*. Philadelphia: Temple University Press

Harper, Shaun R. 2010. "An Anti-Deficit Achievement Framework for Research on Students of Color in Stem " in *An Anti-Deficit Achievement Framework for Research on Students of Color in STEM*, edited by S. R. Harper and C. B. Newman. San Francisco: Jossey-Bass.

hooks, bell. 1981. *Ain't I a Woman: Black Women and Feminism*. Boston, Massachusetts: South End Press.

Hurtado, Sylvia, NL Cabrera, MH Lin, L Arellano and LL Espinosa. 2009. "Diversifying Science: Underrepresented Student Experiences in Structured Research Programs ". *Research in Higher Education* 50(2): 189-214.

Johnson, Dawn R. 2011. "Examining Sense of Belonging and Campus Racial Diversity Experiences among Women of Color in Stem Living-Learning Programs." *Journal of Women and Minorities in Science and Engineering* 17(3): 209-233.

Kanter, Rosabeth Moss. 1977. *Men and Women of the Corporation*. New York: Basic Books.

LaFollette, Marcel C. 1988. "Eyes on the Stars: Images of Women Scientists in Popular Magazines." *Science, Technology, and Human Values* 13(3-4): 262-275.

Lagesen, Vivian. 2004. "Strength in Numbers: Strategies to Include Women into Computer Science." *Social Studies of Science* 37(1): 67-92.

Margolis, Jane and Allan Fisher. 2002. *Unlocking the Clubhouse: Women in Computing*. Cambridge, Massachusetts: The MIT Press.

Maton, Kenneth I., Shauna A. Pollard, Tatiana V. McDougall Weise, and Freeman A. Hrabowski III. 2012. "The Meyerhoff Scholars Program: A Strengths-Based Institution-Wide Approach to Increasing Diversity in Science, Technology, Engineering and Mathematics." *Mt Sinai Journal of Medicine* 79(5): 610-623.

McIlwee, Judith S. and Greg J. Robinson. 1992. *Women in Engineering: Gender, Power, and Workplace Culture*. Albany: State University of New York Press.

Miller, Gloria E. 2004. "Frontier Masculinity in the Oil Industry: The Experiences of Women Engineers." *Gender, Work & Organization* 11(1): 47-73.

National Science Foundation. 2017. Women, Minorities, and Persons with Disabilities in Science and Engineering. Retrieved May 5, 2017 at: https://www.nsf.gov/statistics/2017/nsf17310/digest/about-this-report/.

O'Brien, Laurie T., Alison Blodorn, Glenn Adams, Donna M. Garcia and Elliot Hammer. 2015. "Ethnic Variation in Gender Stem Stereotypes and Stem Participation: An Intersectional Approach." *Cultural Diversity and Ethnic Minority Psychology* 21(2): 169-180.

Ong, Maria. 2005. "Body Projects of Young Women of Color in Physics: Intersections of Gender, Race, and Science." *Social Problems* 52(4): 593-617.

Pawley, Alice L. 2009. "Universalized Narratives: Patterns in How Faculty Member Define "Engineering." *Journal of Engineering Education* 98(4): 309-319.

Pawley, Alice L. 2012. "What Counts as 'Engineering?: Towards a Redefinition " in *Engineering and Social Justice: In the University and Beyond*. Purdue, Indiana: Purdue University Press.

Riley, Donna. 2011. "Hidden in Plain View: Feminists Doing Engineering Ethics, Engineers Doing Feminist Ethics." *Science and Engineering Ethics* 19(1): 189-206.

Seymour, Elaine and Nancy Hewitt. 1997. *Talking About Leaving: Why Undergraduates Leave the Sciences*. Boulder, Colorado Westview Press.

Snyder, Thomas D., Cristobal de Brey, and Sally A. Dillow. 2016. Digest of Educational Statistics 2015. National Center for Education Statistics.

Steele, Claude M. and Joshua Aronson. 1995. "Stereotype Threat and Intellectual Test Performance of African Americans." *Journal of Personality and Social Psychology* 69(5): 797-811.

Strayhorn, Terrell L. 2012. "Sense of Belonging and STEM Students of Color." Pp. 61-76 in *College Students' Sense of Belonging: A Key to Educational Success*. New York: Routledge.

Strayhorn, Terrell L., Michael Steven Williams, Derrick L. Tillman-Kelly, and Marjorie Dorime Williams. 2013. "Stemming the Tide: Psychological Factors Influencing Racial and Ethnic Minority Students' Success in Stem at Community Colleges." in *Community Colleges and STEM e*dited by R. T. Palmer and J. L. Wood. New York: Routledge.

Traweek, Sharon. 1988. *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge, Massachusetts: Harvard University Press.

Wingfield, Adia Harvey. 2007. "The Modern Mammy and the Angry Black Man: African American Professionals' Experiences with Gendered Racism in the Workplace." *Race, Gender and Class* 14(2): 196-212.

Wulf, William. 1998. "Diversity in Engineering." *The Bridge* 28(1): 48.

Yoder, Brian L. 2016. "Engineering by the Numbers ": American Society for Engineering Education. Retrieved March 22, 2015 at: (https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf)

Chapter 4: An Analysis of Three Outreach Campaigns to Recruit Young Women to Engineering

Introduction

Since 1982 women have been outpacing men in terms of college completion. Women now earn approximately 57 percent of all college degrees, but fields of study remain strongly segregated by gender (DiPrete and Buchmann 2013). This is perhaps nowhere more apparent than in engineering, where women complete only 19 percent of undergraduate degrees (National Science Foundation 2017). For the past 20 years, women's numbers in the field have remained stagnant and their relatively slow movement into engineering majors contributes to their underrepresentation (Xie and Shauman 2003) The issue remains one that garners a great deal of attention from scholars, business leaders and educators (Hill et al. 2010; National Academy of Science 2006) Engineering continues to be male dominated, male-identified and male controlled and many argue that the profession must change this reality and diversify its workforce if it hopes to develop and maintain a strong domestic talent pool (National Academy of Engineering 2008). Scholars also argued that diversity along gender lines (as well as racially and along other dimensions) will also increase creativity and problem solving and leads to better solutions and technologies that contribute to advancing scientific productivity (Blickenstaff 2005; Page 2008; Wulf 1998)

As a result, at the beginning of the twenty-first century, interventional programs aimed at increasing girls and young women's participation in engineering proliferated (Bix 2014). Media campaigns, informational websites, television programs and various educational activities and programming have expanded dramatically to provide girls and women with opportunities and information related to science and technology, in the hopes that they will pursue it.

Such campaigns are clearly influenced by feminist progress. Unlike times past, when

women were barred from colleges of engineering or when overt sex discrimination was largely tolerated in engineering education, shifting social norms and changes in laws and policies have all made the participation of women in engineering possible, not to mention desirable (Bix 2014). In a dramatic reversal of trends, women have also surpassed men in terms of their grades, their college attendance, and the postsecondary degrees they earn (DiPrete and Buchmann 2013). Parents and educators now encourage girls and young women to seek out an array of professional work. As third wave feminists Baumgardner and Richards (2000 p. 83) have argued, young women today are simply born with feminism in the water, which they compare to a sort of "invisible political fluoride that protects against the decay of patriarchy." Indeed, in theory, women can pursue any career they wish and succeed at the highest levels, if they seize the opportunities that have become available (Sandberg 2013).

But despite such progress, some have warned of a backlash against feminist gains, arguing that that we should not become passive about lingering gender injustice and must continue to focus on the subtle ways in which women are still disadvantaged relative to men (Faludi 2006). Expanding on this idea, many gender scholars have identified and critiqued what they call a postfeminist movement or sensibility, that both invokes feminism while also repudiating it (Gill 2007; Gill and Scharff 2011; McRobbie 2007; Stacey 1987). Postfeminism suggests that equality has been achieved, glosses over continuing sexism, and downplays the need for continuing collective action to combat it (Gill 2007; Gill and Sharff 2011; McRobbie 2007; Stacey 1987) Existing scholarship notes that this is particularly prescient in consumer culture and the media. To date, a number of studies have examined the how cultural narratives about women's increasing professional and personal freedoms and options play out on popular television, books, movies and magazines and other areas of social life (Tasker and Negra 2007).

Few have sought to better understand how feminist and subsequently postfeminist messaging are expressed in efforts aimed to influence career planning and college major choice, such as the recruitment of women to male dominated fields such as engineering (Bystydzienski and Brown 2012).

In this article, taking such debates into consideration, I provide an analysis of the messages aimed at young women to consider engineering as a profession. Relying on the websites of three prominent engineering outreach efforts, the analysis asks how they promote engineering as a profession in relation to women's expanded opportunities and shifting cultural norms around gender and work. In doing so, I highlight how these campaigns draw on postfeminist themes by calling upon women to develop individual coping strategies to help them excel in the field, utilizing ideas about gender differences to recruit women, and promoting the profession as a fun and playful one. I then argue that as a result they fail to address deeper structural gender issues that make it difficult for women to belong and be successful in engineering and thus unwittingly reproduce barriers to women engineering.

Background

Women's Entrance into Engineering

Given that the aim of this paper is to investigate three campaigns that seek to recruit women to engineering, it is necessary to understand the commonly understood reasons they are underrepresented, that these campaigns must work to address. Gender segregation across college majors is a strong feature on college campuses, as women and men select widely divergent academic fields upon coming to college. Scholars studying this phenomena note however that the segregation of women in men into different professions declined dramatically particularly after 1960, when women began to integrate many formerly male strongholds such as law, medicine and business (England and Li 2006). Yet after 1990, progress stalled, despite the fact that

women's college completion rates surpassed those of men (England 2010). Women's lagging progress in certain fields, despite their increased gains in higher education, is quite apparent when one observes the demographics of different college majors today. For example, in 2015, women earned 85 percent of all degrees in nursing, 80 percent in education, 77 percent in psychology but only 19 percent in engineering (Snyder et al. 2016).

Disparities in college major choice fuel the gender wage gap and are considered one of the most significant forms of gender inequality among undergraduate students. For this reason, one area of interest is to examine why women have not entered may STEM fields in higher numbers. Sociologists Xie and Shaumann (2003) have written one of the most comprehensive books on the topic using multiple datasets to perform an analysis of women's pathways into STEM over their life course. A key finding from their work, is that differences in achievement and ability cannot explain women's underrepresentation as women are now performing as well as men. Further, the transition point between high school and college is a key source of the gap. They determine that if women were as likely as men to select a STEM major, the gap would be significantly reduced and cite cultural and social forces as the primary cause of women's choices in the regard.

Many studies have attempted to better understand women's career inclinations to shed light on these cultural and social forces. Academic psychologists have been perhaps the most influential in the research on women an engineering, focusing heavily on individual based arguments, which ask how women's achievement and attitudes influence how they choose professions. One particularly prominent scholar is Jacqueline Eccles (1994, 2011a, 2011b) who has been researching the issue for three decades. Her expectancy-value model is one of the most comprehensive and is still highly influential. It seeks to understand processes that occur very

early in young peoples lives that lead women and men to choose gender differentiated majors. Eccles maintains that in order for young women to pursue STEM degrees they must expect and believe they can be successful and they must see value in a STEM profession. Central to her argument is the fact that women internalize dominant cultural ideologies about men and boys' superior math skills as compared to women and girls. She focuses on how women lose confidence and interest in a STEM profession as a result. She maintains, that through a process in which women themselves subjectively evaluate their skills, women come to regard their math skills as weak and STEM as less interesting and less valuable. The result is that they perceive their career options in STEM as less viable. Eccles also makes a second argument that women also reject STEM professions because they value family over career and deem the two incompatible with one another.

More recently, scholars Ceci and Williams and colleagues (2009a; 2009) have also generated a great deal of attention on the topic. They claim that discrimination against women in STEM has waned substantially, and emphasize the "free and constrained" choices women make around STEM career choices. They argue first that women make "free" choices to avoid STEM because many simply have preferences to do something else. The free choices are viewed as a result of deeply ingrained and essentialist preferences for professions that women perceive as more nurturing and social relevant. The constrained choices involve women's avoidance of STEM, and particularly academic STEM positions. In their view women believe STEM jobs cannot be reconciled with the realities and exigencies of being a mother, due to the time commitment and requirements demanded in such positions during a woman's childbearing and childrearing years.

In another recent stream of research, many have sought to parse out how and why women reject certain STEM fields such as engineering and computer science (Cheryan 2009, 2011, 2013; Diekman et al. 2011) Recently, Sapna Cheryan and colleagues (2009, 2012, 2013) have investigated why women have largely reached parity in some math related careers (i.e. biology and medicine) but not others (i.e. computer science and engineering). Using experiments, they argue that it is not math attitudes that are holding women back but rather the fact that young women hold powerful and often, negative, stereotypes about the cultures of engineering and computer science and the work and people engaged in them, which they see as incongruent with the female gender role. Some of these include images of nerdy white men who possess above average intelligence needed for success. Others include the idea that engineering is not a field that allows individuals to do socially relevant work. Cheryan (2012) argues that many women, who now perform equally to men in math in science in school, are now well poised to enter any STEM field they choose. Her research suggests that altering images and stereotypes of the cultures would like make women more inclined to choose them and thus will substantially decrease issues of gender parity.

Postfeminism

The dramatic increase in expansion of research on women's underrepresentation in engineering also intersected with other political trends, such as rise of neoliberalism. Neoliberalism gained prominence as both a political and economic philosophy in the 1980s in the United States, and elsewhere, and is a dominant political frame still today, which advocates for the withdrawal of public social services, the increased privatization of government programs, and the veneration of individualism as the highest form of human achievement. It is understood as a ideology that envisions individuals as entrepreneurial subjects, who are well poised to make the best possible decisions about their life choices, often in capitalist marketplaces and through

rational choices (Harvey 2005).

Post-feminism and many of the ideas affiliated with it are currently understood as deeply tied to this frame (Fraser 2009; Gill and Scharff 2011) and has been described as an ideology or a set of dominant discourses, which infuse and shape contemporary understandings of the position of women, by engaging with feminist aims while simultaneously undermining them as unneeded (McRobbie 2007; Stacey 1987). According one leading cultural theorist on the subject, Angela McRobbie (2007),

> Postfeminism actively draws on and invokes feminism as that which can be taken into account in order to suggest that equality is achieved, in order to install a whole repertoire of meanings which emphasize that it is no longer needed, a spent force (p. 28).

Thus, postfeminism does not seek to dismantle many of underlying tenets of feminism. Instead it celebrates principles of equality between women and men and reveres the rise of women's expanded choices and opportunities. However, it dismisses any need for political activism, expanded legal protections, or social programs as unnecessary. It postulates that women must not see themselves as victims, that they should not dwell on sexism or marginalization, but instead place their emphasis on individual lifestyle choices and even consumption to get ahead and be successful.

There are many threads that characterize postfeminist understandings and narratives. One of them includes the resurgence of ideas about natural sexual difference between women and men (Gill 2007). One area where this can be seen is to spotlight women who are confident and successful professionals, but also deeply interested in normative feminine interests such as shopping, men, and beauty rituals (Sex and the City is an excellent example). Such ideas are also evident in the popularity of numerous books on the topic of innate sexual differences between women and men, such as *Men are from Mars, Women are from Venus* written by John Gray

(1991), but also works more serious works written by academics and scientific experts such as *The Blank Slate: The Modern Denial of Human Nature* written by Harvard psychologist Steven Pinker in 2002, and *The Female Brain* written by neuropyschiatrist Louann Brizendine in 2006. More than simply bestselling novels, these books have a sort of truth effect (Foucault 1977a, 1977b), purporting that women and men are equal, but fundamentally different and thus are best channeled in different professions and social roles.

Former Harvard President Larry Summers cited Pinker's research in a widely publicized talk he gave to faculty at Harvard in 2005, to claim that perhaps the most influential reasons women were underrepresented in STEM was because of intrinsic biological differences. His remarks caused a furor, as scholars from an array of fields refuted his claims as highly debatable and critiqued his argument by pointing out that any small gender differences in aptitude among the highest performers, could not adequately explain the rather large gender gap in STEM. Critics said he exaggerated and magnified gender differences, which could be used to dismiss structural barriers that held women back (such as glass ceilings, sexual harassment, tenure clocks, and a lack of adequate family leave) in science and technology. Many also saw it as perpetuating cultural stereotypes about women's math and science abilities that might be used (both explicitly and implicitly) to judge and assess their competence and research (Dillon 2005; Hemel 2005; Pinker and Spelke 2005). Yet, this incident represents the rising popularity of ideas about gender difference, which promotes the postfeminist idea that women and men are equals, but simply have different proclivities and skills (Charles and Bradley 2009).

Another element of postfeminist discourse is the emphasis on women's personal individual efforts rather than collective actions. It emphasizes the ways in which they can get ahead and be happy by focusing on behaviors and self work that allow for success in various

areas of social life, such as the workplace (Banet-Weisser 2015; Gill and Orgad 2015). One way this can be achieved is by building women's self-confidence so they can get noticed and be taken seriously in various professional contexts (Banet-Weisser 2015; Gill and Orgad 2015; Kay and Shipman 2014; Sandberg 2013). Gill and Orgad, (2015) describe this happening in an emerging "culture of confidence" and label it a 'technology of self.' Technology of self is a concept developed by Foucault (1988), in which he describes it as a process by which individuals now have the power (and are expected to use it) to transform themselves and they way they operate in the world, so as to achieve a state of happiness, purity, wisdom, perfection and even immortality. It is organized by offering a range of techniques so that women can measure, assess, inspire and ultimately develop self-confidence to realize success. Numerous books, career coaching, counseling, trainings and self help groups have popped up as a result. Its messages are disseminated through the knowledge of experts who promote it as an ideal solution for women in a changing professional landscape where opportunities are limitless if they are unable to overcome their insecurities. The self-confidence culture is also strongly gendered, as it almost exclusively marketed to women (Gill and Orgad 2015).

Girls and young women have also taken a special role within the emergence of this postfeminist movement, which is important to consider for campaigns aimed at younger audiences. Anita Harris (2004) describes this phenomena by theorizing the rise of the future girl in popular Western understandings. In her words, the future girl is,

> a kind of young woman celebrated for her desire, determination and confidence to take charge of her life, seize chances, and achieve her goals (p 1).

Such an image has gained popularity with a number of new terms given to such girls. Future girls are often also known as alpha girls (Kindlon 2006), amazing girls (Rimer 2007), perfect girls

(Currie, Kelly and Pomerantz 2009) and supergirls (Ringrose and Walkerdine 2008). Images abound in popular culture of girls who are popular, excel academically, play sports, participate in extracurricular activities, and often maintain a normative feminine appearance and interests. Future girls have unlimited choices and can make lifestyle choices for careers and professions. Often future girl rhetoric relies on meritocratic language, promoting girls as active agents who no longer must grapple with sexism but are in complete control of their lives and futures (Harris 2004; Pomerantz, Raby, Stefanik 2013; Rimer 2007; Ringrose and Walkerdine 2008). Scholars note that the impact of future girl frames has led to tensions for many young women, who are steeped in ideas that they can have it all as a result of feminism but have trouble identifying and challenging gendered barriers and sexism in schools when they do experience them (Pomerantz, Raby and Stefanik 2013).

One illustrative example of these frames as it relates to STEM is pop icon Danica McKellar who is a vocal math advocate encouraging young women into STEM (McKellar 2015). A talented actress known for her roles on the television show The Wonder Years and The West Wing, she is also an accomplished mathematician with a degree from the University of California at Los Angeles. McKellar is also a writer of three bestselling books to encourage women to pursue math and science (her first is titled *Math Doesn't Suck: How to Survive Middle School Math Without Losing Your Mind or Breaking a Nail,* 2007). According to her website she has won numerous awards for her work as a math advocate, and her discovery of a mathematical physics theorem which bears her name. McKellar openly celebrates fundamental differences between women and men, refuses to call herself a feminist, and has posed in revealing lingerie for the men's magazine Maxim, a media outlet she claims does not give a positive message to girls at all (Champion 2007; Marcus 2010).

Taken together, this literature indicates that there is a great deal of attention focused on the career choice process of young women and STEM, with interest in finding ways to channel more women to engineering by altering their attitudes and experiences. Furthermore, it also points to the fact that feminist and postfeminist frames deeply pervade and influence how we understand women's interests, lives and professional and personal opportunity structures. Therefore this article addresses the following questions: How do outreach campaigns attempt to attract young women to a field that many avoid as a result of deep cultural reasons that make it an unattractive career option? How do such campaigns attempt to recruit women who now have increased options as result of changes in their academic achievement and the opening of fields that were once off limits to them?

Data

For this project, three engineering outreach efforts known as GoldieBlox, Engineer Girl and the Nerd Girls were selected for analysis. In order to conduct an analysis, I utilized their website as the primary source of information. These programs were chosen primarily because they are national in scope and are affiliated with organizations and/or individuals who have considerable influence and the ability to promote engineering to a national audience. The first, GoldieBlox, is a toy company whose founder, Debbie Sterling, is a mechanical engineering graduate from Stanford University. After spending a year researching women's underrepresentation in engineering, she decided to create a toy that would interest young women in engineering at a young age. She was able to generate a successful fundraising campaign and begin her own business, which has had phenomenal success. Through her utilization of media outlets, such as YouTube and Kickstarter, she told her own story by creating a heartfelt video about the lack of building toys marketed to girls, which won an advertising spot in the 2014

Superbowl. She raised a quarter of a million dollars in thirty days as a result, and began a business built on marketing sets of female inspired building toys that are sold in stores across the United States (Loudenback 2016).

The second, Engineer Girl, is an informational website administered by the National Academy for Engineers, which is part of the National Academies of Science. Women's underrepresentation in engineering, as well as the need to create new messages to inspire young people to pursue the profession, has been an important area of focus for the organization and the website represents its efforts to influence girls through online outreach. In 2015, it received two million dollars to devote to Engineer Girl, among other programs.

Finally, the third is the Nerd Girls, which is a group created by engineering professor and dean at Tufts university, Karen Panetta. According to her website, Panetta has conducted outreach activities for more than 85,000 girls and is considered an expert on issues of women's underrepresentation in engineering. Panetta says her greatest accomplishment is her work to recruit young women to engineering (*Nerd Girls*) and she edits the Institute of Electrical and Electronics Engineers journal, *Women in Engineering*. She was awarded a Presidential Award for Excellence in Science, Math and Engineering Mentoring in 2011. Panetta founded the Nerd Girls in 2000, which is privately funded and is involved in identifying female role models whose aim is to encourage young women to become engineers (Karen Panetta 2015).

Methods

All three of these campaigns were analyzed using the method known as textual analysis, with the aim of producing an "exegesis" about ideas that circulate in popular texts on our understandings of how women can best be recruited to engineering (McKee 2003). Textual analysis incorporates ideas from semiotics, focusing on the ways that objects, images, and

dialogue in texts are imbued with social meaning. Its aim is to map out a likely analysis of meanings within texts to shed light on the context within which individuals think. Rather than reducing texts to smaller units to be statistically analyzed for the frequencies or preselected themes, this analysis looks deeper in the data and to inductively map out thematic patterns.

It is important to note however, that this method does not suppose that there is one absolute meaning of the texts affiliated with these campaigns (McKee 2003). Indeed, it accepts that multiple readings are possible and that different audiences will bring a variety of backgrounds and orientations to the presentation of a text. Yet, to be clear, textual analysis is also not simply imposing a meaning on texts. Rather, it asks how audiences might reasonably interpret texts, in the terms of the context of the current zeitgeist in which they are composed and consumed.

Specifically, in order to perform the analysis presented in this article, all images, language and video on each site were included in the sample. I analyzed the sites from a period of September 2016 to December 2016. Each campaign has a somewhat different target audience and one is even a for profit company, yet they all have the same overarching goal. For example, GoldieBlox is aimed at young girls as well as their parents and is meant to sell a product that will lead to the goal of increasing women's representation in engineering. It's website contains a great deal of outreach information and content for young girls and parents who are inclined towards engineering. Engineer Girl is a part of the nonprofit organization The National Academy of Engineering and was developed primarily for middle school girls, though it has also been adopted by high school girls and even parents (Bix 2014). The Nerd Girl's audience is primarily middle school to high school girls. While there are limitations to analyzing only three national campaigns, there are also significant strengths to this approach. These campaigns are powerful

examples of attempts to shift women's perceptions of engineering and facilitate their entrance into the field. The represent bounded, but high profile and influential examples, of how the media illustrates women's choices relating to career planning.

For this analysis, all sections for each website were explored and subjected to close analytical scrutiny. I analyzed the sites individually in the first round of coding, but sought to ask how they related to one another to understand how they create a larger narrative package about women in engineering. I paid careful attention to the language, rhetoric, style, context and pictures portrayed. Engineering is widely perceived in the United States as masculine, manly and male dominated, so it was important to determine how campaigns attempt to appeal to young women with this in mind. The following two overarching questions guided the analysis: How do these websites categorize the interests, needs, skills, and the situation of girls and women in relation to engineering and how do they disseminate information to young girls and why and how and why they should become engineers? During the analysis the follow questions also guided the study: What are the cultural assumptions underlying these texts? How are messages presented across these campaigns?

In order to code, I relied on a grounded theory approach to examine websites as outlined by Charmaz (2014). In the first phase of initial coding each website was examined separately using short sentences to describe what was happening in the data to create several preliminary codes. Next I used focused coding to refine themes that were similar and collapse codes into smaller categories comparing and contrasting between sites. This process led to an iterative process of recoding and further analysis where codes where further refined and in which three overarching themes were identified. As I will argue, these websites rely heavily on postfeminist messaging, which attempts to appeal to women to enter the profession, but fails to recognize

larger structural and cultural barriers and thus uphold the gender status quo. As the findings detail these campaigns focus on the following messages: 1. Women are called upon to exercise individual agency to enter and achieve success in engineering. These sites do this primarily by encouraging women to act in an assertive, confident manner to be successful in engineering, which they must learn to cultivate through self-work. 2. Women are fundamentally different than men and thus need different strategies to attract them to engineering that appeal to their "feminine" nature 3. Engineering is presented as fun and exciting lifestyle choice for young women.

Focusing on the Individual

Across all of these campaigns, there is a strong emphasis on the individual and the ways in which women can find success in engineering by relying on strategies to cope with a profession that is deemed masculine. Building women's self confidence as a means of encouraging them to become engineers is especially prominent in this respect. Existing evidence does demonstrate that that on average, young women are less self confident than men in their math abilities and this is an important mechanism that works to keep out of math intensive careers (Correll 2004; Eccles 1994). Some studies also find however that the women who do choose engineering are quite confident in their math abilities, but they often lose self confidence in engineering education, process as they come to realize that they have chosen a field that counters gender norms and one in which their competencies are often doubted (Dryburgh 1999; McIlwee and Robinson 1992). These campaigns address this by encouraging women to be adaptable, proactive go-getters who must work to conquer such a loss of confidence by turning inward to find personal solutions to this issue.

This kind of self-disciplining behavior is evident in one TedTalk given by Debbie

Sterling posted on the GoldieBlox website, in which she passionately describes her own pathway into engineering and her motivation for creating building based toys for women. Describing her college experiences, she like many other students, found the curriculum engaging but also demanding and touches on a particularly difficult episode in her studies. She relays an experience in which she submitted an assignment for an engineering drawing class in which she had invested considerable time and effort. When she received her assignment back she suffered humiliation, as her professor made an example of her work, by mockingly holding up her drawing in front of the entire class, asking her mostly male colleagues, if they believed that she deserved to pass the class. Despite her upset and frustration, she clearly accepted his assessment as accurate, and describes this as a pivotal moment for the idea behind GoldieBlox. She recalls how she faced self-doubts and was unsure of her next steps. It was at this point that she realized that her drawing and spatial skills were lacking in comparison to her fellow students because of the toys she played with. If gendered differences are presented in this way, with women seen as weaker in spatial skills, then they will have to take steps as individuals to overcome these limitations. However, in this story, there are a wealth of implicit assumptions made about women's spatial skills and subsequently self-confidence. For example, Sterling does not consider the fact that when women perform worse than men on spatial skills, research often finds this often occurs as a result of cognitive biases that often impact performance and beliefs about ability, rather than an innate lack of ability in women that can be trained or developed (Fine 2010). Additionally, her story fails to consider that professors often hold mental images (many times unconsciously) of women in such fields as less qualified, and thereby judge their work or credentials more harshly than men's, net of their actual performance (Downey Hegg and Lucena 1993; Moss Racusin et al. 2012; Reuben, Sapienza, and Zingales 2014). Of course, it is not clear

if such explanations have any merit or relevance in relation to Sterling's particular situation, but her framing of events is one in which the message becomes that women must adapt themselves to fit into engineering. It ignores the ways in which norms and interactions in the field still negatively impact women's experiences in engineering.

Messages on these sites also bombard users with photos and interviews with role models, who primarily communicate their can do spirit and successes with very minimal discussion given to setbacks. For example, on the Nerd Girls site, alumnae pose in ways that suggest they exude self-confidence. Their profiles often provide pithy statements that speak to the importance of being self-assured, self-making and unstoppable. As one example, Casey tells us her motto is, "Don't sweat the small stuff. Be confident and comfortable with yourself." In another interview on the Nerd Girls blog with professor Bonnie Bassler from Princeton, she tells the viewers that the main issue for them in the field is one they can manage, claiming, "It has been harder for females to succeed in science because of the confidence gap." As the interview progresses she explains how she has dealt with this,

> Interviewer: You once rushed a podium, demanded a job from a speaker, and got it. How important is it for women in science to be assertive?
>
> Bassler: Honestly, I was terrified! But I thought, if he says no, ok — nothing will be different. And if I don't ask, I can guarantee I won't get the job! I really wanted the opportunity, but how would he have found me out of 500 people if I didn't assert myself? Right now there are probably girls who are really interested in working in my lab, but are too scared to just email me. I want to find you! I was not shy, and I've been very lucky.

Engineer Girl too focuses on the issue of young women's ability to be adaptable and independent. The use of role models in interviews with practicing engineers is very prominent with 187 interviews present on the site. In their close up section, for example, they showcase interviews of questions and answers with practicing female engineers both in the United States and abroad. Here, a number these women speak much more frankly than on the other two sites,

explaining the challenges of being a minority in the field, the self doubt they grapple with, and the fact that their competence is regularly questioned by others and their challenges in balancing work and family. Of the 187 women however, 77 offer some form of advice or statement about these issues reflective of the confidence culture. These include providing suggestions for women to push any doubts aside, seeking out mentors in order to deal with the isolation and counter prejudices, working hard and proving oneself to facilitate their acceptance among their male colleagues and generally to be strong and persevere to overcome adversity.[3] As one example, one female engineer explains,

> When I started my job at AOC, I was nervous about the engineering work. This was my first exposure to such work and I had always believed I wasn't smart enough to be an engineer due to my difficulty in math and science. However, I faced my fear, participated on every project team to which I was assigned, and eventually learned to read blueprints and plans allowing me to perform the work for which I was hired. Some people even said I couldn't do it, that I would quit the job because I didn't have an engineering background. I proved them all wrong.

In thinking about such rhetoric in these campaigns, it should be pointed out that a number of scholars describe how women's struggles with self-confidence and isolation do not operate in a vacuum. Indeed, subtle gender dynamics in engineering workplaces and classrooms undermine women's beliefs about their suitability for the profession and thereby their credibility, often regardless of their actual ability (Cech et al. 2011; Dryburgh 1999, Faulkner 2007; McIlwee and Robinson 1992). For example ethnographic studies have demonstrated a tendency of faculty to hold mental images of women of similar abilities and backgrounds to high performing men, as "not the real engineering type" (Downey, Hegg and Lucena 1993). Studies also demonstrate that

[3] In fact, in my coding of these interviews very few even suggest that companies or cultural norms should be altered in engineering. In one rare (albeit small) example of this, one female engineer states, "This is a field dominated by males. Don't be naive or surprised when you arrive and find that men sometimes misbehave. Keep your integrity high, *and insist that the company you work for takes its bar higher*."

women, on average, fail to build self-confidence at performing engineering tasks in the educational process, even when they are high performers and have high levels of math self confidence, as a result of pervasive cultural ideologies and professional cultures in engineering that deem them as less qualified in such professional competencies (Cech et al. 2011; Dryburgh 1999). Yet, these websites fail to take into account the social processes that undermine women's self confidence, portraying it as issue as one that is deeply personal and one can be managed on one's own. As Gill and Orgad (2015) argue, for women to be self-confident is the imperative of our time. Confidence has become a commodity that women are offered as a means of conquering biases and barriers in the workplaces. However, as they also contend, popular dialogues, as evidenced on these websites, often do not examine more deeply why women begin to lose confidence as they train to become professional engineers and the role that cognitive biases play in this process, thus masking larger systems of inequality and privilege. Equally problematic is that they do not consider that confidence on its own is often not enough to surmount gendered obstacles.

Gender Essentialism

The image of men and women as fundamentally different is a dominant theme across all of these campaigns, which embrace the idea that that women will likely seek out engineering for dramatically different reasons that men. They follow a strong postfeminist media portrayal of gender differences and seek to rebrand engineering as compatible with stereotypical femininity as a means of appealing to women.

Such notions are quite striking with respect to the Nerd Girl site, which attempts to counter engineering's masculine identity through the use of hot pink images, and by replacing masculine images with those of successful and beautiful engineering role models who have

appropriately feminine interests. In the text on the site, references are made about how engineering can be combined with women's seemingly natural desires to shop, date men and maintain their appearance through fashion and beauty work. In fact, the biographies of the original Nerd Girls offer information about their fashion habits and show pictures of them in revealing clothing. All of the women shown on the Nerd Girls are conventionally attractive and defined by hegemonic beauty ideals, such as fair skin, long hair, and slender figures. All wear fashionable clothing and make-up and on the site there are several photos of them positioned in seductive poses. There are no images on the site of women who deviate in their appearance from those of conventional hegemonic Western femininity.

Through interviews with female engineers posted on the Nerd Girls site, viewers also learn that one of the benefits of choosing engineering as a career is the salary and this message is often coupled with the information that their earnings can be used to buy fashion and clothing items that are important to their identity. According to the tagline of Cristina, one Nerd Girl featured on the site,

> I am a master's student in Biomedical Engineering at Tufts University, and I can't wait till the day that my career allows me to buy my first pair of Jimmy Choos or Manolo Blahniks!

Jimmy Choos and Manolo Blahniks are shoes, which represent high fashion and have an average starting price of $500. In another video interview with Dr. Karen Panetta, the founder, we also learn that her father encouraged her to become an engineer, not simply because of her talent in math and science, but also because she needed a career that would allow her to support "bad shopping habit." A key claim of the Nerd Girls is that it's purpose is to change stereotype so that engineering will become more welcoming for women, many of whom believe they have to suppress or hide their interests in their beauty and appearance. While this may be true for some

women, the strategy risks replacing masculine stereotypes with feminine ones, which can have detrimental effects. As existing research shows, highly feminine role models can actually demotivate some women, rather than inspire young girls towards science and math professions (Betz and Sekaquaptewa 2012). Perhaps, the expectations of being both beautiful and an excellent engineer do not capture many women's experiences or become too burdensome.

In terms of GoldieBlox, the company was created based on Sterling's understandings of innate gender differences. According to the website,

> Our founder, Debbie, spent a year researching gender differences to develop a construction toy that went deeper than just "making it pink" to appeal to girls. She read countless articles on the female brain, cognitive development and children's play patterns. She interviewed parents, educators, neuroscientists and STEM experts. Most importantly, she played with hundreds of kids. Her big "aha"? Girls have strong verbal skills. They love stories and characters. They aren't as interested in building for the sake of building; they want to know why. GoldieBlox stories replace the 1-2-3 instruction manual and provide narrative-based building, centered around a role model character who solves problems by building machines.

As this quote demonstrates GoldieBlox's creation is based on "scientific" claims about women's strong verbal skills, despite the fact that there is considerable evidence among scientists to refute the claim that there is any real measurable gender differences in this respect (Hyde and Linn 1988). In her Kickstarter video where she pitches her campaign, she also claims, "It all came down to one simple thing. Boys like building and girls like reading!"

In her view, girls must be coopted, or manipulated into using engineering toys and this can be done by combining them with reading, storytelling, and books. So while Sterling is attempting to "disrupt the pink aisle" by offering these toys, her approach is based on the notion that girls and boys need fundamentally different toys. This approach fails to consider scholarship which demonstrates how preferences for toys and activities are actively shaped by parents and peers. (Fine 2010; Kane 2006; Messner 2000; West and Zimmerman 1987). This means that

there may be no need for a girl's building toy versus a boy's building toy. The issue may be more about the gendering of toys as appropriate for boys and girls in the first place.

Engineer Girl is much more nuanced than the other sites, particularly because it depicts a wide range of women who are engineers through its interviews with practicing engineers. However, this site emphasizes gender difference by invoking the technical/social dualism, which is a salient ideology in engineering (Hacker 1981; Faulkner 2000). According to this ideology, there are distinct parts of engineering practice, which require a separation of technical and social competencies. Though a false distinction in practice, as engineering is heterogeneous in nature, there is a strong tendency to equate the first side with masculinity and the second with femininity and to presume that this maps onto individual men and women. Engineer Girl draws on the technical/social dualism in particular, by assuming that women will be more interested if they emphasize the social aspects of job. To be clear, Engineer Girl does reference and discuss technical elements of engineering, but it is the social elements that they so often give special importance to, and this is important because it is a site designed specifically with women in mind. As just one example, they offer a yearly essay competition contest, encouraging young women to write an essay on a topical area related to engineering. At the time of writing this paper, the essay contest asks young how engineers might create solutions to improve the lives of animals and their habitats, a topic which suggests gender stereotypical notions of women as well suited and interested in caring for and saving animals (Irvine and Vermilya 2010). In past years the majority of the competitions, have also focused primarily on topics commonly understand as more social than technical, not to mention areas of engineering perceived of as appropriate for women because they are seen as more people-centered, such as the following located and labeled as such on the website: 1.) responsible engineering (with a focus on safety, health, well being) 2.)

50 years of engineering in society (how has engineering improved our quality of life) 3.) engineering: essential to our health 4.) food engineering guidelines, 5.) engineering & human service: relief from disaster, 6.) engineering: improving our world, 7.) save the dolphins 8.) engineers as dreamers.

While some many argue that this strategy is necessary to change current images of the profession as masculine and will allow young women to find a place within it, many feminist scholars from diverse traditions argue that such approaches often uphold gender inequality because they rely on reductive and essentialist stereotypes of women. Feminist philosopher, Judith Butler (1990) argues, for example, that in creating descriptive categories we affiliate with individuals we classify as women, we stabilize a set of identities or norms to which women must cohere. In her view, such categories create marginalized "others" who then must find a way to belong or risk invisibility. Psychologist Janet Hyde (2005) has also postulated the gender similarities hypothesis, which argues that women and men are more similar than they are different, calling into question a strategy predicated on gender differences. Others point to statistical data indicating that there is as much overlap among women and men as there is between them (Eagly 1995).

Social psychologists and sociologists also argue that by heightening awareness and emphasizing gender differences, this activates stereotypes and perceptions of gender difference, even in cases where none may exist (Banaji and Greenwald 2013; Ridgeway 2010). When gender differences are made salient, this leads to tendencies to use cultural understandings about women and men, and often automatic gender stereotypes, to categorize individuals and coordinate social behavior. This in turn, leads to biased and inaccurate evaluations of individuals' competencies and skills (Ridgeway 2010). Ethnographic work in engineering tends

to lend strong support to this theory. Feminist science and technology scholar, Wendy Faulkner (2007) has found there is a strong tendency of engineers to assume that women are highly skilled at tasks such as project management or working with clients, while men are seen as better at the "nuts and bolts" tasks, or more technical, parts of engineering. Yet as her fieldwork reveals such perceptions are often false. As she explains,

> Actual people and practices in engineering diverge significantly from the conventional technical gendering found in images of engineering (p. 3)

She argues that the perpetuation of the technical/social dualism creates tensions for the women she observes (and for some men as well, though for somewhat different reasons), who often have a more difficult time cultivating and proving their sense of belonging both to themselves, as well as to coworkers. Furthermore, the technical/social dualism leads to the gender segregation of jobs within engineering, which has negative impacts on female engineers' promotions and pay. Women are paid less than men with equal qualifications, when they work in subfields deemed highly technical, and they often move into lower paying and less prestigious areas considered more social and less technical because they are seen as more "gender authentic" (Cech 2013; Faulkner 2007).

Engineering as Playful and Fun

All three websites also rely heavily on encouraging women to come to engineering by depicting it as playful, fresh and fun. Embedded in postfeminist discourses the sites focus on framing engineering as a lifestyle choice and an expression of identity. As Anita Harris writes in work on the future girl and the workplace, "Employers no longer offer jobs, they promise to reward or provide a flexible and glamorous subjectivity (p. 111)." Much like in the last section, gendered narratives about what women are presumed to enjoy guide this message as well. The websites utilize bright colors of orange, green and pink and purple are present across the sites to

represent creativity, positivity and girlishness. Images on Engineer Girl show scrapbook inspired pictures of flowers, rockets, mobile phones, atoms and fish creating a sense that engineering is vibrant and inviting. A common theme is the use of upbeat vibrant language and pictures that encourage women to find what is pleasurable in engineering. Consider the following statements taken from the GoldieBlox website: "Goldie's aim is to introduce women to the joy of engineering at a young age," and "Goldie's stories relate to girls' lives, have a sense of humor and make engineering fun."

Pictures and video of children laughing, smiling and enjoying themselves, permeate the entire site. The site also features humorous videos from professional YouTube toyhacker and robot builder Simon Giertz, who is known for her funny and quirky robotic inventions and repurposing of toys. In this way, engineering becomes something that can be mastered by through the consumption of the right toys, electronic apps, technologies and hobbies in one's free time.

The NerdGirls site also uses similar language advising parents to indulge girls and to let them express themselves in ways that can then be linked to engineering rather than forcing math and science on them. As one blogpost by Panetta states,

> Most parents haven't got any idea how to get their girls interested in STEM but want these opportunities for their daughters. Oftentimes, their approaches end up being viewed as trying to stuff the science in their child's face. This typically drives girls even further from STEM. Start by asking what does your daughter like and what does she do in her free time.

Panetta goes on to say,

> For instance, a girl can like fashion and dressing up dolls. Using patterns and artistic abilities, she can learn how to think like a mechanical engineer, determining how pieces of material can be put together to fit around an object or even making new materials out of recycled objects.

In one video interview about her own pathway into engineering, Panetta shows off two Barbie dolls from her childhood toy collection, modeled on the leading female characters of the popular 1960s and 1970s sitcoms, Bewitched and I Dream of Genie. She holds the dolls up explaining,

> These are the two ladies who helped inspire my dream of becoming an engineer, using magic. I liked the fact of making things happen that people said couldn't happen!

Equating engineering with lighthearted television shows about a witch and a genie, and toys like Barbie Dolls serves to gloss over its link with math and science and align it with gender appropriate interests and personal choices. Engineering is presented as a carefree career path portraying it as a profession where they can simply enjoy themselves. Thus, young women are encouraged to build and assemble a parade float (a toy from GoldieBlox) or perform magic (The Nerd Girls), while little attention is paid to how educational structures and shapes their pathways to engineering.

Exciting descriptions aimed at motivating young women are also provided on Engineer Girl. For example on one page, they pose the question, "Why Should I Become an Engineer," replying with the statement,

> You'll get to do cool stuff. Be the first to develop or try out a new technology, like a flying car or an undersea house. Design and build virtual reality amusement parks, patent a new material that can mend broken bones or cure arthritis. Engineers will be involved in making all the wonders of the future a reality.

It also allows users to peruse engineering by "trying on careers" as one might a new outfit or pair of shoes, by clicking on different tabs, and offering descriptions through interviews with practicing engineers. Engineer Girl does feature interviews with female engineers discussing their jobs and it has a section titled "How to Get There" with feature stories about science competitions, internships and extracurricular activities.

Using examples of engineering which foreground the entertaining nature of the profession but fail to emphasize the importance of preparation can have negative consequences that come to bear on STEM careers. For one, this approach downplays the math and science and involved and rarely emphasizes school choice and effects of school environments. Instead the message is aimed at the importance of choice, self-expression and indulging one's educational and career preferences as an individual and through extracurricular activities often located outside of school. As Kekelis and her colleagues (2005) warn in their study of an engineering outreach program for young women,

> Career choices involving professional and technical careers appear to be more important as objects of discourse than as paths the girls actually plan to follow. Unless they receive career guidance and understand the benefits an advanced educational degree can bring, these students will face enormous challenges and difficulties achieving their dreams of careers that require years of challenging studies and professional training (p. 102).

Many of their respondents and their families lacked concrete guidance and information, that would allow them to make informed academic and career plans to lay the groundwork for a future in science and technology. In fact, a key finding from their work, is that sparking an interest in engineering through exciting hands on projects is a necessary first step, but on its own, it is unlikely to lead to an actual career in a technological field. While girls may be strongly encouraged to go to college, parents take a hands off in respect to their children's educational choices. Often talented young women are given minimal advice about how they can prepare for STEM professions, which they claim leads to an " alarming disconnect between dreams and plans."

While engineering's strong connection to math can be intimidating to women, the importance of engineering's connection to math is not trivial. Undergraduate engineering programs often have prerequisites requiring advanced high school math and science coursework.

An undergraduate degree in engineering is largely designed for students who are expected to possess a solid foundation in math and science upon beginning such a degree. While the gap between women and men has dramatically narrowed in recent years in math and science course-taking, women are still less likely than their male peers to take physics and computer science (Ma 2011; Xie and Shauman 2003). As Ma (2011) demonstrates through a detailed study of the predictors of the pathways into different STEM fields, taking physics acts as a filter that predicts entrance into and completion of an engineering degree, but this is not the case for other STEM majors such as biology. Her analysis shows that this gender gap in physics matters for engineering and that encouraging more women to take physics would help boost their degree attainment of engineering in college. Sociologists, Legewie and DiPrete (2014) further show that high school curricula and context is also extremely influential factor on the declaration of a STEM major. They argue that a strong STEM curriculum with a variety of STEM classes in high school stimulates interest in science, but perhaps more importantly they argue it plays a pivotal role in breaking down gender stereotypes of these subjects as inherently masculine domains. According to their analysis, high schools that are successful in attracting students to rigorous STEM courses can reduce the gender gap of those who are planning to declare a STEM major by 25 percent.

Thus, without knowledge of how school structure can impact a future in STEM women may be at a disadvantage. The educational system in the United States allows a wide latitude in students' selection of courses, even among STEM subjects, as well as in the types of schools students attend. Yet whether or not one choses between physics or anatomy can predict the specific STEM major one choses. Additionally, schools can vary in terms of how much they magnify gender stereotypes about women and math and how much thy mitigate them and place

them in the background (Legewie and DiPrete 2014; Ridgeway 2011). It is also the case that for the majority of students, success in engineering requires a great deal of effort, time and discipline that begins in high school. Therefore, messages that paint images of individual women finding their passions for engineering in playful ways, without making it clear about how students can prepare themselves academically may limit the possibility of a future engineering career. These outreach campaigns focus more on encouraging women to cultivate personal interests in engineering through toys (GoldieBlox), by playing or performing magic (Nerd Girls), or seeking out STEM related hobbies that they deem as personally stimulating (Engineer Girl) that may not translate into a future in engineering.

Finally, such messages obscure important issues around race and social class. Presenting engineering as fun and exciting appears to be largely informed by understandings of white middle class women. For example, scholars have shown that young black women often express a keen interest in math, science and technology early in their educational path and are encouraged to pursue this interest by their families who view such careers as a source of stability and social mobility (Hanson 2009; O'Brien et al. 2015). Thus ideas about sparking enthusiasm may be misplaced. Black women often face discouragement and discrimination from teachers and educators as a result that impede their pathways to engineering futures rather than a lack of interest (Hanson 2009).

Finally, these campaigns assume that their users have the financial ability to buy numerous toys and gadgets, possess the social capital and connections to attend summer camps, join professional groups, job shadow professionals, and find and perform unpaid internships. All of this ignores how race and social class can shape these opportunities and possibilities.

Conclusion

In this article, I ask how three prominent engineering outreach campaigns create messages for young women to better understand how images of engineering are being marketed to young women. The analysis finds that postfeminist understandings of an individualist, consumer culture, in which women and men are conceptualized as vastly different psychologically, are emphasized to encourage women to study engineering. Larger structural and cultural issues that work to promote gender inequality are often minimized and neglected. The analysis revealed three important points.

First across campaigns, all emphasize individual solutions to coping with issues such as a gender confidence gap. These campaigns address this by focusing on ways in which women can engage in self-work to remedy it. Second, such campaigns use gender differences and stereotypes to sell engineering to young women. Designed solely for women, these sites create a narrative about how culturally acceptable expressions of femininity can coexist with engineering. Finally, such campaigns also promote the notion that engineering is playful and fun in order to spark an interest in the profession, while glossing over the training and educational preparation necessary to make engineering a future reality.

These findings offer opportunities to rethink the ways in which outreach is conducted. They certainly highlight the dilemma that such campaigns confront in terms of presenting engineering to young women: How should campaigns attempt to make engineering relevant and appealing to young women, without essentializing women and maintaining the gender status quo in the field? I suggest three steps in this direction:

In terms of self-confidence, scholars have demonstrated gender differences in this respect which impact how and if women engage in engineering, which must be addressed. However,

postfeminist narratives that propose that women can cultivate self-confidence as a technology of the self to overcome and conquer their insecurities may be unwittingly reproducing gender inequality. While building confidence is laudable and bound to have many positive effects for young women, such messages could be augmented with information about how the social and cultural dimensions of their lives chip away at their confidence, so they can seek to engage with and transform these dimensions. If young women are unable to identify and challenge the bias and sexism in educational systems as a collective problem, as opposed to dealing with it as individual problem, engineering will fail to address gendered barriers. Equally important, as well, is that schools and universities must continue to recognize and work towards the abolishment of the norms and structures that ultimately cause women to struggle with issues of self-confidence.

Campaigns can also consider displaying the wide range of masculine and feminine identities that engineers possess, throughout all their programming, language and messaging. Some women may be motivated by seeing highly feminine role models, but existing research suggests that some will be more inspired by a range of female role models who are diverse in their interests and appearances (Betz and Sekaquaptewa 2012). In this respect, Engineer Girl's numerous interviews with practicing engineers, is an excellent example of such representation, as compared to the women featured on the Nerd Girls who appear narrowly focused on their appearances and fashion.

Furthermore, creators of outreach must challenge stereotypes not just about engineering as masculine, but also about women as a monolithic group. They should also think carefully about how they present ideas about innate gender differences and be careful not to exaggerate differences between women and men in marketing efforts. While some women are motivated to

become engineers because they are seeking socially relevant professional opportunities, some recent studies demonstrate the differences between why women and men choose engineering are slight. While many factors often go into the choice, the salary and job opportunities and of the intellectual challenges are attractive to both women and men (Goodman et al. 2002; Lagesen 2007). In this sense, it might be wise to also consider the similarities.

Finally, while such campaigns seek to reposition engineering as creative, exciting and fun to recruit more women, they could also take steps to pair this message with the importance of structured educational pathways and learning opportunities to achieve this goal. Sparking an interest in engineering is very important. Yet it is not enough to ensure that women become engineers. Specifically outreach should prominently highlight the importance of educational programming and school environment in the process. When women stay enrolled and engaged in courses such as physics they are more likely to select an engineering major. When women are exposed to math and science subjects by teachers and in high school through a range of coursework, stereotypes of 'math and science as masculine' also can be broken down, and women stay in the engineering pipeline.

References

Banaji, Mahzarin R. and Anthony G. Greenwald. 2013. *Blindspot: Hidden Biases of Good People.* New York: Delacorte Press.

Banet-Weiser, Sarah. 2015. "'Confidence You Can Carry': Girls in Crisis and the Market for Girls' Empowerment Organizations." *Continuum: Journal of Media and Cultural Studies* 29(2): 182-193.

Banet-Weiser, Sarah and Laura Portwood-Stacer. 2006. "I Just Want to Be Me Again!" Beauty Pageants, Reality Television and Post-Feminism." *Feminist Theory* 7(2): 255-272.

Baumgardner, Jennifer and Amy Richards. 2000. *Manifesta: Young Women, Feminism and the Future.* New York: Farrar, Straus, and Giroux.

Betz, Diane E. and Denise Sekaquaptewa. 2012. “My Fair Physicist? Feminine Math and Science Role Models Demotivate Young Girls.” *Social Psychological and Personality Science* 3(6): 738-746.

Bix, Amy. 2014. *Girls Coming to Tech: A History of American Engineering Education for Women.* Cambridge Massachusetts: MIT Press.

Blickenstaff, Jacob Clark. 2005. “Women and Science Careers: Leaky Pipeline or Gender Filter.” *Gender and Education* 17(4): 369-386.

Brizendine, Louann. 2006. *The Female Brain*. New York: Morgan Road Books.

Butler, Judith. 1990. *Gender Trouble: Feminism and the Subversion of Identity*. New York: Routledge.

Bystydzienski, Jill M. and Adriane Brown. 2012. “I Just Want to Help People”: Young Women’s Gendered Engagement with Engineering.” *Feminist Formations* 24(3): 1-21.

Cech, Erin. 2014. “The Self-Expressive Edge of Occupational Sex Segregation.” *American Journal of Sociology* 119(3): 747-789.

Cech, Erin. 2013. “Ideological Wage Inequalities?: The Technical/Social Dualism and the Gender Wage Gap in Engineering.” *Social Forces* 91(4): 1147-1192.

Cech, Erin, Brian Rubineau, Susan Silbey and Caroll Seron. 2011. "Professional Role Confidence and Gendered Persistence in Engineering.” *American Sociological Review* 76: 641-666.

Ceci, Stephen J., Williams M. Wendy and Susan M. Barnett. 2009. “Women's Underrepresentation in Science: Sociocultural and Biological Considerations.” *Psychological Bulletin* 135: 218-261.

Ceci, Stephen J. and Wendy M. Williams. 2009. *The Mathematics of Sex: How Biology and Society Conspire to Limit Talented Women and Girls*. Oxford, England: Oxford University Press.

Champion, Edward. 2007, “Tough Questions, Journalistic Truth, and Danica McKellar.” Retrieved March 9, 2017 at: (http://www.edrants.com/tough-questions-journalistic-truth-and-danica-mckellar/).

Charles, Maria and Karen Bradley. 2009. “Indulging Our Gendered Selves? Sex Segregation by Field of Study in 44 Countries.” *American Journal of Sociology* 114(4): 924-976.

Charmaz, Kathy. 2014. *Constructing Grounded Theory Second Edition*. London: Sage.

Cheryan, Sapna. 2012. “Understanding the Paradox in Math-Related Fields: Why Do Some Gender Gaps Remain While Others Do Not?” *Sex Roles* 66: 184-90.

Cheryan, Sapna, Paul G. Davies, Victoria C. Plaut, and Claude M. Steele. 2009. “Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science.” *Journal of Personality and Social Psychology* 97(6): 1045-1060.

Correll, Shelly J. 2004. "Constraints into Preferences: Gender, Status, and Emerging Career Aspirations.” *American Journal of Sociology* 69(1): 93-113.

Currie, Dawn H., Deidre M. Kelly and Shauna Pomerantz. 2009. *"Girl Power": Girls Inventing Girlhoods*. New York: Peter Lang.

Danica McKellar Website. Retrieved March 1, 2017 at: http://www.danicamckellar.com.

Diekman, Amanda, Emily K. Clark, Elizabeth. R. Brown and Mia Steinberg. 2011. "Malleability in Communal Goals and Beliefs Influences Attraction to Stem Careers: Evidence for Goal Congruity Perspective." *Journal of Personality and Social Psychology* 101: 902-918.

Dillon, Sam. January 18, 2005. "Harvard Chief Defends His Talk on Women." in *The New York Times.*

DiPrete, Thomas A. and Claudia Buchmann. 2013. *The Rise of Women: The Growing Gender Gap in Education and What It Means for American Schools.* New York, New York Russell Sage Foundation.

Downey, Gary, Shannon Hegg, and Juan Lucena. 1993. “Weeded Out: Critical Reflection in Engineering Education.” Paper presented at the American Anthropological Association Annual Meeting Washington DC.

Dryburgh, Heather. 1999. “Work Hard: Play Hard: Women and Professionalization in Engineering—Adapting to the Culture.” *Gender & Society* 13(5): 664-82.

Eagly, Alice H. 1995.“The Science and Politics of Comparing Women and Men.” *American Psychologist* 50(3): 145-158.

Eccles, Jacquelynne S. 1994. “Understanding Women’s Educational and Occupational Choices.” *Psychology of Women Quarterly* 18:585-609.

Eccles, Jacquelynne S. 2011b. “Gendered Educational and Occupational Choices Applying the Eccles Et Al. Model of Achievement-Related Choices.” *International Journal of Behavioral Development* 35: 195-201.

Eccles, Jacquelynne S. 2011a. “Understanding Women's Achievement Choices: Looking Back and Looking Forward.” *Psychology of Women Quarterly* 35: 510-16.

Engineer Girl website. Retrieved November 9 through March 9 2017 at: https://www.engineergirl.org.

England, Paula. 2010. "Gender Revolution: Uneven and Stalled." *Gender & Society* 24(2): 149-166.

England, Paula and Su Li. 2006. "Desegregation Stalled: The Changing Gender Composition of College Majors." *Gender & Society* 20: 657-677.

Faludi, Susan. 2006. *Backlash: The Undeclared War against American Women*. New York: Crown.

Faulkner, Wendy. 2000. "Dualisms, Hierarchies, and Gender in Engineering." *Social Studies of Science* 30(5): 759-792.

Fine, Cordelia. 2010. *Delusions of Gender: How Our Minds, Society and Neurosexism Create Difference*. New York:W.W. Norton & Company

Foucault, Michel. 1988. "Technologies of the Self." Pp. 16-49, edited by L. H. Martin, H. Gutman and P. H. Hutton. Amherst: University of Massachusetts Press.

Foucault, Michel. 1977a. "The Political Function of the Intellectual." *Radical Philosophy* 17: 12-14.

Foucault, Michel. 1977b. *Discipline and Punish: The Birth of a Prison.* New York: Vintage Books.

Fraser, Nancy. 2009. "Feminism, Capitalism and the Cunning of History." *New Left Review* 56: 97-117.

Gill, Rosalind. 2007. "Postfeminist Media Culture: Elements of a Sensibility." *European Journal of Cultural Studies* 10(2): 147-166.

Gill, Rosalind and Shani Orgad. 2015. "The Confidence Culture." *Australian Feminist Studies* 30(86): 324-444.

Gill, Rosalind and Christina Scharff. 2011. *New Femininities: Postfeminism, Neoliberalism and Subjectivity* Palgrave Macmillan.

GoldieBlox website Retrieved September 9th 2016 through December 9th, 2016 at: http://www.goldieBlox.com.

Goodman, Irene F., Christine M. Cunningham, Cathy Lachapelle, Meredith Thompson, Katherine Bittinger, Robert T. Brennan and Mario Delci. 2002. *Final Report of the Women's Experiences in College Engineering (WECE Project)*. Cambridge, MA.

Hacker, Sally L. 1981. "The Culture of Engineering: Woman, Workplace and Machine." *Women's Studies International Quarterly* 4(3): 341-353.

Hanson, Sandra. 2009. *Swimming against the Tide: African American Girls and Science Education*. Philadelphia: Temple University Press.

Harris, Anita. 2004. *Young Women in the Twenty-First Century* New York: Routledge.

Harvey, David. 2005. *A Brief History of Neoliberalism.* Oxford: Oxford University Press.

Hemel, Daniel. January 14, 2005. "Summers' Comments on Women and Science Draw Ire." in *Harvard Crimson* Cambridge, Massachusetts.

Hill, Catherine, Christianne Corbett, and Andrea St. Rose. 2010. *Why So Few? Women in Science, Technology, Engineering, and Mathematics*. American Association for University Women. Retrieved November 27th, 2014 at: (http://www.aauw.org/research/why-so-few/).

Hyde, Janet S. 2005. "The Gender Similarities Hypothesis." *The American Psychologist* 60(6): 581-92.

Hyde, Janet S. and Marcia C. Linn. 1988. "Gender Differences in Verbal Abilities: A Meta-Analysis." *Psychological Bulletin* 104: 53-69.

Irvine, Leslie and Jenny R. Vermilya. 2010. "Gender Work in a Feminized Profession: The Case of Veterinary Medicine." *Gender & Society* 24(56): 56-82.

Kane, Emily. 2006. "'No Way My Boys Are Going to Be Like That!' Parents Responses to Children's Gender Nonconformity." *Gender & Society* 20(2): 149-176.

Karen Panetta Website. Retrieved March 1st, 2017 at: http://www.karenpanetta.com/#about-overview.

Kay, Kathy and Claire Shipman. 2014. *The Confidence Code: The Science and Art of Self-Assurance--What Women Should Know*. New York: Harper Collins.

Kekelis, Linda S., Rebecca Wepsic Ancheta and Etta Heber. 2005. "Hurdles in the Pipeline: Girls and Technology Careers." *Frontiers: A Journal of Women's Studies* 26(1): 99-109.

Kickstarter GoldieBlox: The Engineering Toy for Girls. Retrieved November 9 to December 9, 2014,at: https://www.kickstarter.com/projects/16029337/goldieblox-the-engineering-toy-for-girls.

Kindlon, Daniel J. 2006. *Alpha Girls: Understanding the New American Girl and How She Is Changing the World.* New York: Holtzbrinck.

Lagesen, Vivian. 2007. “Strength in Numbers: Strategies to Include Women into Computer Science.” Social Studies of Science 37(1): 67-93.

Legewie, Joscha and Thomas DiPrete. 2014. “The High School Environment and the Gender Gap in Science and Engineering.” *Sociology of Education* 87(4): 259-80.

Loudenback, Tanza. June 15th, 2016, “This Company's Toys Are Helping Mold a New Generation of Engineers.” *Business Insider*.

Ma,Yingyi. 2011 “Gender Differences in the Paths Leading to a Stem Baccalaureate.” *Social Science Quarterly* 92(5): 1169-1190

Marcus, Sara. September 17th, 2010. “Danica McKellar: Are Her Math Books Bad for Girls.” in *Salon*. Retrieved March 2, 2017 at: http://www.salon.com/2010/09/18/danica_mckellar_interview/.

McIlwee, Judith S. and Gregg J. Robinson. 1992. *Women in Engineering: Gender, Power, and Workplace Culture*. Albany:State University of New York Press.

McKee, Alan. 2003. *Textual Analysis: A Beginner's Guide*. Sage: London

McKellar, Danica. 2008. *Math Doesn't Suck: How to Survive Middle School Math without Losing Your Mind or Breaking a Nail*. New York: Penguin Books.

McRobbie, Angela. 2007 "Postfeminism and Popular Culture." Pp. 255-64 in *Interrogating Postfeminism: Gender and the Politics of Popular* Culture, edited by Y. Tasker and D. Negra. Durham, NC: Duke University Press.

Messner, Michael A. 2000. "Barbie Girls Versus Sea Monsters: Children Constructing Gender.” *Gender & Society* 14(6): 765-84.

Moss-Racusin, Corrine A., John F. Dovidio, Victoria L. Brescoll, Mark J. Graham and Jo Handelsman. 2012. “Science Faculty's Subtle Gender Biases Favor Male Students.” *Proceedings of the National Academy of Sciences of the United States of America* 109(41): 16474-16479.

National Academy of Engineering. 2008. *Changing the Conversation: Messages for Improving Public Understanding of Engineering*. National Academy Press.

National Academy of Sciences. 2006. *Beyond Bias and Barriers: Fulfilling the Potential of Women in Science and Engineering*. Washington, DC: National Academy Press.

National Science Foundation. 2017 Women, Minorities, and Persons with Disabilities in Science and Engineering. Retrieved May 5, 2017 at: https://www.nsf.gov/statistics/2017/nsf17310/digest/about-this-report/.

Negra, Diane and Yvonne Tasker, eds. 2007. *Interrogating Postfeminism: Gender and the Politics of Popular* Culture. Durham, North Carolina: Duke University Press.

Nerd Girls website. Retrieved November 9 through March 9, 2017 at: http://nerdgirls.com.

O'Brien, Laurie T., Alison Blodorn, Glenn Adams, Donna M. Garcia and Elliot Hammer. 2015. "Ethnic Variation in Gender Stem Stereotypes and Stem Participation: An Intersectional Approach." *Cultural Diversity and Ethnic Minority Psychology* 21: 169-80.

Page, Scott E. 2008. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies*. Princeton, NJ: Princeton University Press.

Pinker, Steven. 2002. *The Blank Slate: The Modern Denial of Human Nature*. New York: Penguin Books.

Pinker, Steven and Elizabeth Spelke. 2005. "A Conversation with Steven Pinker and Elizabeth Spelke." *Harvard University, Mind/Brain/Behavior Initiative*. Retrieved March 1, 2017 at: http://stevenpinker.com/publications/science-gender-and-science-conversation-steven-pinker-and-elizabeth-spelke.

Pomerantz, Shauna, Rebecca Raby and Andrea Stefanik. 2013. "Girls Run the World? Caught between Sexism and Postfeminism in School." *Gender & Society* 27(2): 185-207.

Renold, Emma and Alexandra Allan. 2007. "Bright and Beautiful: High Achieving Girls, Ambivalent Femininities, and the Feminization of Success in the Primary School." *Discourse: Studies in the Cultural Politics of Education* 27(4): 457-473.

Reuben, Ernesto, Paola Sapienza and Luigi Zingales. 2014. "How Stereotypes Impair Women's Careers in Science." *Proceedings of the National Academy of Sciences* 111(12): 4403-4408.

Ridgeway, Cecilia. 2010. *Framed by Gender: How Gender Inequality Persists in the Modern World*. Oxford: Oxford University Press.

Rimer, Sara. April 1st, 2007. "For Girls, It's Be Yourself and Be Perfect Too." In *New York Times.*

Ringrose, Jessica and Valerie Walkerdine. 2008. "What Does It Mean to Be a Girl in the Twenty-First Century? Exploring Some Contemporary Dilemmas of Femininity and Girlhood in the West " in *Girl Culture: An Encyclopedia*, edited by C. A. Mitchell and J. Reid-Walsh. Westport, Connecticut.

Sandberg, Sheryl. 2013. *Lean In: Women, Work, and the Will to Lead*. New York: Alfred A. Knopf.

Snyder, Thomas D., Cristobal de Brey and Sally A. Dillow. 2016. *Digest of Educational Statistics* 2015. National Center for Education Statistics.

Stacey, Judith. 1987. "Sexism by a Subtler Name: Postindustrial Conditions and Postfeminist Consciousness in the Silicon Valley." *Socialist Review* 17(6): 7-28.

West, Candace and Don Zimmerman. 1987. "Doing Gender." *Gender & Society* 1(2): 124-51.

Wulf, William. 1998. "Diversity in Engineering." *The Bridge* 28(1): 48.

Xie, Yu and Kimberlee A. Shauman. 2003. *Women in Science: Career Processes and Outcomes*. Cambridge, Massachusetts: Harvard University Press.

Chapter 5: Conclusion

Between 1940 and 1990, the segregation of occupations declined dramatically as women began entering male dominated careers that were previously off limits to them. Yet beginning in the 1990s, even as women outpaced men in their enrollment and graduation rates on college campuses, the pace of integration of occupations and majors slowed and has remained stalled (England 2010). In the case of engineering, the field has remained remarkably resilient to gender integration. In the 1970s women made up only 3 percent of engineering majors. Beginning in the 1980s they increased to 10 percent. By 1991, they made up 15 percent. Today they complete 19 percent of all engineering undergraduate degrees (National Center for Education Statistics 2015).

The three articles presented in this dissertation contribute to our understanding of this issue by filling in some of the gaps in our knowledge on the topic of women's engagement and underrepresentation with engineering. In these articles, I look at three topics that are critical to increasing the representation of women in engineering and enhance our understanding of the issue using sociological theories. I attempt to shift the focus on studies of women in engineering to encompass both issues of retention *and* the choice of an engineering major from a sociological perspective. Furthermore, I have focused on extending the literature on Black women in engineering in order to understand how intersectional identities shape women's experiences in engineering education. Finally, I offer a feminist sociological analysis of outreach campaigns in engineering in an effort to bring a gender aware gaze to the important work outreach programs engage in.

However, there are many fruitful avenues for future research that emerge from this dissertation. First it is critical that more work seek to understand how men make a choice of an engineering major. As this dissertation points out much of the literature related to college major

choice is quantitative and based on large scale datasets with little qualitative research on this topic. While these studies are important in outlining trends, they cannot reveal the nuances behind the choices that are important in understanding gendered patterns. This dissertation offers an analysis of women's accounts of why they choose engineering to remedy this shortcoming in the literature. However, to truly understand how gender shapes this choice, men should be included in the research. For example, scholars claim that gender socialization between boys and girls is a key mechanism fueling the gap as boys are more likely to tinker at home which channels them into engineering. Yet this may be changing as scholars argue that fewer boys are engaging in this type of activity (Faulkner 2007). Thus we need to understand why young men are still more likely to chose engineering and what they find attractive in engineering as a college major.

Additionally more work needs to look at comparing different STEM majors and the variations among them instead of aggregating them together. Women make up 50 percent of students studying biology and 40 percent of those in chemistry but only 19 percent of those in engineering (National Science Foundation 2017). They are also differentially represented within engineering majors. At the university where I conducted my research, they make up 50 percent of the students in biological engineering but only 7 in mechanical engineering. I am currently at work on this topic with more interviews underway to better understand gendered patterns among engineering majors. If we do not consider the variation within engineering disciplines and STEM fields more generally, then we will never understand what drives women and men towards some majors but not others.

Finally, for too long, scholars studying women's participation in engineering, seem to really only be writing and researching issues that are concerned with white women. The research

on women of color in engineering is woefully inadequate. To be sure, the low numbers of women of color in engineering education make it difficult to do this research, however this should not impede more studies in this direction. Future quantitative and qualitative research is necessary to better understand and capture the experiences of Black women in engineering. Comparisons should also be made between Black women and Black men and studies should also consider comparing historically black colleges and universities (HBCUs) and primarily white institutions (PWIs).

Another important conclusion of this dissertation is that a great deal of the literature that deals with the topic of women in engineering is not informed by current sociological gender scholarship. In fact, chapter four was written to call attention to how outreach programs may unwittingly reproduce gender inequality even amidst much of the important work they do. Policy efforts, outreach programs and scholarly work on women in engineering programs can be enhanced by engaging with sociological feminist theory and through cross-disciplinary work.

References

England, Paula. 2010. "The Gender Revolution: Uneven and Stalled." *Gender & Society* 24(2): 149-66.

Faulkner, Wendy. 2007. "'Nuts and Bolts People' Gender-Troubled Engineering Identities." *Social Studies of Science* 30(5): 759-92.

National Center for Education Statistics. Digest of Education Statistics. Retrieved March 15, 2015 at: https://nces.ed.gov/programs/digest/d15/tables/dt15_318.50.asp.

National Science Foundation. Women, Minorities, and Persons with Disabilities in Science and Engineering. Retrieved May 5, 2017 at: https://www.nsf.gov/statistics/2017/nsf17310/digest/about-this-report/.

Appendix: IRB Approval

Application for Exemption from Institutional Oversight

Institutional Review Board
Dr. Robert Mathews, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu | lsu.edu/irb

Unless qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/ projects using living humans as subjects, or samples, or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

-- Applicant, Please fill out the application in its entirety and include the completed application as well as parts A-F, listed below, when submitting to the IRB. Once the application is completed, please the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at http://sites01.lsu.edu/wp/ored/human-subjects-screening-committee-members/

-- A Complete Application Includes All of the Following:
(A) A copy of this completed form and a copy of parts B thru F.
(B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
(C) Copies of all instruments to be used.
*If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
(D) The consent form that you will use in the study (see part 3 for more information.)
(E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (http://phrp.nihtraining.com/users/login.php)
(F) IRB Security of Data Agreement: (https://sites01.lsu.edu/wp/ored/files/2013/07/Security-of-Data-Agreement.pdf)

1) Principal Investigator: Emily Blosser **Rank:** graduate student

Dept: sociology **Ph:** 225-588-3351 **E-mail:** ebloss2@tigers.lsu.edu

2) Co Investigator(s): please include department, rank, phone and e-mail for each
*If student, please identify and name supervising professor in this space
Supervising Professor-Wesley Shrum Professor, sociology (225) 578-5311
shrum@lsu.edu

IRB# E8417 LSU Proposal #
✓ Complete Application
✓ Human Subjects Training
✓ IRB Security of Data Agreement

3) Project Title: Profiles of Women in Engineering: What Attracts Women to Engineering?

STUDY EXEMPTED BY:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
130 David Boyd Hall
225-578-8692 / www.lsu.edu/irb
Exemption Expires: 9/19/2016

4) Proposal? (yes or no) No **If Yes, LSU Proposal Number**

Also, if YES, either ○ **This application completely matches the scope of work in the grant**
OR ○ **More IRB Applications will be filed later**

5) Subject pool (e.g. Psychology students) Engineering students and professionals in LSU and Baton Rouge

*Circle any **"vulnerable populations" to be used**: (children <18; the mentally impaired, pregnant women, the ages, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature Emily Blosser **Date** 9-12-2013 (no per signatures)

** **I certify my responses are accurate and complete.** If the project scope or design is later changes, I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study. If I leave LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted ✓ Not Exempted ____ Category/Paragraph 2

Signed Consent Waived?: Yes (No)

Reviewer Mathews **Signature** [signature] **Date** 9/20/13

ACTION ON EXEMPTION CONTINUATION REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu | lsu.edu/irb

TO: Emily Blosser
Sociology

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: February 6, 2017

RE: **IRB#** E8417

TITLE: Profiles of Women in Engineering: What Attracts Women in Engineering?

New Protocol/Modification/Continuation: Continuation

Review date: 2/3/2017

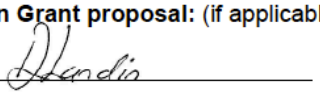
Approved X **Disapproved**_____

Approval Date: 2/3/2017 **Approval Expiration Date:** 2/2/2020

Re-review frequency: (three years unless otherwise stated)

LSU Proposal Number (if applicable):

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Dennis Landin, Chairman 

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: Please be aware that projects approved by exemption can be active for three years. Approvals will automatically be closed by the IRB on the expiration date unless the PI requests a continuation.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

Vita

Emily Gwen Blosser was born in San Antonio, Texas and raised in Lubbock, Texas. In 1997, she graduated from the University of Texas at Austin with a Bachelor of Arts degree in German. After this she taught English in Austria for three years. She received a Master of Public Affairs and Russian East European Studies from the University of Texas at Austin in 2005 and worked for several years in the nonprofit sector. She expects to receive her Doctor of Philosophy in Sociology from Louisiana State University during the Fall 2017 commencement ceremony. In the Fall of 2017 she will be working as a sociology instructor at the University of Louisiana at Lafayette. Her research focuses on gender, race, education and science and technology studies.