Opening the Gendered Toolbox: The Advancement and Treatment of Women in Engineering at the Undergraduate Level

Emily R. Baker
Clarkson University
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Abstract

The engineering field is one of the most underrepresented fields for women in STEM professions. With waning retention rates of women in the engineering field as women get older, young women truly hold the power to change the engineering environment now and in the future. This research explains why women enter undergraduate engineering programs and how their environment compares to women's past academic and social environments in engineering.

In the late nineteenth and early twentieth centuries, there were very few women in the engineering field. However, women's admittance into engineering jobs during the world wars and into American university programs in engineering increased these numbers. Feminist thought in the twentieth century gave women more agency in their career choices, making it acceptable for women to have careers in engineering. But there still remains a stigma attached to women engineers described as microdiscrimination and microaggression. Minute cultural reminders exist in the lives of women engineers that limit their advancement.

Clarkson University, a small engineering school in New York, today has 366 enrolled women in engineering. Founded as a coeducational institution in 1896, Clarkson excluded women from 1907 until 1964 when it reintroduced coeducation. My ethnographic work with the current Clarkson women in engineering shows that, while women in engineering are in greater numbers and have greater confidence, there are still elements of the engineering culture that should change in order to reach gender equality. I propose three possible solutions to meet these milestones: more recruitment in elementary schools, university curriculum adapted for more real-world application, and more women engineering faculty and more professional women engineers who can serve as mentors for the next generation of women. Clarkson's past and future advancement of women reflects the progress of women nationally.

Introduction

Former NASA Ambassador and *Star Trek* actress Nichelle Nichols once emphasized, "Science is not a boy's game, it's not a girl's game. It's everyone's game. It's about where we are and where we're going" (McKenzie, 2014). However, women in STEM (science, technology, engineering, and mathematics) undergraduate programs only began full-scale enrollment at America's major schools within the past sixty years (Bix, 2004).

Statistically, engineering has been the most underrepresented field for women out of all STEM careers. As of 2010, women made up 18.4% of the undergraduates enrolled in engineering at American colleges (Bix, 2010). This is a significant advancement from the 12.1% of undergraduate engineers in 1979. However, women still only made up less than one fifth of the total engineering undergraduates five years ago; this is the same year that 57% of all undergraduates were women. While it is one of the five top grossing careers for women (McIlwee, 1992), engineering is still dominated by men. What about engineering is unappealing to women?

This study deals with the advancement and treatment of women in the engineering field at the undergraduate level. There are many more opportunities for women in the engineering field today than in the twentieth century. Yet women are not moving into the engineering field nearly as fast as they are in other occupations. While researchers have shown this through university statistics and surveys, doing analysis at a local level and talking with female engineering majors gives researchers a personalized and culturally specific point of view on women engineers' experiences.

I break down my research into three parts: the history of women engineers in America and the impact of feminism on women in engineering, the history of Clarkson University (the university in Potsdam, NY where I conducted my research), and the ethnographic work I conducted with the current undergraduate women at Clarkson University. These three components work together to track the progression of women in engineering as a whole and compare the environments of women engineers in the past and in the present.

There is a rich history behind women in the engineering field. After the Industrial Revolution changed the nature of blue collar work, there was an entirely new profession for technical workers with more advanced skills. However, women weren't allowed into the field of what came to be known as engineering until World War II. During the war, women were recruited by schools and the government because of the influx of industrial jobs previously held by men. Women were temporarily trained in science and mathematics to contribute to the war industry (Bix, 2011). In the 1960's, second-wave feminism, an activist movement striving for gender equality, specifically in the workplace, broadened the opportunity for women considering careers in engineering (Mack 2001). However, the attitudes and treatment of women in the engineering field did not change significantly in nature. Different schools of feminism varied in their beliefs on whether or not women belong in engineering. As a result, engineering remained a more male-friendly profession.

Compared to overt discrimination against women in the engineering field exhibited in the past, women currently are dealing with more subtle forms of sexism. Opportunities such as

summer camps and organized recruitment have motivated thousands of young American women to enroll in undergraduate engineering programs. These have produced many professional engineering women with the same college-level education as their male peers. But beliefs about women's lack of ability in math and science – knowledge areas engineers need to be fluent in – have rested on women's faltering self-confidence since they were first handed Barbies and their brothers were handed plastic toolboxes. In a recent study, Erin Cech and her colleagues found that the almost 300 people they surveyed often associated engineering with "…men and masculinity….So, there are these micro-biases that… add up [and] they result in women being less confident in their expertise and their career fit" (Cech et al., 2011). On a micro-level, confidence levels can make or break a student's success at a university. Looking at individual students became important in my research to find where women make and break themselves in engineering. To find students, I first had to go to a university.

This is where the women of Clarkson University come in. Founded in 1896, the Thomas S. Clarkson Memorial School of Technology initially admitted women as undergraduates until 1907. The institution became an all-male school due to a larger focus on engineering and the lack of students attending the school at the time. It integrated women into the student body once again in 1964 and has remained co-ed to this day. Newspapers such as the *Watertown Daily Times* and *The Clarkson Integrator*, Clarkson's Archives, and oral history research conducted with women who went to Clarkson in the 1970's document the steady rise in numbers and confidence of women at this engineering-oriented institution. For example, Dr. Laura Ettinger, a history professor at Clarkson, conducted oral history interviews with alumni and administrators to construct a narrative of the lives of Clarkson women engineers in the 1970's ("Clarkson's Pioneering Women in Engineering: Oral History Interviews," http://people.clarkson.edu/~lettinge/home/pioneers/).

First housed in the historic Holcroft House, the original manor of the Clarkson family, women steadily became essential members of both the undergraduate and faculty populations. Clarkson University's student body is now 50% engineering majors and 28.3% women (Clarkson University, 2015). However, women currently make up only 20.3% of the School of Engineering (*Institutional Research Statistics, Clarkson University, Fall 1963 - Fall 2014*, 2015). What about Clarkson's engineering programs is attractive to some women and unattractive to so many others?

My ethnographic research uses interviews and observations with female engineering majors at Clarkson University**.** I focus on their upbringing, their interest in engineering and Clarkson, their experiences in classes, their relationships with mentors and professors, their professional experiences, and their views on feminism and the advancement of women. I also went to engineering classes, asked general questions of my peers, and attended the events of Clarkson's chapter of the Society of Women Engineers (SWE). I found the women engineers to be quite fascinating and very driven to succeed. While their views on women's advancement differed, their actions as successful women professionals represent actions integral to an equitable environment in engineering.

1. History of Women in Engineering

Knowing the history of women in engineering can shed light on the problems female engineers face currently. To predict where women in engineering are going, it's important to know where they came from. In a series of essays on the pioneering women in engineering, authors Jill Tietjen and Betty Reynolds stressed that engineering began as a technical approach to warfare machines and strategy (Layne, 2009). But today's engineering is about far more than war machines. Engineering arose from the more advanced blue collar workers building the modern world. Historically, the creation of a new technology generated an urgent demand of trained professionals able to work with the new technology (Brown, 2009). The growth of industry and cities in America created a need for engineers able to work with engines, buildings, and chemicals. Training to handle this technology was delegated to universities such as Massachusetts Institute of Technology, Rensselaer Polytechnic Institute, and the California Institute of Technology. And, like any high-demand and highly paid field in the early twentieth century, most training and subsequent career paths were principally given to men.

There are examples of highly skilled and motivated women engineers in the late nineteenth and early twentieth centuries. These include Emily Warren Roebling, a chief engineering manager of the construction of the Brooklyn Bridge while her husband Washington Roebling was sick (Rosser, 2011), along with select few women like Elizabeth Bragg, Margaret Ingels, and Elsie Eaves who earned their degrees in engineering and went on to be very successful engineers and administrators (Layne, 2009). As mentioned in Tietjen and Reynolds' work, engineers are required in masse when there is a war going on. In World War I and II, women were recruited for these jobs because of the immense deficit in industrial workers. However, women had to fight long and hard to enter the engineering field in the numbers that they are today. Even then, in 2013, a measly 13% of engineering and computing jobs were held by women (AAUW, 2015).

1.1. War, Technology, and Femininity: World War II and the Birth of Women Engineers

The immense size of the two World Wars required many soldiers to go and fight. Those that were recruited for war were mostly men as women and children were left on the home front. The American government prioritized demand for soldiers over domestic industry; as a result, over 5.8 million men went to Europe and Asia to defend their country abroad (Bix, 2004). This left a gaping hole in the labor pool for industrial workers. World War I and II both pulled women into the industrial workforce, but World War II had a greater effect on working women. For example, during World War II, the Curtiss-Wright Airplane Company sponsored 10-month intensive aeronautical engineering programs for college women. The graduates, known as the Curtiss-Wright Cadettes, designed airplanes.

A field not previously friendly to women welcomed women temporarily to learn the skills of engineering in order to promote the war effort through mass industry (Bix, 2004). Advertisements were distributed as a way to recruit women for both factory jobs and engineering programs to teach women the skills required to fill the space of soldiers at war. The advertisements depicted women who were strong, as well as feminine and family-oriented. This simultaneously empowered women while still publicly placing them in the domestic sphere (See

Figure 1). But regardless of the quality of the women's work, American men were more than happy to take their jobs back after World War II. Those 5.8 million soldiers returning from the trenches after World War II also expected to come back to the workforce that they left in order to fight.

The intensive recruitment and training during World War II gave women a taste of freedom outside of the home and in industry. However, this would disrupt the traditional household and economy present in the United States at the time. According to Janet Chafetz (1997), the branch of Feminism titled Socialist Feminism equates women's place in the home to free labor enforced by the patriarchy. Men effortlessly enter into a workforce of a capitalist and patriarchal economic system while women take care of children and domestic duties for no wages. This childcare and domestic work is seen as inferior; thus, women in traditional roles are disenfranchised, and those who want to enter the paid workforce have limited agency. Of course, America entered into the Cold War immediately after World War II and couldn't be found supporting any socialist sentiment. Deep societal entrenchment in the domestic sphere was one of many barriers women faced when trying to become engineers.

Figure 1: Examples of media produced during the World War II era intended to recruit women into industrial and professional positions (*Rosie the Riveter*, 2015; Edelstein, 2012).

Another was getting an engineering education. American universities still only admitted select numbers of women by the 1940's. Becoming a professional engineer required a lot of networking and eventual membership in engineering societies such as the American Society of Civil Engineers or the National Academy of Engineering, but these societies were boys' clubs. (Layne, 2009). As a result, Beatrice Hicks of Newark College of Engineering and others founded the Society of Women Engineers (SWE) in 1950. SWE aimed to "inform the public of the availability of qualified women for engineering positions" (Bix, 2004). The organization incorporated in 1952 and spread across American universities. By 1958, SWE had 510 members (Mack, 2001). SWE remained fairly moderate in its political activism. It was there simply as a support system for engineering women at universities and for the education of young girls

interested in the engineering field. However, feminist activism in the 1960's produced debate over what women were capable of in work, including engineering (Mills, 2014).

1.2. Second Wave Feminism in the 1960's

The first "wave" of feminism occurred around the turn of the twentieth century. Protestors and activists known as suffragettes worked specifically for the right for women to vote in America. And after their efforts in World War I, the Nineteenth Amendment, which gave women the right to vote, was ratified in 1920 (Layne, 2009). However, many women were not satisfied. This dissatisfaction resonated in a second wave of feminism happening in the 1960's. Second Wave Feminism focused on more societal issues related to women like family, their bodies, and their careers. Applied to engineering, Second Wave Feminism achieved mixed results in integrating women into the field.

While Second Wave Feminism was essential in promoting women's entrance into the engineering field, different schools of thought in feminism presented varied plans of action about what place women should have in the field. Two branches of feminism were struggling to control the conversation about women's rights in the 1960's. Equal-rights feminists believed that men and women have essentially the same skills and should be given the same social and economic opportunities. On the other hand, difference feminists thought that women had special skills that they could contribute to any field. However, difference feminists saw women's "feminine" characteristics as a disadvantage in the math and science-intensive field of engineering due to an innate lack of objective thinking in women (Mack, 2001). Most Second Wave Feminists approached gender inequality from more of an "equal-rights" point of view. Nonetheless, difference feminists authored gender theory literature and promoted the distinct differences between the sexes which, while empowering feminine characteristics, discouraged women from entering fields like engineering because of its apparently masculine skillset.

In the post-war era (and before then), men and engineering schools seemed a more compatible pair because men were seen as the more technical thinkers. At an early age, parents were likely to teach their sons technical skills – such as working on cars, electrical systems, and machines. Women were seen as more subjective thinkers and thus more attuned to art, some humanities fields, and of course, child care. These beliefs helped to direct those who guided women and men as they chose college majors and careers. Women who showed interest in math or science-oriented fields received negative responses from their families and academic advisors when deciding their future careers (Bix, 2013). High school guidance counselors and teachers steered women with an affinity for math and science towards the family and consumer sciences.

Few women entered undergraduate programs in engineering in the 1960's. According to statistics compiled by the National Science Foundation, only .4% of all Bachelor's degrees in engineering were awarded to women in the United States in 1966 (AAUW, 2010). The women who were accepted into undergraduate engineering programs entered into an "androcentric" culture, which according to Lindsey and Christy means a culture possessing "male-centered norms operating throughout all social institutions that become the standard to which all persons adhere" (2011). Contrary to the stereotype of women not being good in math or science, female students in engineering received some of the highest grades in both high school and college. In their in-depth examination of the experiences of Californian female engineering students in the

1980's, McIlwee and Robinson found that, "Women engineering students nationally are a high achieving group. They enter college with higher SAT math scores than male engineering students (558 vs. 549) and they are more likely to have earned an A average in high school" (1992). Most women who later succeeded in the engineering field were the girls with high ambitions while in school.

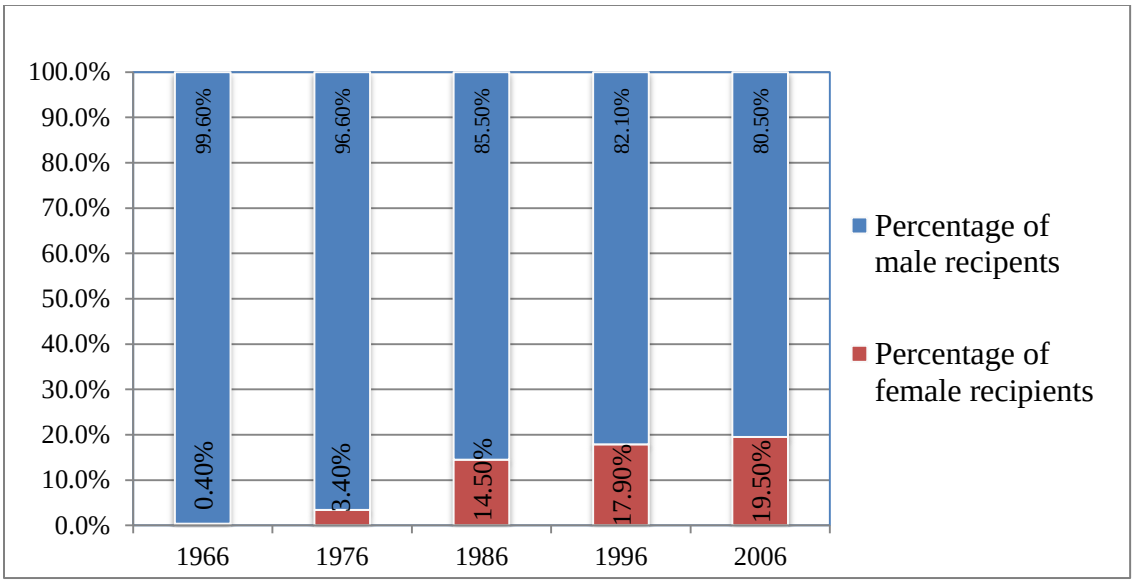

Figure 2: Ratio of recipients of Bachelor's degrees in engineering based on gender, 1966-2006 (AAUW, 2010).

Despite the fact that women were earning higher grades than their male peers, they were not welcomed immediately as peers by their fellow students. The stereotypes placed upon women engineers reflected a low opinion of their intellect coming from their fellow male students and often the male faculty. Many felt that women in undergraduate engineering programs could either be incompetent and pretty *or* intelligent and unattractive. When discussing the perception of women engineers before Second Wave Feminism, Amy Sue Bix emphasized that "an undergraduate climate that assessed women primarily in terms of their appeal as potential girlfriends or sex objects made it hard for women to be treated as intellectual equals, future professional colleagues, or even normal fellow students" (2013). Even after Second Wave Feminist ideals became well-known, this objectification continued. Women were assumed to be either unattractive but smart or "dating material" but completely incompetent in the field. These were roles forced upon women, making them objects rather than nuanced agents of their own destinies.

McIlwee and Robinson used the term tokenism to define the otherness experienced by women. They defined token as "…highly visible in the social group. The other members are more aware of her presence than they are of each other's. All of her behaviors – good and bad – are noticed" (1992). This made blending in or even participating more difficult for women because of the responses they'd receive from their classroom members based on their gender. Therefore, women participated and asked questions in their classes less. This often isolated

women or left them confused when they didn't understand a subject and didn't feel comfortable asking.

In addition, while women in engineering often earned better grades than their male peers and company quotas drawing numbers of women in, men were often more prepared for the engineering field after years of tinkering and synthesizing materials at home. It is a common experience for engineers to get their first job and learn that their Bachelor's didn't teach them much useful material for on-the-job work. Engineering stems from vocational, hands-on professions. Women could know as much of the theory behind engineering as their books could teach them. Unfortunately, conditioning towards less technical fields began when they were given their first sewing kit. How could women enter the workforce without having prior experience in hands-on practice? While some women abstained from college in order to pursue an engineering-intensive profession in the 1970's and 1980's, there was little mobility for uneducated persons in engineering jobs (McIlwee & Robinson, 1992). Women were often left without either an education or prior knowledge of the ins and outs of engineering. As a result of these inherent disadvantages, it was easier for employers to ignore women's applications due to their lack of experience. Second Wave Feminism worked to change overt gaps in education and opportunities for women.

The Equal Rights Act of 1964 prohibited employers from discriminating against potential employees based on their gender. This act created the Equal Employment Opportunity Commission which produced legal and monetary incentives for employers to recruit women. Previously, companies like General Electric and Chrysler catered their advertisements towards men. They promised a life of intelligence, wealth, and beautiful women. Suddenly, the same companies looking for male engineers crafted advertisements for women. Advertisements began reflecting equal rights feminist ideals. For example, the microprocessor company Inmor depicted a young boy proclaiming, "I want to be an engineer like my mom!" (Bix, 2013). At a lecture at MIT, Gloria Steinem once explained feminism as believing in "…political, social, and educational autonomy for women" (Bix, 2004). The idea was that women could have both a family and a career thanks to these new rights. And they could get this career through hard work and technical skills.

Overt acts of discrimination ebbed as more women entered into undergraduate engineering programs (refer to Figure 2). Organizations like SWE campaigned and networked with members nationally, producing pamphlets and events that brought young women together in a STEM-intensive environment. In the 1970's, they became active in the efforts to pass the Equal Rights Amendment, which would have given women a constitutional law against discrimination nationally, though it was never made a part of the constitution (Mills, 2014). Having both a family and a career was suddenly possible with a more understanding employer and work culture for women to enter into (Layne, 2009). Although the unconcealed contempt for women in engineering after Second Wave Feminism discontinued, a more subtle cultural boundary for women in engineering disguised itself and snuck into the twentieth century. Scholars call this hindrance microdiscrimination.

1.3. Third Wave Feminism and Microdiscrimination

Sallie Chisholm coined the term "microdiscrimination, describing it as "…the subtle, mostly nondeliberate biases and marginalizations that ultimately added up to serious assaults on women's careers" (Bix, 2013). Microdiscrimination is the term that articulates the inconspicuous limits women have when pursuing something outside of the role they're supposed to fulfill in a certain society. And while there are no overt rules against women in engineering, the culture of engineering often leaves women at a disadvantage because of their gender. Chisholm drafted this term after a study of the women at MIT in 1999. The investigators found that women doing research in a university setting were statistically given less funding, lab space, and awards for their research compared to their male counterparts. While MIT has allowed women to do research in engineering for decades, the university's microdiscriminatory behavior limited what female researchers could do.

The term "microaggression" has also been thrown around as the more aggressive form of microdiscrimination in today's climate for women. Derald Wing Sue's edited compilation *Microaggression and Marginality: Manifestation, Dynamics, and Impact* discusses the different types of microaggressions exhibited towards different groups of people. The authors of Chapter 9 began the piece by contrasting overtly aggressive and covertly aggressive forms of discrimination. In their words, "Whereas overt and blatant sexism refers to harmful and unfair treatment of women that is intentional, visible, and unambiguous…subtle or covert sexism is hidden or unnoticed because it is built into cultural and societal norms…" (Sue, 2010). Both microdiscrimination and microaggression are acceptable forms of sexism in today's society because they don't overtly limit the opportunities of women like telling them they can't vote or have a career. But a community's perception of a previously oppressed group of people may still hold some of the same discriminatory attitudes that held that group back.

Third Wave Feminism in the last decade of the twentieth century and into the twenty-first century began in order to combat microdiscrimination and further educate the world about feminist theory. One part of Third Wave Feminism, multicultural feminism, classifies people by not just their gender, but race, ethnicity, economic status, and the impact of globalized practices (Lindsey & Christy, 2011). According to Third Wave Feminists, women with "bad" or disadvantaged intersections often aren't allowed the same choice in the job market as those with better intersections (such as a middle class white male). Women in engineering at the time of Third Wave Feminism didn't face the blatant discrimination their predecessors faced. In theory, this should have meant a better chance of success. However, their gender still left them disadvantaged in a field that remained traditionally masculine. There is evidence in the number of women in engineering over the past couple of decades. There are still fewer women than men in engineering by a large margin. And this number is decreasing.

In 2002, women earned 20.9% of all Bachelor's degrees in undergraduate engineering. Only nine years later in the 2010-11 school year, women received 18.4% of all engineering degrees. 44.3% of environmental engineering degrees, 39.1% of biomedical engineering degrees, 33.1% of chemical engineering degrees, 9.4% of computer engineering degrees, 11.5% of electrical engineering degrees, and 11.7% of mechanical engineering degrees went to women (Bix, 2013). Compared to the .4% of all engineering degrees in 1966, this is definitely an improvement. But why the cap at about one fifth of all degrees earned when the trend was nearly exponential over

the past half century? And why are the degrees still associated with life (environmental, biomedical, and chemical) the most prominently female while the mechanical, electrical, and computer degrees are still at extremely low percentages? Similar to the arguments of difference feminism, women may still feel inherently different from men in their skillsets. Some women may even reject feminism as a method of distancing themselves from their own lack of agency.

McIlwee and Robinson argue that women rejecting feminist titles simply perform a certain version of the female gender in a way that gains acceptance in the community. While there are many masculine and feminine versions of gender expression, men performing masculine identity traits are valued most in engineering. (1992). Their study in the late 1980's and early 1990's involved women of an earlier era. But McIlwee and Robinson described a phenomenon that still exists as a defense mechanism today. Women are still discouraged by others and in turn unconfident in their own skills, making it challenging to seek out opportunities in engineering education. A lack of confidence in young women's desired field can lower test scores and fulfill the stereotype of women not being competent enough for engineering (AAUW, 2010).

This does not mean that all women in engineering claim an anti-feminist stance or that women can't and don't reach their goals in the engineering field. In their original incorporation pamphlet in 1952, SWE described its organization's goal in the following words: "…to inform the public of the availability of qualified women for engineering professions; to foster [a] favourable attitude in industry toward women engineers to contribute to their professional advancement; to encourage young women with suitable aptitudes and interest to enter the engineering profession; and to guide then in their educational programs" (Mills, 2014). SWE is the largest organization of female engineers in the world. With hundreds of thousands of members, both men and women, SWE is the go-to organization for potentially employed or student women engineers, as well as professional women engineers.

In addition to SWE, groups catering to younger groups like the Girl Scouts and Nerd Girls brought in young women interested in the STEM field and nourished their interests. Nerd Girls was founded in 2000 to bring young girls into the STEM fields through programs and outreach centered in science and computing. In fact, Nerd Girls' creator Karen Panetta made its motto, "Brains are beautiful. Geek is chic. Smart is sexy" (Mills, 2014). The enthusiasm of the groups' creators and the membership generated popular opinion of girls educated in math and science as well as informed girls considering a field involving math and science. Summer camps, school visits, scholarships, and professional experience were provided specifically for young girls interested in engineering.

The United States is currently seeing a small decline in the number of women in engineering (from about 20% last decade to about 18.4%). This is curious since our technology and knowledge seems to be advancing as information on the internet expands infinitely every day. Is this just a small shift, or are we seeing a drop in the demand for educated STEM workers? Or since there is higher demand and competition for these high-paying jobs, are women still being treated differently? A small school in Potsdam, NY demonstrates the progression of women in engineering since Second Wave Feminism. Clarkson was one of the schools admitting female coeds in the 1960's and has since claimed that it is a grand opportunity for women seeking advancement in undergraduate engineering. While its history is women-friendly at face

value, its female coeds today may not have the same sense of opportunity as past Clarkson women.

2. Clarkson University

The Thomas S. Clarkson Memorial School of Technology was founded in 1896 by Thomas Clarkson's three sisters in honor of his death at a nearby sandstone quarry (Clarkson University: History & Facts, n.d). The school has rich ties with the community and has been funded by important figures in the Northern New York history such as the Snell and Cheel families. It is currently ranked in the top 150 colleges in America and a research university especially well-respected for engineering, as well as, to a lesser extent, for its majors in the arts, sciences, and businesses. A brief history of women at Clarkson and its current standing as a coeducational institution will frame the ethnographic research I conducted there.

2.1. History of Women at Clarkson University

When Clarkson University first opened its doors as the Thomas S. Clarkson Memorial School of Technology, it had a total of six programs: Mechanical Drawing and Design, Electrical Engineering, Domestic Science and Art, Machine Work and Smithing, Wood Working and Pattern Making, and Normal Manual Training. Women could receive certificates for certain programs as well as one to two years of classes, mainly in Domestic Sciences and Arts. They could also receive their B.S. in Domestic Engineering (Carden, D. & Broughton B.B., n.d.). Clarkson's motto came from one of Thomas Clarkson's cherished Bible verses, "A Workman that Needeth Not be Ashamed" (Clarkson University: History & Facts, n.d). But when the school eliminated the domestic sciences in its curriculum in the academic year 1906-07, this eliminated any chance of the unashamed workwomen at Clarkson for the time being.

Figure 3: Women in a consumer science class at the Thomas S. Clarkson Memorial School of Technology, 1905 (North Country Remembered, 1991).

Little activity involving women at Clarkson occurred until the school became coed again in 1964. By that point, it was renamed the Clarkson College of Technology. The Clarkson

Women's Club, mainly a faculty wife-based booster club that hosted events like dinners and daycare for college associates, existed before women became students in 1964. But it took nearly sixty years for women to be allowed back into Clarkson's halls. They were given Holcroft House on the top of Clarkson Hill to live in and a curfew of 11:00 pm on weekdays and 2:00 am on weekends. These nine women (pictured in Figure 4) entered into engineering, science, and liberal studies programs with the same curriculum as their male counterparts. Suddenly in Clarkson yearbooks titled *The Clarksonian* (1965), there were female students in pictures other than in social gatherings. Women behind test tubes, in the field, and reading books were spread across their photo montages. The women even formed a women's cheerleading team. It seemed like women had found a place at Clarkson.


Clarkson Accepts Nine Co-eds

RECENT ADDITIONS TO THE CLARKSON CAMPUS are shown from left to right: Nancy Taxido, Liverpool; Andrea Bridge, Schenectady; Catherine Fry, Drexel Hill, Pa.; Betsy Tiemann, Malverine; Joyce Bator, Springfield, Mass; Grace Canning, Barre, Vt.; Mary Ann Scherman, Farmingdale; Karen Politica, Tenafly, N. J.; and Jill School, Bloomfield, N. J.

Figure 4: Photo in the October 1964 edition of *The Integrator* of the first nine coed women at Clarkson (The Integrator, 1964).

Organizations founded by women began changing Clarkson's all-male community. Clubs and organizations like the Society of Women Managers, 9 to 5, and the Society of Women Engineers were established to provide specifically female professional space. Founded to help Clarkson women students and recruit young women, these groups traveled and spoke about their experiences as women in technology fields. They spoke out against discrimination towards working women with families and sexual harassment of women in the engineering field. National connections at conferences and through newsletters spread the word to Clarkson students that women were in the workforce to stay. By 1973, 23 graduating seniors were women (*Watertown Daily Times*, 1991). And in 1986, The Horizons Program began as a summer program for adolescent girls with an interest in math and science (Clarkson University: Clarkson's Horizon Programs Introduce Girls To Career Possibilities In Science, Engineering And Technical Fields n.d.). Women's presence in Clarkson's engineering programs grew to around 300 in 1980 (*Institutional Research Statistics, Clarkson University, Fall 1963 - Fall 2014*, 2015).

Female presence at Clarkson came with some resistance. Previously, men would only see women from Potsdam State and interact with them at a purely social level. But the arrival of women seeking an education similar to their own incited some sexist commentary in school media. Take for example the 1979 edition of *The Knight*, Clarkson's school magazine. The cover had an altered Clarkson crest with the knight, Clarkson School of Technology encircling the outside, and the phrase "A Workman that Needeth not Female Companionship" circling the middle (The Knight, 1979). With this binary of feminist progress and misogynist and superficial values of looks and male companionship placed on Clarkson's women, what path did Clarkson take on the road to gender equality in the engineering field?

2.2. Women at Clarkson University Today

The number of women enrolled in the School of Engineering has fluctuated over the years. However, from 30 women in 1970 to 364 in 2014 (examine Figure 5), Clarkson is currently experiencing its greatest number of enrolled women in engineering in its history (*Institutional Research Statistics, Clarkson University, Fall 1963 - Fall 2014*, 2015). Through recruitment at high schools, the Horizons summer camp, and generous scholarships to promising young women enrolling in the freshmen class, Clarkson has steadily increased its proportion of women in the student body. Ranked as the 121st best school in the nation by the US News, Clarkson currently has about a 3:7 ratio of women to men (Clarkson University, 2015).

Since the Title IX Education Amendments of 1972 and in subsequent institutional amendments, Clarkson students would in theory not face discrimination on the basis of "admissions or financial aid, housing and facilities, courses, academic research and other educational activities, career guidance, counseling or other educational support services athletics (scholastic, intercollegiate, club, or intramural), employment, training for employment or advancement in employment, or certain cases of lesbian, gay, bisexual, and transgender harassment" (Clarkson University: Title IX, 2015).

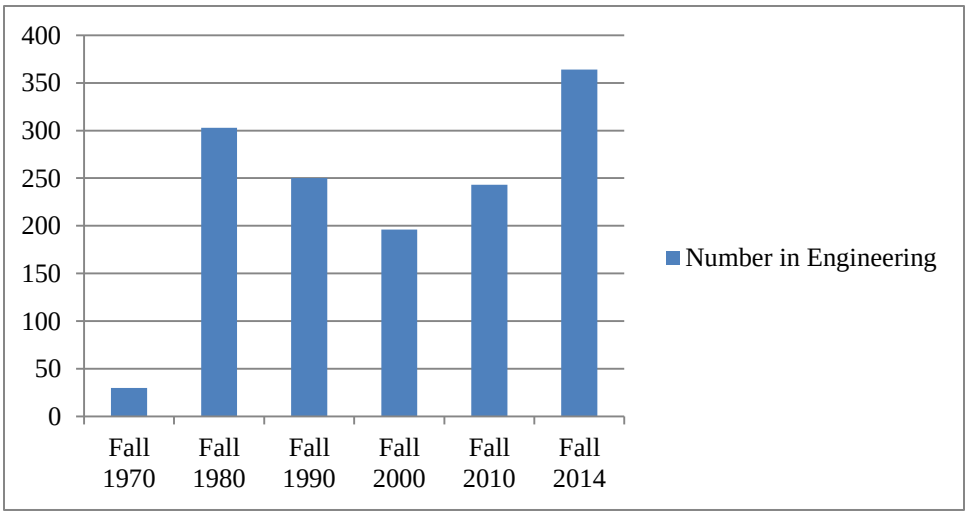

Figure 5: Enrollment number at Clarkson University from Fall 1970-Fall 2014 (*Institutional Research Statistics, Clarkson University, Fall 1963 - Fall 2014*, 2015).

Clarkson now has a plethora of sports teams, sororities, clubs, and organizations. The Clarkson Women's Division 1 Hockey Team recently won the NCAA championships for hockey. 15% of the female student population belongs to sororities (Clarkson University, 2015). And of course, the Clarkson chapter of the Society of Women Engineers (SWE) recently won an award at the Region F SWE conference held in Boston, MA and has over fifty active members. At face value, Clarkson has become a welcoming place for women.

Women are not flocking to engineering specifically. The gender ratio of 3:7 is skewed by mainly the School of Arts and Sciences. Women are about 20.6% of the engineering population as of Fall 2014 (*Institutional Research Statistics, Clarkson University, Fall 1963 - Fall 2014*, 2015). Clarkson's School of Arts and Sciences has grown in recent years with research opportunities in Biology, Psychology, and Applied Math and Statistics. While there are individualized programs in the Business programs and Arts and Sciences programs that have increased greatly the number of women in recent years, there hasn't been the same kind of growth in the School of Engineering.

As shown in the total enrollment as of Fall 2014 (Figure 7), the greatest percentages of women in the School of Engineering are majoring in Chemical Engineering (37.5%), Civil Engineering (24.5%), Engineering Studies (25.3%), and Environmental Engineering (57.9%). In fact, as of Fall 2011, more women than men have majored in Environmental Engineering. But women are severely underrepresented in Mechanical Engineering (10.7%), Aeronautical Engineering (9.7%), Electrical Engineering (15.0%), and Computer Engineering (10.0%). All are generally influenced by the "hard" sciences, physics and computer science. While Civil Engineering is a physics-intensive field, women like Emily Warren Roebling (as discussed in 1.1) already made way for women in construction, architecture, and building.

These engineering fields deal with complex mechanics and computer programming. This is not to say that women *are* less apt in mechanics and computer programming, but perhaps it is women that *think* that they are less apt or at least less welcome. This was my hypothesis entering the ethnographic research I conducted. What I found were strong, intelligent women with what seemed to be the same abilities as their male counterparts. Yet as in any anthropological study, the cultural perception of a group of people can influence individual acting in the setting of that culture. And as students looking to succeed in the future, the subjects I observed often performed in a way that would allow them to advance in the context of that ethos.

3. Gender in Engineering at Clarkson University: An Ethnography

Joan Cassel defined embodiment as "…the way in which people experience and inhabit their bodies, and the way in which these bodies incorporate and express social information" (Cassell, 1998). In Cassell's field work with women surgeons, she found that male-dominated fields like surgery, race car driving, and test piloting – all "haunted" by death on a regular basis – reject women who are trying to act as subjects (those who act) rather than as objects (those acted upon). In other words, women trying to "embody" the physical role of a successful surgeon were shunned by egocentric and traditional men. I saw a clear connection between Cassell's work with women surgeons and my own with women in engineering, both male-dominated fields.

Cassell's work was anthropological in nature, focusing on a small subset of people having learned their place in society through daily cultural intake. Successful male surgeons portrayed themselves as entitled from Cassell's perspective, throwing tantrums and acting as if Cassell

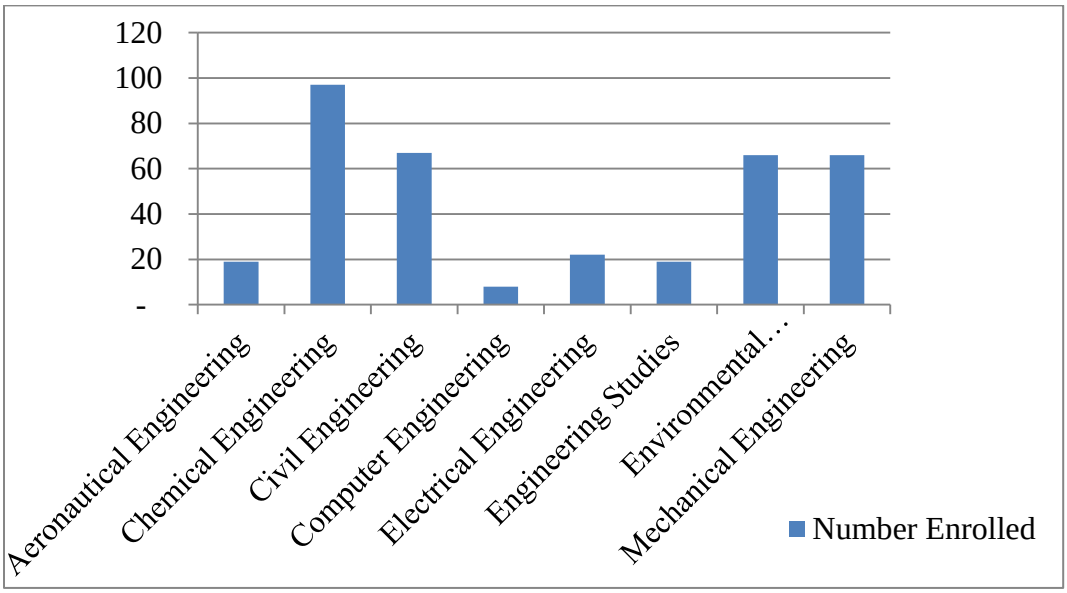

Figure 7: Enrollment number in each engineering program as of Fall 2014 (*Institutional Research Statistics, Clarkson University, Fall 1963 - Fall 2014*, 2015).

were their daughter while she was doing her research. Cassell found that the women surgeons she observed had the same level of intelligence and masculine gusto as their male counterparts without the arrogance Cassell experienced when working with male surgeons. The same can be said about both men and women at Clarkson University. Many interviewees experienced inherent disadvantages because of their gender or because of a man's own gender expression.

I had six main focuses in my research. First, I investigated the starting interest Clarkson women had in engineering in childhood and adolescence. Second, I examined the choices behind going to Clarkson and their intended field of study. Third, I learned of their experiences in classes, with faculty, and with the potential for mentorship. Fourth, I investigated the reasons for and passions behind the clubs and organizations they associated with. Fifth, I delved into the professional experiences of these aspiring professionals. And finally, I studied the activist views the women had or didn't have in regards to feminism. Together, these life events and daily interactions make up the pieces of these women's lives and influence important decisions for the future.

Like Joan Cassell, I want to address feminists, anthropologists, and readers alike. I want my research to mean something to the women I interviewed and promised change by compiling their life stories. Since this will be a visual ethnography in the future, I also want to employ what James Fernandez refers to as "an argument of images" (Cassell, 1998). Cassell executes this in her writing, painting the picture of women surgeon's daily lives in the OR, scrubbing up, visiting patients, and literally running between places in their fast-paced lives. With words, I hope to express the same sort of carefully framed snapshot of the lives of women in engineering. My

interview subjects were often the only girl in their team project for classes. With their advisors, they had to negotiate next semester's classes and were frequently discredited for their work as full-time students. Small microdiscriminations added up to large problems for some women. For example, multiple subjects found that their father didn't like how they were changing as they grew up (not fitting a certain gender role). Fellow students called many of my interviewees bossy or abrasive when they took control of a project. These were from women who saw a clear problem with the behavior pattern of others in regards to their gender. But in many other cases, the Clarkson women didn't always see these as microdiscriminations. They just saw it as a way of life for women in engineering. And either they were too shy or too unmotivated to say something about the slight microdiscriminations.

In a journal article in the *Women's Studies International Forum*, Judith Stacey lays out the pros and cons of using ethnography in feminist research. The highly story-based element of ethnographic work creates a voice for individual women's experience as well as an overarching narrative of women's experiences, or as she calls it, a "positivist" experience. But Stacey found it ironic that ethnographic work is also known for being highly exploitative and potentially harmful to the subjects, which for women as the gender minority could affect their future goals negatively (Stacey, 1988). I understood this going into the research. As a research topic not required to be reviewed by the Institutional Review Board, my research posed no threat for my subjects. In fact, many of my research subjects volunteered to participate because they saw my work as offering future advantages for Clarkson women. To provide context to my findings, I will give a demographic snapshot of the women I interviewed and observed.

3.1. Demographics

I conducted interviews with sixteen undergraduate women majoring in engineering. They were predominantly from the Northeastern United States (other than one woman from Eastern Europe) with economic backgrounds ranging from working class to upper middle class. While Clarkson University has some ethnic diversity, especially in the engineering program, I spoke with all white women. There were five Environmental Engineers, four Chemical Engineers, three Civil Engineers, three Mechanical Engineers, and one Aeronautical/Mechanical double major. There were two freshman, two sophomores, four juniors, and seven seniors. Twelve of the sixteen women had already done their professional experience required by Clarkson for graduation; two hadn't done an internship and two had internships lined up for this summer.

I found that the women who either sought me out or were suggested to me by professors created an inherent bias in my research. They were all active, mainly highly achieving women interested in my research. While I made many efforts to draw in a more diverse set of volunteers, I talked with many like-minded women. They were intelligent, very active in academic and professional ventures, overloaded with extracurriculars, and passionate. As Joan Cassell observed in her research with women surgeons, women in professional male-dominated fields tend to operate at an intense level (Cassell, 1998).

My observations outside of interviews primarily involved the Clarkson chapter of the Society of Women Engineers (SWE). In fact, ten out of the sixteen women I interviewed were associated with SWE. I attended Board of Directors meetings, community events, and discussions. This also presents a distinctive bias. SWE is a vigorous and organized group on campus. They hold

constant public and club events including study sessions, dinners at local restaurants, and educational activities for Girl Scouts and foster children. They go to both the national and regional SWE conferences and hope to one day host their own regional conference at Clarkson. Again, the intensity expressed by women engineering students extended into extracurricular and public activity. They see themselves as a force of community ties and change. However, women outside of the organization think that SWE attracts specifically the "girly girls". I will go more into the perception of SWE in my section on organizations.

Major	**Year**	**SWE Member Y/N**	**Internship Y/N/F**	
Aero/Mechanical	Junior	N	Y	Y – Yes
Chemical	Senior	Y	Y	N - No
Chemical	Sophomore	Y	F	F - Future
Chemical	Senior	N	Y	
Chemical	Junior	N	Y	
Chemical	Senior	N	Y	
Civil	Sophomore	Y	F	
Civil	Senior	Y	Y	
Civil	Senior	Y	Y	
Environmental	Senior	N	Y	
Environmental	Senior	Y	Y	
Environmental	Senior	N	Y	
Environmental	Junior	Y	Y	
Environmental	Freshman	Y	N	
Mechanical	Freshman	Y	N	
Mechanical	Junior	Y	Y	

Table 1: A table describing the sixteen interview subjects I had, listing their major, academic year, and SWE membership (Y/N)

I have lived with women engineers and observed their classes. They have constant homework, projects, tests, and whatever else they choose to participate in. Then there is the professional experience required for all Clarkson graduates. This is something that all Clarkson students have to deal with, not specifically the women. But in most organizations besides those designated as specifically male (fraternities, male sports teams) or extremely oriented toward the masculine (racing teams), I see women spearheading the events and often on executive boards in addition to their immense workload. Beyond the classroom where they often succeed, Clarkson women engineers are a force to be reckoned with. And whether this is because of professional goals, a mover-and-shaker attitude, or simply passion to participate, these women went through lives prior to Clarkson that led them to their desired career path and extracurricular interests. It took many mistakes and years of cultivation to get to this point.

One of the environmental engineers I talked to emphasized, "I mean, obviously I haven't done well before, but that's the nature of learning. You can't get everything right the first time." While engineering is a difficult field to succeed in, the success I saw in the lives of my interview subjects was taken as a given for many of them. Gender roles in engineering often make women's successes seem less impressive; they feel like they have to work that much harder. It is not part of the gender they are expected to "embody". Some of these same gender roles are what prevent women from feeling comfortable with being in the engineering field. That's not to say that traditionally female occupations automatically make women feel comfortable, but often femininity is associated with domestic duties rather than professional training. And this discomfort begins during their childhood.

3.2. Traditional and Nontraditional Gender Roles in Childhood: The Cultivation of Young Engineers

Interest in math and science developed at a young age for many of the women I talked to. Often this was done with games, toys, and hands-on activities meant to teach math and science. Think back to when you were a kid. What toys were you given? Did they reflect your future goals as an adult? Very often, these toys are gendered – like Tonka trucks for boys and play kitchens for girls.

In a study by Sorby and Baartmans, the factors behind some women's lack of spatial thinking skills which are very important in engineering was examined through a spatial skill test and questionnaire. Mentioned in the 2010 AAUW report, they found through tests that first, an early introduction to spatial thinking and toys (Legos, Lincoln Logs) made engineering a much more attractive career at a later age. Second, Sorby and Baartmans found that women were three times more likely to fail the spatial thinking test (AAUW, 2010).

Many of my interviewees were taught about what they could or could not do. This often did not include becoming engineers. Many came from small towns with specific ideas about what women should do in the future – social work, teaching, or mothering to name a few. Embodying an engineer, as Cassell saw women embodying surgeons, caused varied reactions in their familial and academic communities.

There was pushback as there always is when one doesn't "do gender" in the way a community expects you to. An Eastern European interviewee grew up in a very strict school

system. In that school system, girls learned how to write cleanly, multiply numbers, and dance precisely at young ages. She demonstrated her impeccable cursive on a piece of graph paper during the interview, saying that she would have earned a bad grade if she were to write like that in school. Girls were not encouraged to go into engineering. Her grandparents were both advanced engineers. Her grandmother was successful in government work in engineering. In a country formerly a part of the Soviet Union, her grandmother's path was practically unheard of. Despite this, she was still discouraged from going into engineering. Her family moved to the United States when she was young. While there was some kick-back when she chose engineering as her intended career path, she became very successful in biomedical/chemical engineering research. Ann was not the only one who, while showing great potential in engineering, was doubted by the people around her when expressing her ambition. There were women I interviewed who faced constant ridicule for their interests. But there was a consistent stubbornness to do what they wanted, even to defy others' expectations. For example, the former President of SWE prided herself on her ability to prove people *wrong.*

Some of the women I talked to had parents with a technical background. They ranged from high school graduates who became mechanics or technicians to those with a Master's degree in Mathematics. Many had family members like uncles, aunts, cousins, and even siblings who became engineers; some were even Clarkson alumni. The women who grew up with math and science-intensive households had more confidence and incentive to pursue a career in the STEM fields. Whether it was a family legacy they held up, an honest interest in math and science, or both, many of the women I talked to entered their engineering major with knowledge in math, physics, chemistry, or biology.

Clarkson's Horizons program sponsors a math and science-intensive summer camp for girls with the hope that it will bring more women into the engineering field. Many of the women I talked to also experienced a program like this or AP math and science classes, technology courses, or actual engineering courses meant to prepare students for the engineering field. In this way, current engineering students had communities that propelled them into the engineering field. There is a stigma that these sorts of programs are meant to fulfill quotas in future professional engineering programs. But every woman I interviewed deserved to be at Clarkson based on merit.

The subjects I interviewed trained for the fields within their interests and came across a type of engineering that combined their different interests into one successful field. In middle and high school, they took all the science classes they could find and took advantage of programs at their schools in their communities to get experience. Universities and colleges recognize women with a good work ethic. And often, the women I talked to were interested in many engineering universities. But something about Clarkson, as one of the junior chemical engineering majors phrased it, "felt like home".

3.3. Research, Compost, and "Big Pipes": Choosing Schools and Majors

Clarkson was not always their first choice because of the size, the cold, and the location to name a few reasons. But during their college tours, these prospective students were greeted with a welcoming campus along with friendly administrators. Clarkson is known for its research

opportunities; Clarkson's faculty often utilize the student body to take on a significant amount of research. Opportunities to advance were what drew these women to Clarkson.

Clarkson has academic facilities that interested many of the women I interviewed. An environmental engineering freshman said that she would "compost until the day I die" and was excited by Clarkson's digester. A mechanical engineering major I talked with had an obsession with large machinery, specifically "large pipes". Multiple civil engineers had an affinity for building big buildings and bridges. Clarkson provides students with physical machinery as well as electronic testing facilities that would provide an outlet for the creative engineering projects they were interested in.

Choosing a major was easy for some. Many chemical engineering majors were good in chemistry or biology in high school; chemical engineering also offers a wide range of future careers that the student could choose from after experimenting with a couple of subjects. Mechanical and aeronautical engineers liked physics and moving parts. Environmental engineers often liked the outdoors and had a desire to conserve the environment and help people live in healthier communities. Clarkson has engineering majors in mechanical, aeronautical, chemical, civil, environmental, electrical, and computer engineering.

Cassell spent a good amount of time in *Woman in the Surgeon's Body* talking about Dr. Hannah Krieger, an accomplished breast surgeon with her own cancer treatment center. While Dr. Krieger was very caring and dedicated, breast surgery was somewhat second rate for her skills. In the surgeon community, surgeons who specialized in body parts specific to the female body weren't respected. Cassell believed this to be a result of what certain types of surgery and, as a result, certain types of surgeons embody in medicine. That which is feminine is automatically lesser because it is feminine (Cassell, 1998).

Choice of field can even be gendered in nature. As Cassell alluded to, field femininity, or the ability to be feminine in a professional field, provides a specific space and methods in professional fields where women are allowed to express gender comfortably. For example, reading a blog post about feminine expression in academia, it became apparent that the author as a feminine figure in her academic discipline separated her from her male colleagues. She worried more about dress and presentation than she ever had to. The author automatically did gender differently because of field femininity (Tenure She Wrote, 2013). Even in the male-dominated fields of surgery and engineering, there are subsections of these professions where women are more accepted or attracted to because of how they can express gender in them. For Cassell's work, breast surgery is an example of a feminine field. In engineering, there is often a link to living or changing things unlike the inanimate materials often present in engineering.

As explored in Section 1, women found a way into the engineering field previously dominated by men and therefore seen as masculine. But as seen at Clarkson, there are a disproportionate amount of women in engineering programs that involve the life sciences – environmental and chemical engineering to be specific. Chemical engineering majors are required to take Organic Chemistry – dealing with chemicals that possess the substance carbon. Carbon, oxygen, and hydrogen are some of the basic building blocks of life. Biology majors are required to take the same class. Many of the women showed an interest in biomedical research. While environmental engineers still have a focus in water filtration and sustainable energy

(nonliving things), there is a strong focus in how these nonliving things impact nature. Life sciences are definitely complex, scientific, and honorable. But just as Cassell discussed the femininity of certain medical fields, I found this in engineering as well—the idea that women in engineering will flock towards science and math that deals with life. Section 2.1 covered the percentages of different engineering majors at Clarkson. Statistically, there are more women in engineering fields that incorporate the life sciences.

This is more anecdotal than actual theory, but it was interesting for me to see the reasoning behind many of the choices that led to these students' intended fields. However, don't be mistaken: not all environmental and chemical engineers are interested in the life sciences. I talked with multiple women in chemical engineering who wanted to go into industrial chemical engineering such as the purification of polymers and metals. The environmental engineers interested in water filtration were often as interested in urban growth as the civil engineers interested in large-scale construction or mechanical engineers interested in "big pipes."

3.4. "It's what you have to do": Engineering Curriculum and the Token Woman Engineer

I also attended three engineering classes during my research. Two were with some volunteers and one was with a group of students I knew. As a History major, the most scientific or math-intensive classes I took were Biology and Calculus 1. I love biology and am considering declaring a minor in it because of the number of biology classes I have taken. But nothing, not even calculus, could have prepared me for these classes. As an outsider, I can say with conviction that engineering classes are *dry.* They are dense, long-winded, and so specific that a single engineering course could not teach an engineering student how to act on the job.

I first attended Rigid Body Dynamics. After some quiet whispering to my guide in the class and some research on my phone, I learned that rigid body dynamics deals with the behavior of interconnected bodies in a machine under the influence of external forces. That day, the professor was covering the intersection of two vectors given their points of origin to determine their velocity at any given point. And there I was having just come from my Anthropology class on the history and culture of drugs and drug foods!

The second class I attended was Statics. I learned that this was a predecessor to Rigid Body Dynamics. Before they learn how machines move, engineers must be able to predict how a machine will move before it moves. A lot of engineering is very abstract. As discussed previously, women university students have typically understood abstract engineering at a higher rate than men (McIlwee & Robinson, 1992). Sitting with these women – let's call the woman in the first class Rachel and the second Donna – I could see a comprehension in their expression during the lecture that I could only achieve after years of engineering classes. Rachel and Donna were both sophomores with different majors, but they were taking some of the same general education classes. It would get more specific later on.

The third class I attended with some friends was Mechanics of Machine Elements. In this class, I counted eight women including myself out of the seventy-four. There were eight women out of thirty-five in Statics and five out of thirty-one students in Rigid Body Dynamics. While many of the women claimed that they didn't feel tokenized by the lack of women, often they

became more aware of the lack of women in their classes as their college career went on. The few freshmen I talked with didn't notice the difference in numbers as much as the tenured seniors.

This can cause both neutral and un-neutral interactions between students in group project. Many of the women I talked to felt like they could go about group work without their gender being a deciding factor in how they interacted with other classmates. They made it clear that as long as everyone was working, their projects went swimmingly and they got a decent grade. As I'd phrase it, some of the interviewees "play well with others" and see their classmates as good playmates.

However, other women I talked with had to embody different personas in order to keep peace in their group projects. A junior mechanical engineering major said that "clothes are a terrible thing for me." She felt like she needed to dress more feminine (but not too feminine) for both other students and professors to acknowledge her or treat her in a way that she wanted to be treated. During a lab, she was prompted by a lab partner to raise her hand in an all-male group so the teaching assistant would come to their group faster than if a male lab partner raised his hand.

On a more negative note, some women feel like they aren't heard in groups. Some women felt that their group members assumed that they didn't have the skills in math and science that their male counterparts have, so they were designated the secretary or report-writer rather than the head of equations or graphing. And often they did that work because it was the only way to get projects in on time. One subject described a project where she worked until 5:00 AM with a teammate only to have him tell her that girls couldn't function at the capacity that the men in their class did. But in general, the women I talked to either suck it up since they see this sort of comment as inherent in their field or at times stood up for themselves when facing this kind of microdiscrimination. In the end, as long as they got a good grade, they could shake it off.

The academic intensity of engineering rivals that of other professionally-oriented degrees such as pre-med and pre-law. There are labs that go along with science classes, hours of calculation, coding in languages such as C++ and MATLAB, and memorization of equations and facts for tests. These classes operate on a similar schedule, so midterms, projects, and finals are due around the same time. I hear many of my engineering friends (mainly men) complaining about their workload. But I never heard a complaint about the amount of work they were given during my interviews and observations. There was an attitude that, while the curriculum was hard and they faced constant anxiety about failing, it was what they had to do in order to get a good GPA and subsequently successful career. And some of the women I talked to took this mentality very seriously. There were women I talked who, by their senior year, still maintained a GPA that got them on the President's List (3.8 or above). A chemical engineering major I'll call Mallory maintained a 3.97 GPA (4.0 within her major) while tutoring, working as a teaching assistant, going on three internships/co-ops, and running multiple societies of professional engineers including SWE as the Vice President.

The unfortunate part is that, even with a 4.0, Mallory is set up to make less than her male counterparts earning lower grades than her. In a study done by the University of Miami, the researchers estimated that a woman who earned a 4.0 in high school would make less than a man who earned a 2.6 GPA (Your High School GPA Could Affect Your Income, n.d.). Women

statistically earn higher grades in math and science classes in high school than their male peers (St. Rose, n.d.). But many of my interview subjects emphasized that you do what you have to.

3.5. Faculty, Role Models, and Mentors

> "So… Professor Callahan has been a mentor for almost everything. Whenever I have like a, not a problem, but I just want to, like, talk through something, I always go to her. She's probably the easiest to relate to. Yeah, because, my other two mentors are men, right?"

This was a senior civil engineer who I'll call Julia talking about a professor she had a mentor-mentee relationship with (name substituted as Professor Callahan). Her two male mentors gave her professional and sparing personal advice which, while she appreciated their help in getting ahead, didn't feel as personal as Professor Callahan's advice. The faculty member I am calling Professor Callahan is a member of the School of Arts and Sciences with a background in the history of women in scientific fields. She and Julia formed a close relationship after Professor Callahan got involved in SWE. Through Julia's four years at Clarkson, Professor Callahan advised Julia first on how to navigate one's profession as a woman, then on personal matters like how to balance a husband and kids while still having a career. Julia felt like she could talk more with this female professor. Other interview subjects felt similarly, like their female professors would understand their anxiety better than their male professors.

In a study of 118 male and female engineering students, researchers Foor and Walden delved into the negotiation of gender identity in college engineering. When discussing the establishment of role models, many students found that professional academic engineers and engineers on-the-job still approached engineering as a "man's field." Professors who came from the more traditional era of engineering still saw women as incompetent or unable to really succeed in engineering because they were going to disrupt their careers with a family. Or even without those biases, male professors didn't have the experience to anticipate how the female students' careers would pan out. At the same time, the women in the study found it significant when they interacted with female professors because they represented the best case scenario for women in engineering. When they could balance a family and their careers, they negotiated their genders in a space not particularly open to women (Foor &Walden, 2009).

Mechanical solidarity seems to accurately describe the experiences of these women. Durkheim argued that mechanical solidarity functions in like-minded groups with similar goals and beliefs. They go through the same things, learn the same things, and follow the same rules as methods of bonding. Women at Clarkson represent a community having only formed within the past fifty years (when Clarkson became co-ed). Women engineers at Clarkson fit the mold of a like-minded group with similar ideals, even more so as a disadvantaged minority in a competitive environment. (*Durkheim's Mechanical and Organic Solidarity: What Holds Society Together?*, 2014).With the same stressors as other students as well as common stressors as women, it makes sense that women find comfort with others having the same experience. In this way, women create solidarity both with superiors and with their peers who have been through similar challenges.

There were some who bonded well with a male professor. Ann, the chemical engineering senior I mentioned in Section 3.1, maintained a close relationship with a member of the faculty

who she ended up doing research with. A couple of environmental engineering majors bonded well with a particular professor who provided feedback and support during rough academic and personal times. The smaller departments like chemical and environmental engineering had much more personal student-professor relationships. However, departments like civil and mechanical engineering seemed to be much less individualized. And when one of the women I spoke with chose to avoid office hours because she was intimidated by the professor, she didn't get the help she needed. Even those who went to office hours felt like the answers were too vague or round-about to really help them.

Most women I talked to didn't have horror stories about overt discrimination from professors. Engineering is known as a particularly cold subject to begin with; having unavailable professors in any discipline isn't unusual. But I heard tales of microdiscrimination from a particular tenured professor who had been working at Clarkson for a long time. He seemed to favor his male students and offer them more help than his female students. While this may just be rumor, one subject heard from a friend that this professor blatantly told her that women do not belong in engineering. This is also not uncommon in traditionally masculine fields.

None of the women I talked to faced such negative feedback from their mentors personally. Some women just had trouble finding a mentor in the first place. Out of over 100 engineering professors at Clarkson, about a dozen of them are women. None of them are in a senior position such as Chair of a department. This is not to say that they don't make a difference to other students, including women engineers I didn't get a hold of – but the lack of female professional role models may be a factor in why some of my interview subjects couldn't find a professor that they could bond with.

Some of the women I interviewed compensated for their lack of professional mentorship through friendships, familial ties, and Clarkson's departments centered on success such as the Career Center and the Honors program. While the lack of engineering women is evident in university faculty, the women I interviewed utilized resources in the younger generations that resulted in both very strong personal and professional bonds. I interviewed two peers a couple of days apart after the first suggested that I contact the second.

The first interviewee emphasized that much of her success was as a result of her older friends. They went through things first with little guidance and taught her how to navigate the same problem. The second woman I interviewed was immensely proud to know the women she did. "Intimidating" and "amazing" were two words she used to describe her cohort in the environmental engineering department. Seeking out a like-minded cohort can be what salvages a person's stability in an environment where she has less social capital (an exchange of social activity for acceptance or empowerment in a society). Both in classes and in extracurricular social situations, the women I talked with were quite skilled in creating bonds with a community of like-minded individuals.

3.6. Organizations

As shown in Table 1, ten out of the sixteen women I interviewed were SWE members. The creation of a professional engineering society at first exclusively for women (they do accept men now) at Clarkson occurred originally out of necessity. SWE provided a space for Clarkson

women to gather and cultivate personal and professional relationships with an understanding group of women. Now, they see themselves as a celebration of the professional engineering woman.

SWE is the largest professional organization in place for the promotion of women in STEM fields in the world (as stated in Section 1.2). Alumni funnel what seemed to be thousands of dollars of donations into SWE's budget. As a result, they can afford to do outreach and even send members to both the regional and national conferences. In the academic year 2014-15, the national conference took place in Los Angeles and the regional one took place at West Point Academy, north of New York City. SWE conferences consist of keynote speakers, banquets, and even career fairs with companies that reserve spaces specifically for SWE members. Like I said, this is a *large* organization.

After attending their Board meetings and club events, I spotted SWE women everywhere. I ran into two freshman SWE members I did not interview in Clarkson's student government office. We were all printing out posters for various events. To my frustration, we faced the challenge of a paper jam; I work with a copier in my university job and despise the malfunctions of an overworked copier. But these two freshmen simply followed the instructions on the screen, one relaying phrases like "Turn knob 3a counterclockwise" and "Lift lever 4b and remove all paper" to her counterpart kneeling into the open machine and finding the described knobs and levers. They solved it in less than two minutes. When I faced another paper jam by myself, I felt both frustrated that it took longer than the two freshmen but proud that I figured it out for myself. I thought to myself, "Is this what engineering feels like?"

Internal and external community events run by SWE happened on what felt like a weekly basis. At every Board meeting, the Directors had all items on the agenda planned and discussed cordially. While an onlooker would only see the bureaucracy of these meetings, I learned through interviews what SWE meant to its active members. Julia sought out SWE her freshman year while also participating in the pep band and a sorority. But SWE was the only organization she could see herself sticking with. Sororities to her were too exclusive while SWE accepted all men and women interested in the organization.

Other directors only had good things to say about their former president. The Director of Publicity described Julia's regiment of school work, professional growth, and even planning a wedding as "crazy" and something she wished to aspire to. This is the *exact definition* of a strong female role model: passionate, on top of the things she cares about, and important to a community. Many SWE women aspired to be their own version of Julia or a similar female role model they had in their lives. For those that sought out SWE, it provided a forum for their thoughts on being women in engineering.

SWE is not a positive community for all women. A non-SWE member I talked to – we will call her Amber – saw SWE as a place for "girly girls" which she honestly didn't see herself fitting in at. And for Amber, gender expression was important during her transition to a feminine gender role as a trans woman. The national SWE organization has a public policy that advocates for LGBT women (Membership Benefits | Society of Women Engineers, n.d.). However, on a small scale, Amber has not experienced complete acceptance of her expressed gender. Many Clarkson community members choose to see her as a "weird guy" rather than as a woman.

Instead, Amber got involved with the honors program and the Formula team which builds a professional race car every two years.

Both SWE and non-SWE members involve themselves in extracurricular organizations. There were members of the Clarkson Union Board, a Steel Bridge team, honors societies, coed fraternities, sweethearts of fraternities, sororities, tutoring services, sports teams, and Residence Life. The women engineers I interviewed integrated themselves into all aspects of campus life. While they have had fifty years to do so, Clarkson women are an essential part of the professional and social life of Clarkson students. This initiative translated well into resumes and interviews as women found success in the engineering workforce.

3.7. Professional Experience: Internships, Co-ops, and Career Fairs

Clarkson is a school that prides itself on its students' high rate of employment after graduation and the salaries of those graduates. In an ABC news article by Alan Farnham, Clarkson was ranked among the top twelve schools of students who graduate into jobs with higher salaries than Harvard University (Farnham, 2012). Twice a year the Student Center and Educational Resource Center (ERC) are filled with employers and students in business wear waiting to have their resumes checked and offers for interviews extended. Big-name companies like GE, Exxon Mobil, and IBM pay to attend these events and recruit upper-class students into internships and full-time positions after graduation. While Clarkson prides itself on its professional and well-stocked career fair, there was only one woman I interviewed who obtained an internship from a Clarkson career fair. The rest knew someone through extensive networking or hadn't obtained one yet because of their inexperience.

One obvious route to go in engineering is industry. As mentioned in Section 3.4, Mallory, a chemical engineering major, maintained a lot in her professional life. She held four internships in two companies, taking on different roles each time. She worked for a glass company in process engineering, then for Exxon Mobil as more of a business-oriented intern. Another chemical engineer I interviewed went into a co-op in industrial engineering hoping to get the experience she needed to make allergy drugs in the future. There were interns in aluminum plants, GE's power and water division, and even in National Grid's engineering office.

Many of the civil engineers I interviewed found a calling in building and government project operations. The Department of Transportation employed two women I talked with; their duties were scouting out roads, bridges, and construction to make sure sites were safe. As they explained, it's not just roads, but home inspections for certain chemicals and unstable environments are essential in the real estate business.

Environmental engineering majors at Clarkson are often trained in water filtration systems. Some of the women such as the engineer who took on the GE power and water internship, as well as the one who ended up with GE aviation sourcing, acquired the leadership and organization skills required in environmental engineering projects. While there was a lot of desk work to be done, they learned the efforts put into things like water filtration and sustainability. Many of the environmental engineers I talked with were also very research-oriented. Clarkson has its Institute for a Sustainable Environment which fosters research for both faculty and

students. The interns both in this program and working with a professor studied local water contents, the process of digesting, and energy conservation.

In addition to environmental engineers, chemical and mechanical engineers found themselves entrenched in research both at Clarkson and beyond. Ann, as mentioned in Section 3.1, has worked in two cities outside of Potsdam and gone to conferences all over the country involving the work that she did with her engineering professor. Amber, the woman I mentioned in Section 3.6, worked with a professor on a project Clarkson researchers were trying to mechanize further: a tractor trailer they had built over the course of fifteen years and sold. Amber worked with her professor one-on-one to draft the next big tractor trailer design.

Not all of the women I talked to had entered into a professional experience yet. The two freshmen I talked with were only just getting into the swing of things. They hadn't narrowed down their area of interest quite yet. The two sophomores I talked to had internships lined up for that summer. The first had gotten her internship after networking with national SWE members at conferences and national career fairs. According to another SWE member, these career fairs "put Clarkson's career fairs to shame". It was an industrial chemical engineering job with Dow Chemicals. The other networked with our own career fair and got an internship as a sophomore at a company that usually took upper-class students. She strongly emphasized that she wanted to get away from home to experience new things. Ultimately, the women I talked with were looking to experience new things via their professional experiences.

3.8. Activism and Feminism, or Lack Thereof

Not all new things in a woman's life are completely good; not all new things are unique for every woman. SWE invited Professor Callahan to host a moderated forum for interested members to discuss their experiences as both engineers and as women. They found an activity from a SWE member they met at a conference called "Stop Light". They handed out three sheets of paper, each with red, yellow, or green writing on it. On the red, they were to write about a negative experience they had caused by another person's interpretation of their gender. On the yellow, they were to write about an uncomfortable experience along the same line. Then on the green, they were to write about a positive experience. They ended up giving me all of the sheets for my research. What I found on the red sheets were stories that fell between blatant sexism and more forms of microdiscrimination and microaggression. I think of a phrase a couple of my interview subjects said; paraphrased, they stressed that even though no one told them that they wouldn't make it in engineering, no one told them that they *would* make it in engineering.

Many of the women claimed that they didn't have a forum such as the event Dr. Callahan put on to discuss issues like this. For me, this sounded abnormal because I talk about discrimination and inequality on a regular basis. But these women don't; they don't have a cohesive idea about what is and isn't discrimination when it's so subtle. Even well-intentioned actions like walking someone to their car for safety make women feel like they have something to be afraid of. Cassell's surgeon subjects faced this kind of discrimination from both other doctors and patients and often put up with it because it was just part of being a surgeon (Cassell, 1998).

Feminism is a resource that can combat discrimination through knowledge and community for women engineers; it has been a resource for them since the latter half of the twentieth century

(as described in section 1.2). But not all engineering women accept feminism as a method of combat. As I learned during my interviews, some women engineers believe that feminism is unnecessary or counterproductive to the advancement of professional women.

I asked in my list of interview questions, "Do you consider yourself a feminist?" This felt pertinent considering the advancements women have made directly caused by feminist theory and politics (refer back to Sections 1.2 and 1.3). I got one of three responses: a very clear "Yes", a mild "No", or some variation of, "In a way". Professor Ettinger had told me that some of her oral history subjects, women who had graduated from Clarkson in the 1970's, did not identify as feminists. Professor Ettinger's research is how I got my idea to do this project. She encountered a similar hesitancy from some women she interviewed because, by claiming any affiliation with feminism, they would be associated with the more extreme version of feminism that didn't match their goals or their values. I want to make clear that I identify as a feminist, very strongly in fact. And while I had small discussions about feminism with both those that did and did not identify as feminists, I tried not to let my own views seep into their responses when asked if they considered themselves feminists.

In a way, their responses were a reiteration of the different schools of feminist thoughts in the 1960's. Equal rights feminists believed that women could do anything and be anything, including engineers. Difference feminists saw inherent characteristics for each gender that worked well or not as well in the engineering field. While many people *say* they believe women should be engineers, there is a clause in there about how they are allowed to operate as engineers. Can they work long hours, do the same math, continue their career after a family begins, and climb to the top? Or are there things about engineering that make women less likely to succeed? And, as occurred during the talk with Professor Callahan, many of the women I asked about their views didn't have an articulate argument for why things were the way they were. This is common when privilege and disadvantage is deeply engrained in a culture.

There were eight women that very clearly stated "Yes". Julia, the civil engineer I have mentioned, talked about her feminist mentality before I even asked the question. These women saw feminism as a quest for equality. Many brought up the pay gap, the few women mentors they had in engineering, and the jokes and insults thrown at women that have been tolerated in the communities they've been in ("bossy", "bitch", "make me a sandwich", etc.). A few women in SWE talked about their friends seeing their involvement in the organization as a joke. Some friends even saw SWE as a statement that women *needed* an advocacy group, like they were powerless without it. However, the eight women I talked to that identified as feminists saw their views and their involvement in their chosen organizations as empowering.

SWE obviously gives women professional and personal guidance while navigating through the engineering field. During an anti-shaming campaign run every year by the organization, SWE ran first the #BanBossy campaign and then the #HeForShe campaign in support of banning "bossy" as a way of describing authoritative women and getting more men on board the feminist bandwagon. Amber, the trans woman I discussed in Section 3.6, is the first woman she has seen heading a Formula racecar team. There was also a strong emphasis on a woman's choice to do what she wanted. Obviously, these women didn't want others telling them not to become an engineer, or even the right place and time to have kids, change jobs, or get married. There is no ideal feminism that fits the build of every feminist.

This became very clear as six women hesitated in identifying as feminists. I got responses like, "I'm not sure; I don't know the correct definition of a feminist to be able to say something like that. I do identify as a... Humanitarian." I also received many affirmative responses with a clause: they did not identify with the "radical" feminists. One freshman was scared to actually identify with any feminists because of the stigma attached to radical feminism in the media today, as if radical feminists represented the bulk of feminists today. Many made it clear that they thought that both men and women struggled – it was simply a different struggle because of inherent differences in preference and environment. This sentiment has a strong similarity to difference feminism (Mack, 2001).While one can believe in equality, one can believe that differences between the sexes are natural and inherent. However, this leaves room for the interpretation that the set of skills possessed by one gender is better than the other.

There were only two women who specifically said no when asked if they identified as feminists. One saw current feminism as a movement to place women above men in society rather than as an equality movement. The other saw men and women as equally strong; she believed that feminist movements to elevate women actually demean them more because they make women seem weak. While she described a blatantly sexist professor, her lack of voice in an all-male group, and the empowering efforts of SWE in her life, she saw these events as facts of life that feminism couldn't change since it didn't promote equality. Proving yourself to be a strong person was the only way you could prove that women were strong; trying to push a general perception of women wouldn't work. Feminism only applied to women in her point of view. Having fewer women in engineering is a disadvantage for both men and women. Men aren't allowed to express emotions and she felt like more women would bring more talking and feeling. Men "think" more than they "feel". In her words, "They'd talk more about what they feel than what they think".

There are branches of feminism, more common today, that cover male feminism. Third wave feminists combat unfair gender roles which often make it unacceptable for men to express themselves. It's the same principle that would include Amber as her expressed gender as a woman in the women's movement. People deserve equality and *should* be able to do what they want. Perhaps it's because my research was focused very narrowly on women and their experiences. Perhaps the nay-sayers and undecided feminists expected me to get on my soap box and talk about how feminism will save women from a life of domesticity and submission. But I also pride myself on being a "radical moderate". I work very hard to see both sides of a debate in order both to strengthen my own views and remain respectful of others. I saw the issues with feminism that women who were unsure or unfriendly towards feminism as the *exact issues that feminism is trying to solve.* But yelling that in their face is not how feminism should be used in my mind. My work is a feminist movement. Their participation in my research is a feminist movement. And their existence as strong, professional engineers is a feminist movement. I don't want to exploit the words of women in order to further my own goals. But the stories these women told are testaments to the strength of female movers and shakers of the twenty-first century.

It was the suffragists and female temperance advocates that got the women's vote and prohibition instilled within the same decade after World War I. It was women in American factories using machines during the war effort in World War II and women filling STEM professions while men were at war. Even abroad within the past twenty-five years – in India on

the streets of Mumbai, in Chiapas during the resurgence of conservative politics in Mexico, and online during campaigns like #BanBossy and One Billion Rising – women have been the driving force behind change in the modern world. It's not that men are not integral to changing our world for the better – we all are – but the blind spot people often have for female movers and shakers spreads far and wide in our age. Using the hashtag #YesAllWomen feels appropriate here because yes, all of the women I interviewed represent success and a move towards equality at Clarkson University.

Just as Joan Cassell saw in her work with women surgeons, women in a masculine field tend to survive by either fighting or putting up with things until they have the agency to change their surroundings. During Cassell's interviews with her surgeons, she asked what advice her subjects would give to their younger selves or young people considering surgery. One of her interviewees thought that surgery is meant for the doctors who could literally not do anything less intense than surgery. So when asked what she would tell the youth looking into surgery, she said, "'Do it, if you can't do anything else. That's what I would tell them'" (Cassell, 1998). And I believe that these women can literally do no less than one of the most advanced combinations of math and science there is in industrialized society. And while they may not notice it, these women are the next generation of role models for young girls looking to be engineers.

4. Conclusions: Suggestions for Change

At its release date, the AAUW staff responsible for the report "Solving the Equation: The Variables of Women's Success in Engineering and Computing" brought together many executives from technology companies that were engineering and computing-intensive. Held in the Silicon Valley, this conference was to discuss how to promote women further in engineering and computing, two of the most underrepresented fields for women in STEM. They held a panel including Robin Bienfait, Executive Vice President and Chief Enterprise Innovation Officer at Samsung, Aprille Ericsson, Ph.D., the SBIR/STTR Program Manager at NASA's Goddard Space Flight Center, Elizabeth Gunn, Vice President of Service Delivery and Assurance in the west at AT&T, Jessica Lindl, Executive Director of GlassLab, and Scott McGregor, President and Chief Executive Officer at Broadcom. All claimed that, while they saw few women at the top of their fields, those that made it that far were well accomplished and just as rational and innovative as their male colleagues. They saw plenty of talented engineering and computing women employees, but few made it to the top. But what I saw when watching this panel was the end goal many women in engineering are striving for. And the panel of successful, women-supporting executives represented role models for the young women they were talking about.

After conducting my research, I hope to create change like what they were talking about in both the report and in the panel. Since this is a Social Documentation project, I will be making a documentary in the future about women in engineering at Clarkson. That means that there is more research to be done. Before I break out a camera, I'll require simplified theories to establish the basis of a video documentary. I'll have to debunk a couple of theories about why women shouldn't be engineers. I'll need solid visual ethnographic evidence of both the disadvantages and the advancements of women in engineering.

It has been done before. In a study about changing "toxic stereotypes" of children, Rivers and Barnett worked to discredit the arguments for why girls aren't good at math. It's common to hear that a girl's biological or personality composition is what makes her unable to succeed in math and science like her male peers. But Rivers and Barnett found evidence to the contrary. The notion that girls' genes are inherently disadvantaged in mathematical and scientific thought doesn't take into account the subdivisions of the groups based on class, race, and gender. In a study conducted at Johns Hopkins, researchers found that, while the seventh grade boys they surveyed were overall better at math than the girls, there were outliers within the survey group caused by societal expectations. For example, girls from richer families who showed gifted math skills were not given materials to enhance those skills like their male counterparts. Societal influence in the studies they used added to Rivers and Barnett's argument that a society instills the stereotype that girls are bad at math. While the numbers prompt one to assume that girls are bad at math, what causes those statistics is a lack of confidence and education given to girls who have potential in math and science (Rivers & Barnett, 2011).

I asked the women I interviewed what they would do if Clarkson were to change one thing about the perception and treatment of undergraduate women engineers. I outline three methods of progress Clarkson could take based on this question as a guide and my observations and research as evidence. These are only the beginning of an effective strategy to improve the conditions at Clarkson for women in engineering. While Clarkson has already made big strides since the twentieth century, there is always room for improvement. First, Clarkson can work to reach more young girls interested in math and science in primary schools. Second, Clarkson can work to even the playing field for women when they begin classes; the lack of engineering knowledge can leave some women at a disadvantage coming in with less experience than their male counterparts. Third, Clarkson should bring in more mentors in both the professional and academic sense. Female professors can provide guidance on a regular basis for women seeking advice. Also bringing in more professional guidance such as speakers, career fairs, and workshops would enhance women's experience at Clarkson and empower their understanding of women in the professional engineering field. I hope to expand upon these solutions when I create my documentary.

4.1. Outreach at a Young Age

A lot of the women I talked to said recruitment and outreach when girls are younger would improve conditions for women in engineering in the long run. The Girl Scouts as well as programs like Nerd Girls (as mentioned in Section 1.3) introduce women at a young age to some cool projects that are introductory to more advanced math and science. A lot of the women thought kids made up their minds about what subjects they like by elementary or middle school. And they're not wrong. Both the first and second reports done by the AAUW on women in the STEM fields found that an emphasis on math and science at an early age could cause more women to enter into professional STEM training or higher education programs (Hill, 2010; Corbett, 2015). But when young girls' education is fit to a cultural stereotype of what girls should know, there's less interest in the STEM field at a later age.

I attended the SWE event that the organization hosts every year with local Girl Scout troops. There were multiple stations in Science Center classrooms focused on different math, science, and engineering topics. The Chem-E Car club on campus did a demonstration of how it uses

chemistry and engineering to make a small motorized car that runs on chemicals. The Girl Scouts dropped eggs padded with newspaper and plastic to test properties of physics. They made paper airplanes, balloon hover crafts, and pudding cups demonstrating the layers of the earth. They made their own geo-domes with toothpicks and gumdrops to explore engineering structural design and then their own polymers with glue and other chemicals. They even watched SWE members separate strawberry DNA from its membrane using isopropyl alcohol.

I asked the Girl Scouts questions about the activities. Were the activities fun? Why were they fun? Did they like math and science and school? Would they consider going into a STEM field if they had more games like this? I got mixed responses. Everyone had fun of course; these activities were designed for children to learn about math and science while still having fun. Why it was fun got some interesting responses. The Girl Scouts said that they got to be creative. They could take normal stuff and make it new. They learned about science, experimenting, and got to eat food in the process. There were a promising number of girls that I asked who liked math and science. They got to solve problems, do fun experiments, and got to interact with materials (like animals in Biology, chemicals in Chemistry, etc.) when focusing on a specific subject. And these subjects often came to them easily. Those that didn't like math and science didn't like thinking that hard about a single problem. They didn't like how long it took them to perform equations and experiments. And when asked about going into a STEM field in the future, few girls raised their hands except in the more math and science-intensive groups of girls. If we are able to bring more programs like this to young girls and encourage more girls to explore math and science, perhaps we can change the definition of a "nerd girl" in the engineering field.

4.2. Evening the Gap in Engineering Programs

Another suggestion the women I interviewed had was to basically de-tokenize women at Clarkson; one phrase that stood out was to make women "engineers first, not women engineers". This could be done through multiple ways. Some suggested further recruitment at schools in the area and beyond. Many of the women I talked to didn't hear about Clarkson until a friend's dad suggested it to them or a guidance counselor told them about a scholarship Clarkson gave to the girls at their school with promise in math and science. Others suggested eliminating certain stereotypes that inhibit women's advancement. One woman thought tenure "shouldn't be a thing"; by this, she was addressing how certain older professors treat female students. Also concepts about a woman's intelligence and appearance were commonly what altered the confidence of the women I talked to. Both of these could be solved by seminars on tolerance required for all faculty and students. But even then, you still hear about Clarkson's freshmen orientation tolerance programs in which the student instructors tell their group of male underclassmen about how to successfully hook up with unattractive women.

Another model of change in recent history was at Harvey Mudd College (HMC) in Claremont, California. As of 2009, 9% of their computer science majors were women. But in just five years, they increased that to 40%. An HMC professor Christine Alvarado and colleagues believed that the reason for the initial lack of female computer science majors was because they, unlike many of their male counterparts, had little experience with hands-on computing and therefore less understanding of what computer science was for. So as part of their hypothesis, Alvarado changed three things about the computer science curriculum. First, she made the freshman introductory course in computer science more focused on the purpose of computer

science and provided coding that would help those that were less experienced, as well as useful information for the experienced computer science students, so they would all be learning. Second, she provided research opportunities to their female computer science majors right after their freshman year in order to get them real-world experience early on. Third, she gave many first-year students the opportunity to go to the annual Grace Hopper Celebration of Women in Computing conference as hosted by the Anita Borg Institute for Women and Technology. With these steps, Alvarado gave all students, specifically women, early exposure and a better understanding of what their field was about in order to even the playing field for the students who knew less about computing (Corbett, 2015).

If Clarkson were to create classes that even the score, that give women with a smaller amount of experience in their given field more applicable knowledge, perhaps the perspective of Clarkson women would change. These classes and professional opportunities could extend past women and be offered for all incoming freshmen as a way to equalize students and allow them to progress them at a similar level. This curriculum wouldn't function as a common core, more as a home base for freshmen to use and then decide from there where and what they want to do. A point that Corbett made sure to emphasize in the AAUW's second report on women in the STEM field is that,

> "In engineering, a field in which the educational and professional environments are closely linked, professional role confidence starts to develop as women and men begin their engineering education. Undergraduate engineering students are engineers in training, adding direct experiences with the profession to their previous understanding of the field. As they train for their careers, engineering students consider whether they will be successful, happy professionals in their chosen field. Whether or not they see themselves as successful and fulfilled and whether they feel that engineering is a good fit for their skills and interests will affect whether they continue working toward a degree and whether they pursue an engineering career" (Corbett, 2015).

How can we instill that confidence to stay with their desired field? This problem with confidence extends beyond the classroom. Professional guidance is a necessity when entering into a professional field.

4.3. Role Models

According to the AAUW report, women's retention rate in engineering drops from 65% in the first year with their Bachelor's degree to 40% ten years after their Bachelor's, then to a staggeringly low 25% thirty years after. I talked to some very motivated women during my research. They had plans to go into industry, medicine, large-scale construction, and research. But many of them talked about families. It's not that they can't have both, but many female engineering professionals become part-time employees which give them little advancement opportunity.

If Clarkson were to bring in more role models for women in engineering – more professors, more speakers, and more professionals on the job – they could ask all of the right questions and get the guidance some women feel like they don't get when making big decisions. There were only a few of the women I talked to who had people they referred to as mentors or

role models. Many met them on the job or during research. Many of the SWE women I talked to found their internships through networking with SWE members they met at conferences. But there are only about one sixth of female engineering majors who consider themselves members of SWE. In order to promote role models and mentors among the female engineering community at Clarkson, we will need more universal methods of outreach. Classes, campus events, and professional preparation are three ways to get engineering majors in the same room to talk about women's advancement. And that way, professors, professionals, and public figures can be there to provide the proper role models and guidance for young women engineers.

4.4. Clarkson as a Whole

To be clear, not all women said that there were problems at Clarkson. I have found that many of the women I talked to were reasonably happy with how women engineers are perceived and treated at Clarkson. Clarkson's President Tony Collins has done outreach events with SWE looking for donations and support. Some Clarkson women haven't experienced the horror stories other women have dealt with regarding blatant or microdiscriminatory sexism. Or even if they had, they didn't believe groups like SWE and the Women in Science and Engineering (WiSE) themed dormitory floor advanced women; rather, they singled them out as women and further weakened women's status as simply engineers. But I believe that, because feminist and professional efforts to get women into STEM fields have worked so well, some women don't believe there is a problem anymore.

Clarkson is indeed a very progressive school considering its gender and racial demographics. Things *have* changed for Clarkson women since they were first introduced to the student body in 1964. Our main sources of media such as the school website, *The Integrator,* the television station (WCKN), the radio station (WTSC), and the newsletters promote diversity. But things can only ascend from there. We could see more women given tenure or research funds. We could see more awards and more opinion pieces supporting professional women. We could have more press coverage of women with an exemplary professional history visiting Clarkson.

One of the best examples I can think of in recent Clarkson history is when Dr. Mae C. Jemison visited Clarkson in 2014. She received her Bachelor's degree from Stanford University in chemical engineering and her M.D. from Cornell University. After volunteering for the Peace Corps as a general practitioner, Dr. Jemison applied for astronaut training with NASA. She ended up getting accepted and became the first black woman to enter space on the *Endeavour* on mission STS47 in 1992 (Mae C. Jemison, 2015). She visited Clarkson to talk about her project called the 100-Year Starship. The 100-Year Starship project is researching both the creation of a space vehicle able to sustain a human population and to sustain earth's human population. She worked very hard to be who she is and what she does. And as a response to the nay-sayers, Clarkson's women engineers can use pieces of Dr. Mae Jemison's advice: "You have as much right as anyone else to be in this world and to be in any profession you want. … You don't have to wait for permission."

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