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Women in Engineering; A Phenomenological Analysis of Sociocultural Contextual Meaning of Gender Roles

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WOMEN IN ENGINEERING: A PHENOMENOLOGICAL ANALYSIS OF SOCIOCULTURAL CONTEXTUAL MEANING OF GENDER ROLES

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DEDICATION

Dedicated to My Wonderful Husband,

and

To My First and Finest Teacher, My Mother.

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ABSTRACT

The twenty-first century presents many new challenges in career development and choices in the workforce for men and women. Currently, women comprise nearly half of the United States labor force. United States women are employed in various career areas, ranging from the traditional careers for women, such as education and secretarial, to their growing numbers in business, law, and medicine (U.S. Dept. of Labor, Bureau of Labor Statistics, 2010). As technology becomes the driving force of the economy, it has become essential that science, technology, engineering, and mathematics are areas that more U.S. citizens should pursue. Although engineering is a very lucrative profession, many Americans, especially women, are not choosing engineering as a profession. Recent studies have shown no significant differences in math and science competency between men and women (Spelke, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; McQueen, Clark, & Rumsey, 2008). Therefore other factors, such as social cultural influences seem to affect women's career choices and preferences. The purpose of this study is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. Studying the meaning of the sociocultural gender-linked influences on the experiences of women engineers is intended to provide a better understand to educators and employers. It is hoped that this understanding will enhance the recruitment of more

women, by providing insight on how to meet the needs of twenty-first century women who may consider engineering academia and careers.

A phenomenological method of qualitative research was used in this study, based on interviews of nine women engineers in the Midwest United States. Their stories provided meaning into the sociocultural systems that contribute to successes, as well as barriers and challenges that are faced by women engineers in the workplace. The collected data may provide recommendations for the engineering industry to institute or strengthen sociocultural support and reinforcement in order to recruit, retain, and thereby increase the numbers of women engineers.

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CHAPTER I

Introduction of the Study

The twenty-first century presents many new opportunities and challenges for women in their career development and choices. As a result, the numbers of working women in the United States are increasing. According to the U.S. Department of Labor statistics of 2010, women comprised over half the population of ages 16 or older, totaling 156,964,212, with men totaling 151,781,326 in numbers. During the same year, women represented 47% of the labor force. Their workforce population is primarily represented in conventional fields for women, such as secretarial, nursing, elementary and middle school teaching, sales, and first-line management (U.S. Dept. of Labor Women's Bureau, 2010). In addition to these fields, U. S. women are increasing in numbers in business, law, and medicine. As technology becomes the driving force of the economy, it has become essential that science, technology, engineering, and mathematics (STEM) are areas that more U.S. citizens should pursue. Because of its importance, in November 2009, the President Obama administration initiated an "Educate to Innovate" campaign, developed to allocate more than $260 million to public and private institutions, with the goal to improve STEM education for U.S. students (WhiteHouse.gov, 2009). Although engineering is a very lucrative profession, many Americans, particularly minorities and

women, are not choosing engineering as a profession. This issue is one of concern for engineering college educators and engineering industry as well. The discussion of this issue must first begin with a clear definition of the engineering profession.

The Engineering Profession

Engineering is a challenging and rewarding career field that applies mathematics, science, and the laws of nature to create what is known as modern civilization. More specifically, as defined by the Engineers Council for Professional Development (1961/1979) and adopted by the Accreditation Board of Engineering and Technology (ABET),

"Engineering is the profession in which a knowledge of mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of [hu]mankind" (in Landis, 2007, p. 36).

As today's workforce is becoming more technical, more engineers are needed to meet the demands of industry, healthcare, education, transportation, economics, electronics, telecommunications and more. The National Science Foundation Science and Engineering Indicators 2008 report predicts a 26% increase of job opportunities in science and engineering between the years 2004 to 2014. This increase is due to new technological demands as well as attrition caused by retirement of older employees (2008). To date, the United States has contributed greatly to world technology, but in order to remain competitive with other countries, the United States must enlist the talents of its diverse population to the engineering profession. It is well noted that historically, engineering has been and continues to be a white male dominated profession (Tallmadge,

1944; Jagacinski, 1987; McIlwee & Robinson, 1992; Burke, 2007). This phenomenon is due to the ideology that characterizes engineering as a masculine-gendered social construct in the United States (Pursell, 2001). As a result, too few women and minorities are employed as engineers. This lack of diversity in the engineering workforce is a fact that has become a crucial concern for U.S. industry, not only in terms of maintaining the numbers of U.S. engineers and providing equal employment opportunity, but also in terms of enlisting diverse talent and creativity to the profession. As stated by William A. Wulf, President of the U.S. National Academy of Engineering (NAE): The

> "fact that white males are becoming a minority in the population of the United States and that, unless we include more women and underrepresented minorities in the engineering workforce, we are simply not going to have enough engineers to continue to enjoy the lifestyle we ... enjoyed for the last century or so….As a consequence of a lack of diversity, we pay an opportunity cost, a cost in designs not thought of, in solutions not produced. Opportunity costs are very real but also very hard to measure" (NAE, 2002, p. 8).

As emphasized in Wulf's statement, the problem of a lack in diversity in the United States engineering workforce is pervasive. Confirming his stance, in 2008, women earned only18% of engineering bachelor's degrees, 23% of master's and 21.1% of doctoral engineering degrees (ASEE, 2008), and comprised only 13.5% of the U.S. engineer employees (U.S. Dept. of Labor, Bureau of Labor Statistics, 2008). As women compose approximately half the population of the United States, as well as half of its workforce, these statistics demonstrate an obvious negative disproportion of women in the field of engineering.

The concern discussed by Wulf, representing the NAE was not unique. In fact, the issue of the disparity of women in engineering has been a topic of research for over thirty years (Mattis, 2007).

Statement of the Problem

My research addressed the problem that there is little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. Prior research has been conducted regarding sociocultural gender-linked influences on high school and college level students' academic performance in STEM (Lee & Bryk, 1986; Thomas, 1990; Marx & Roman, 2002; Heyman, Martyna, & Bhatia, 2002). The problem is there is little research known that involves college graduated women engineers in industry (Mattis, 2007). There is a need for further the research beyond the college years into the workforce, to better understand why there is such a disparity of numbers of women engineers. Therefore to add to the research pertaining to the education of college women in pursuit of engineering, the focus of this study was to listen to the voices of professional women engineers to discuss not only the sociocultural gender factors, but also the meaning of those factors that influenced their career decisions and experiences.

Sociocultural gender issues in general, have been explored in reference to the disparity of the number of women engineers. For example, studies related to gender factors such as social and cultural role expectations have shown to affect women's career decisions (Frehill, 2004; Hakim, 2006; Powell, Bagilhole, & Dainty, 2009). Other studies mentioned that women lack awareness of what engineers do, and the lack of women engineering role models has a negative effect on other women pursuing engineering or

even considering it a field for suitable for them (Mattis, 2007). Moreover, engineering is conventionally defined with male-gendered social constructs, focusing on mechanical and technical skills, whereas female engineers find a meaningful connection to the social aspect of engineering, which includes helping people and improving the environment (Beder, 1989; Thomas, 1990; Mills & Ayre, 2003). These studies give evidence to the existence of sociocultural gender-linked factors. However, what these factors mean to women in the engineering industry is what needs to be explored in order to gain a deeper understanding of their experiences. I argue that this understanding is relevant to understanding why there are fewer women than men in engineering.

Other factors implicated in this disparity have been investigated. For example, academic competency between genders has been compared in subjects of mathematics and science, which are required core subjects in engineering curricula. The question of whether there was an inherent difference in mathematics and science competency between males and females was posed, and early researchers contended that males were inherently superior to females in these areas (Bendbow & Stanley, 1980; Gray, 1981). Current researchers however, have proven the contrary, as their studies comparing male and female competency in mathematics and science proved no significant or inherent differences (Marx & Roman, 2002; Spelke, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; McQueen, Clark, & Rumsey, 2008). Such research is relevant to this study, as proven female competencies in mathematics and science areas do not contribute to the understanding of the shortage of women engineers.

In light of the studies that strive to explain today's shortage of women engineers, there are some historical studies that discuss how this shortage was not always the case

(Bix, 2004; Frehill, 2004; Allaback, 2008). In fact, women were prominently represented in the engineering workforce during the World War II era. In brief summary, engineering has historically been dominated by white males. Before World War II, women were banned from engineering college programs (Bix, 2004; Freehill, 2004). During the industrial revolution era of 1820-1920, emerging assembly of factories and technology dominated the U.S. workforce (Kim, 2007). Technical skills evolved throughout the industrial age and developed a social identity of masculinity (Cockburn, 1985). The male gender construct identified with technology carried into the engineering field. White middle-class males sought to professionalize engineering, and in doing so, strengthened the white-male domination construct of the profession. Such dominance is also known as hegemonic masculinity, "a pattern of practice (i.e. things done, not just a set of role expectations or an identity) that allows men's dominance over women," (Connell & Messerschmidt, 2005).

Male dominance in the technical workforce eased in the early 1940's, as the country enlisted men to fight overseas in World War II. During this era, women were technically trained and permitted into the workforce to maintain the profession. Cultural icon, Rosie the Riveter became a popularly known image of confident women with technical skills. Although evidence proving women comparable to men in technical careers increased during the World War II, such evidence eroded by the end of the war, as men returned home and rejoined the workforce. As a result, the images of women carrying wrenches and flexing their strength in technology began to fade, and society reinforced the former masculine identity associated with engineering and technology. Specifically, white males regained their status of ownership of the engineering and

technical domain (Frehill, 2004). This transition in effect ostracized women and ethnic minorities, such as African Americans from engineering (Oldenziel, 1999).

The exclusion of women and minorities contributed to the negative stereotype that considers these populations as inadequate in areas of math, science, and technical fields such as engineering (Good, Aronson, & Inzlicht, 2003; Education Week, 2008). Negative stereotyping of women and minorities is recognized by researchers to often cause negative self-perceptions. Known as stereotype threat, the effected populations thereby develop negative self-efficacy issues (Aronson, 2004). Stereotype threat in this circumstance pertains to women's self-efficacy and its impact on their competency in science, technology, engineering, and mathematics (STEM). Although studies have shown that females are as competent as males in STEM subjects, women bear the challenge of overcoming stereotype threat. Thus, in reference to their interest and competency in science, technology, engineering, and mathematics, stereotype threat may contribute to women and minorities' deterrence from engineering academia and careers still today.

As we enter the 21st century, efforts are being made to reverse the stereotype threat as it is realized that women and minority citizens are not inherently incompetent in math, science, and technology (Spelke, 2005). By contrast, studies have shown that all students, regardless of race or gender, are equally as competent when provided equal opportunity in academia (Marx & Roman, 2002). As a result, the percentages of women in other professional fields that require these skills have been increasing. For example, in 2008 the U.S. Department of Labor and Statistics reported that women comprised 52.9% of biological scientists, 52.3% of the medical science profession, and 33.1% of chemists

and material scientists. Women were also prominently represented in other conventionally male dominated occupations, such as legal occupations, with 34.4% representation of lawyers and 43.6% of judges, magistrates, and other judicial occupations (2008).

Despite strides made within the past thirty years to encourage more women to pursue engineering, by and large, women still are not choosing this profession. The question then is why more women are not pursuing engineering? Researchers assert the reason is likely attributed to the continuous social masculinization of engineering, whereas the engineering profession has been assigned a social cultural construct of male gender identification (Bystydzienski & Bird, 2006). This social masculinization seems to pervade the engineering profession more than other conventionally male dominated professions.

The problem concerning the disparity of numbers of women in engineering is two-fold. As previously mentioned, from a broad scope, the increase of diverse citizens in engineering is significant to the future of the engineering profession in the United States. According to the U.S. Census Bureau in 2001, women accounted for one in five engineering students nationwide. This figure has remained consistent in recent years, whereas men earned 82% of engineering bachelor's degrees in 2008. However, this figure is not due to a dramatic increase in women engineering students, but rather a decrease in men's enrollment in engineering (Frehill, 2004). If fewer men are enrolling in engineering, then it stands to reason that more women are needed in order to maintain the numbers of engineers in the United States.

In addition to supplying the U.S. with more engineers, women should consider engineering from a personal financial point of view, for engineering is not only a rewarding profession, but also a lucrative one. The 2010 report from the National Association of Colleges and Employers (NACE) indicated that despite the recent sluggish economy, engineering salaries are on the rise with the following starting salaries for bachelor's degree earned: bioengineering and biomedical engineering $62,125; chemical engineers at $65,142; mechanical engineers at $58,392; electrical engineers at $59,074; computer engineers at $60,879, and civil engineers at $52,605 (NACE, 2010). Unfortunately, women and minorities are overrepresented in lower paying jobs (U.S. Dept. of Labor Statistics, 2008).

Regarding gender and salary, the 2010 U.S. Department of Labor and Statistics reported that women on average earned only eighty-one percent of men's earning (2010). As the 21st century workforce is becoming more technical, there are fewer decently paid openings for the unskilled, and the demand is increasing in fields of science, technology, engineering, and mathematics. Therefore, more than ever, women representing all races and ethnicities should become more prominent in these professions not only for the country but also for their personal earning power and social mobility. In this respect, the issue of wage earnings in engineering fields supports the problem statement of this study that addresses the little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession.

In order for women to be more competitive in the technological workforce, they must be better made aware of the engineering profession, and privy to the academic

preparation for engineering careers. The subjects of science and mathematics provide the theoretical basis of engineering education. Along this path of awareness, girls and women must be encouraged by educators to increase their level of science and mathematics from K-12 through college curriculum. It is therefore important for educators to study the factors that shape the decisions of girls and women regarding the science and mathematics education, and the historical perspectives that lead to such decisions. As an example, research shows that women with non-traditional college majors such as math, science, and engineering face complex issues in their college and career lives, such as:

- Feminine gender role and socialization
- Internalization of stereotypes
- Sense of isolation and perceptions of sexism
- Inadequate program support for women (Seymour & Hewitt, 1997).

Similar negative experiences seem to pervade the engineering workplace, as women engineers describe their workplace challenges as "lack of support, lack of respect, constant loneliness, and the glass ceiling they experience as women in a man's world" (Mattis, 2007, p. 342). Such experiences by female college students and employees in engineering are based on social cultural factors related to gender constructed roles in careers.

In light of this issue, the problem this study addressed is the little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. Recent studies related to this topic have used quantitative methodology, which provided useful numerical data related to female undergraduate engineering students' perspectives (Gill,

2000; Choudhuri, 2004). However, little research was found that utilized a qualitative analysis, to give voice to the professional women in the engineering industry. As a researcher, I believe it is therefore important to extend the research from college to industry, in order to learn about the current experiences of women engineers. Through a phenomenological qualitative method, this research explored the social cultural experiences, challenges, and successes that attract and retain them in the male-dominated field of engineering. In summary, my research addressed the problem concerning the little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession.

Purpose of the Study

Years of research regarding women engineers has confirmed the existence of the problem of disparity of the numbers of women in the engineering field (McIlwee & Robinson, 2002; Frehill, 2004; Powell, Bagilhole, & Dainty, 2009), but unfortunately a solution has not yet been found. For this reason, research in this area must continue until the issue shows improvement. As previously mentioned, much of the past quantitative research studies have focused on the experiences of high school girls in mathematics and science, and college women majoring in science, technology, engineering, and mathematics (Lee & Bryk, 1986; Thomas, 1990; Marx & Roman, 2002, Gill, 2000; Choudhuri, 2004). Mattis argued that little research has been performed involving women engineers in industry (2007). Studying women engineers could provide insight on how and why they decided to become engineers, as well as the challenges they have faced. To this end, the purpose of this study is to understand the meaning that women engineers

make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. Studying the meaning of the sociocultural gender-linked influences on the experiences of women engineers is intended to provide a better understanding to educators and employers. It is hoped that this understanding will enhance the recruitment of more women, by providing insight on how to meet the needs of twenty-first century women who may consider engineering academia and careers.

Through a phenomenological qualitative study, interviews of nine women engineers gave voice to their experiences in order to explore the essence of the factors that contributed to their career decisions as they pertained to entering and remaining (or leaving) the field of engineering. In this regard, the participants of this study were asked to share their stories of work and family relationships. Socio-cultural constructs were identified through participants' stories to study how women decided to become engineers, and the challenges, barriers, and/or successes they encountered in the engineering workplace. This study included the women's engineering career experiences, such as their relationships with male and female colleagues, supervisors, subordinates, and opportunities for career advancement. Stories encompassed the women's reflective experiences of their journeys to becoming engineers and their perceptions of how their career decisions were perceived by their families, as well as how they balanced their work and family responsibilities. It is intended that an understanding of these factors may contribute to the support or improvement of industry culture and social cultural gender role expectations in effort to thereby improve recruitment and retention of women in engineering careers.

Research Questions

The issue of women engineers and the social cultural factors that influence their career choice is significant to the population of women engineers as well as the status of the engineering profession as a whole. Through a phenomenological study, participants were asked in general, what contexts or situations have typically influenced or affected their experiences as women engineers. Specifically, the following questions were designed for this study.

1. Regarding issues and barriers:
    a. What issues and barriers do/did women engineers in this study encounter in the engineering workforce?
    b. How do/did these issues and barriers shape their career decisions?
    c. How do/did these issues and barriers shape how women learn to be engineers?
2. Regarding successes and supports:
    a. What successes and supports do/did women engineers in this study encounter in the engineering workforce?
    b. How do/did these successes and supports shape their career decisions?
    c. How do/did these successes and supports shape how women learn to be engineers?
3. What is the overarching essence or meaning of the experiences of being women engineers?

Theoretical Framework

The research of women in engineering in this study covered several theoretical approaches. The primary theory that framed this research was the postmodern feminist theoretical perspective in relation to women's academic and career choices in engineering and social capital. In addition, how women learned math, science, and engineering, and the perceptions of women's self-efficacy in these fields were explored from a social learning theoretical perspective. The social learning perspective is also known as a social cultural theory. Socio-cultural theory applies to the social and environmental effects on the issue. The philosophy of the socio-cultural theory is that knowledge acquisition is affected by the "social, cultural, and physical contexts in which human cultures find themselves" (Case, 1996, p. 79). Related theories that framed this study were the social cognitive theory as it pertained to gender roles (Bandura, 1984), the social cognitive career theory, as it pertains to women's career choices based on social influences (Lent & Brown, 2008), and situated cognition, as it related to how women learned through interaction and social context (Hansman, 2001). It is the intent of the research to illustrate how these theories interrelate when applied to the issue of women in the non-conventional work world of engineering.

Significance of the Study

The study of women engineers bears significance to the recruitment and retention of more women in the profession, as well as women engineers' career planning and development. Women engineers' issues, challenges, barriers, as well as successes in the workforce affect their levels of job satisfaction and retention in the field. Negative experiences may contribute to the low numbers of women engineers, and therefore few

role models for prospective future women engineers. This inadvertently has a trickle-down effect to girls and college women, giving them a message that engineering may not hold positive career opportunities for them (Adelman, 2005). Conversely, women engineers' positive experiences and stories are seldom told, which leaves a void of breadth, dimension, and diversity in attracting more women to the field, in addition to balancing perceptions of women's roles in engineering among their male counterparts.

Affirmative action has enabled women's access to careers once denied (Stanford, 2009). Past efforts to achieve this goal must not be forgotten, and much more improvement is needed in order to not only sustain but to move forward. The significance of this study is compliant to the argument of Kohlstedt who contended that it is important to understand "where women and gender fit into... stories of scientific and technological accomplishments and to produce new, inclusive, and more complex accounts that acknowledge both women's achievements and the discrimination that they faced. It is critical to understand that gains may be eroded and that sustaining women's opportunities still requires attentive activism" (2006, p.23). This study is intended to support Kohlstedt's statement by furthering research in this area.

Background and Overview

Researcher's Interests

I am interested in the subject of the social cultural factors women engineers for several reasons. In my profession, I am a manager of engineering student programs at an urban university. A significant area of my responsibility involves recruitment and retention of engineering students. Taking notice of the challenge to recruit more women and minorities to engineering, I realized the importance of mathematics and science

studies for adequate preparation to the field. I also recognized the need for inclusion. It is well known and documented that not all schools and education programs are created equal, and as a result, not all students come to college with equal preparation and awareness of a variety of career opportunities. In this regard, I hope that my research will enlighten female students of all races and ethnicities--from elementary, middle, and high school to college--about the value and importance of excelling in mathematics and science so that they may broaden their choices in career decisions, with engineering as one such viable option.

I write with great confidence in the ability of women and minorities to succeed in engineering. Over the years, I have observed the female and minority engineering students of the University for which I am employed, working with hands-on projects alongside their peers in their engineering design courses. I admire the enthusiasm and perseverance of the students in the chapters of the Society of Women Engineers and the National Society of Black Engineers, as they study long hours, promote their organizations, and encourage more students to join them. It excites me each year to watch the engineering students of all backgrounds earn scholarships, and win academic awards in the annual recognition ceremonies, evidence that equal opportunity and high self-efficacy among all students yields high achieving scholars and future engineers of America. My goal is to increase the number of future engineers by encouraging more women, including women of color, to pursue this profession.

I first began research in this area in 2006 through a pilot study of African American women engineers. The pilot study was a qualitative narrative approach. The research crossed several conceptual frameworks, namely postmodern, feminism, critical

theory, and social constructivist perspectives. Through purposive sampling, three participants were selected who were engineers I had met professionally. They were chosen from my professional networking with the National Society of Black Engineers (NSBE). Unplanned on my part, all three women were civil and environmental engineers, and worked in the area of consulting. As a researcher, I wanted to learn through their reported experiences whether they perceived equity and comparable support to their male counterparts during their college years and in their engineering career worlds. The themes revealed in the results of the study were a) strong parental support, b) either strong academic skills or perseverance in mathematics and science subjects, c) and strong support for their engineering choice of major from most college faculty and staff. The women who experienced negative feedback from teachers were able to turn the experiences into positive motivation for success, for example, by proving they could succeed in the face of doubt from a professor, thereby winning his confidence. Two of the three engineers reported loneliness in college or work environment, as a result of being of the few women of color in engineering fields. Overall, all three participants had positive attitudes about engineering and their career choices, with more positive than negative experiences reported.

In addition to my belief in female and minority students' abilities, I have deep appreciation for engineers as those who make significant contributions to modern society, the United States, and the world at large. The engineering career also affords the potential to earn lucrative salaries. I am concerned about the problem of women composing only 13.5% of the U.S. engineering workforce (U.S. Dept. of Labor, 2008). It is evident that college education increases wages, and enables improvement of the quality of life (2008).

Combining this notion with the call for more U.S. citizens in STEM careers, I wish to continue the efforts of educators and researchers to motivate and prepare more women to pursue engineering for the purposes of social mobility and economic gain.

Stereotyping

Stereotypes are generalized characteristics assigned to certain groups based on race, class, gender, age, etc. Although some characteristics are found common among certain groups, stereotypes can be true or untrue, positive or negative. Stereotypes can also over generalize a group, and take away from individuality within groups. Negative stereotypes can often result in discrimination, and denial of opportunities.

Male and female gender-linked stereotypes affect the social cultural roles and expectations of these groups and are often over generalized. When I think of these stereotypes, I am reminded of male descriptors that characterize them as physically strong, assertive, albeit aggressive, those who work outdoors, work with their hands, and are breadwinners for their families. Conversely, I recall female stereotypes that describe them as gentle, unassertive, team players, more interested in people than things, nurturers, caregivers, and homemakers.

Some of the characteristics listed above may be found true within both the male and female genders. Taking a closer look at these stereotypical descriptors reveals not a clear-cut division, but characteristics that cross genders. In many cases, these stereotypes fail to acknowledge the differences within groups as well as within situations. For example, are there not women who like to work outdoors, are aggressive decision-makers, or are the primary or sole wage earners for themselves or their families? Similarly, are there not men who prefer to work indoors, are gentle in nature, or are the

homemakers and caregivers of children while their wives work outside the home? In other words, stereotypical characteristics assigned to males and females can be found in the opposite genders as well. Like men, some women are assertive, and some have aggressive personalities. Some women enjoy self-promotion versus teamwork, or a combination of the two within situational contexts, others seek and obtain supervisory careers, and many women are generally high achievers in life and work. Some women, married or single, have jobs that require long hours and travel, and thrive on competition. This point has been acknowledged in many situations and career avenues of the twenty-first century. Women are found in demanding, high profile, conventionally male-dominated professions such as business, medicine, police and fire safety, law and politics (U.S. Dept. of Labor and Statistics, 2010).

And so it is with engineering. Women are found in the various career avenues that engineering provides. There are engineering jobs that involve both indoor and outdoor assignments, technical and hands-on skills, or marketing and sales skills. There are project engineers, research engineers, and design engineers, and women are found in all of these arenas. Some work with people, some with things, some with people and things. That is the real world of engineering. It is a world that calls for diversity of skills and diversity of people who possess these skills. Engineering is a world where women belong as well as men. Women engineers are strong, confident, skilled, versatile, and contribute greatly to the profession. The truth then is that women are competent in the career world of engineering. The stereotypes that stand as a barrier to recruiting more women in engineering seem to be the problem. My beliefs coincide with Rosser who states that, "gender stereotypes that reinforce women's socialization to be less overtly competitive

may make it more difficult for a women scientist or engineer to succeed in a very competitive environment" (2006, p. 78).

As a researcher, I want to help the profession of engineering catch up to the other conventionally male dominated fields. It is for this reason that I want to challenge the stereotypes by learning about what inspires women to become engineers and how they experience achievements and challenges in the male dominated engineering profession. In this regard, it is my hope to be a change agent of the social cultural constructs that can negatively affect women's career decisions, in particular reference to engineering.

In effort to increase more women engineers, I want to be an advocate for change in the perception of engineers among girls and women. To modernize the perception of what engineers do, girls and women may associate the field with their social interests, such as the improvement of the environment through green energy, or the study of global warming. I also want to bring to the forefront the history as well as the current presence of women who are engineers, in order to provide leaders, mentors, and examples to young girls that engineering is indeed a career for them. For although the numbers of women are few in comparison to white male engineers, many women and minority engineers have made significant contributions to society and strides toward job equity in the United States. These efforts should be made more known to the general public, and further opportunities in engineering should be open to all regardless of race, class, or gender.

I am aware of the male hegemonic culture of engineering and the challenges that women may incur as a result. The research I have noted in the literature review attests to these challenges (Oldenziel, 1999; Frehill, 2004; Rosser, 2006). Since such research has

been done I need not repeat it. Rather, it is my hope that I can further their research with information that may lead toward solutions to the problem. Specifically, I wish to explore what *is* working for women engineers. How do they learn engineering in the workplace? How do women engineers make meaning of their challenges and barriers? What do women find that brings them success, joy, and continued interest in their engineering career? I believe that focusing not only on the problems but also the successes of women engineers may provide future researchers, educators, engineering employers, both male and female, the impetus to increase the numbers of women engineers. This is the message that needs to be conveyed to young girls and women, as well as their male peers,—that engineering is a world for both genders. Furthermore, diversity in this field is beneficial to us all, as we all have unique ideas and talents to share.

As Metz has noted (2007), the message to young girls and women about engineering has not been encouraging. They hear that engineering is hard, dirty, and not for females. I agree with researchers who argue that females (and males alike) need to hear more about engineering social contributions, and the variety of career opportunities. As an example, the fields of biomedical engineering and environmental engineering are attracting more women, with women comprising 38.6% and 43.2% of earned bachelor's degrees in these fields respectively in the year 2008 (Gibbons, 2008). These fields are more recognized as socially connected than the conventional fields, such as civil, mechanical, and electrical engineering. The societal contributions of engineering are what need to be emphasized to appeal to the social interests of women in effort to increase their interest in engineering careers.

For this reason, I contend that it is time to focus on the positive aspects of what engineers do to benefit society. My wish is to acknowledge the work of engineers and by doing so, encourage more youth, including females of all races and creeds to consider engineering as a rewarding career for them.

Finally, as the problem of recruiting more engineers to the U.S. workforce is a pervasive challenge, it stands to reason that attracting more women to engineering to join forces with their male colleagues offers an obvious solution to the problem. I believe engineering is a wonderful career. My job in higher education has been to motivate, encourage, and recruit more engineering students. I hope that through learning about the experiences of graduated women engineers in industry, my dissertation will improve recruitment efforts. For these reasons, as a researcher, I would like to dedicate my study to ways of increasing the numbers of women of all diverse backgrounds into the world of engineering.

Methodology

Using a purposive sampling, a qualitative phenomenological study of nine women engineers from the Midwest Region of the United States was the focus of this research. The intent of the data gathering was to provide in-depth analysis, using a collection of stories told by women engineers as participants. The selected participants had all earned at least a bachelors degree in engineering, and had three-to-seventeen years of practice as engineers. Little prior research regarding women engineers with work experience in industry was found to compare to this study.

Prior research found of women engineers has primarily focused on college female engineering students. For example, Gill (2000) performed a qualitative study of thirteen

Canadian undergraduate college women in their first two years of study in mathematics, science, and engineering. The study examined interpersonal, intrapersonal, and contextual factors that influenced their decisions to pursue engineering. A study by Choudhuri (2004) was found which involved undergraduate women engineering, using a hierarchical linear model quantitative approach, to examine multiple social cognitive variables, personal and contextual, that influence women's decisions to major in engineering. These two studies are examples of research that involves undergraduate college women in pursuit of engineering. However as mentioned, there is little research known that involves college graduated women engineers in industry (Mattis, 2007). My phenomenological qualitative study of women engineers in industry was intended to further prior research by addressing this need. To add to the research of college women in pursuit of engineering, the participants of this study were women engineering professionals in industry. As a researcher, I aimed to gain insight on how and why women choose engineering as their career choice. By studying women engineers in industry, I wanted to learn about their preconceptions of engineering prior to entering the work force, and how may their perceptions have changed over the years? What social cultural factors played a role in their perceptions and experiences? And what did these perceptions and experiences mean to them as women engineers? To this end, this study was performed through a qualitative phenomenological methodology.

Phenomenological research is a method that is used when exploring a human experience that occurs among a group. Through interviews of participants, phenomenology aims to find the *essence* of meaning of the each individual participant's experience (Creswell, 2007). In this study, phenomenology applies to the experience of

being a woman in the male dominated profession of engineering. A purposive sample of nine participants was selected. The participants were selected from an alumni pool of a Midwest university, as well as professional women engineers in the Midwest region. An open-ended interview instrument was developed to include pertinent questions that gave voice to women, including African American women, who represented the population of women in the work world of engineering. Through these qualitative methods, I as the researcher collected interview data of the participants to determine the socio-cultural impact of gender roles in their career decision-making. Interview transcripts were recorded and transcribed. As the researcher, I explored the impact of social cultural and feminist theories as they pertained to work and family spatial relationships.

Limitations of the Study

Nine women were selected to participate in this study. The study examined experiences that were specific to the participants and may be found to be common experiences of other women engineers. Yet, nine participants are not likely to report stories that are completely generalizable to all women engineers. For example, women engineers who have graduated college five years ago may have different stories than women engineers who graduated college ten to twenty years ago. Likewise, their work experiences may differ from women engineers in the workforce earlier than five years ago. Another difference to consider may be regional, in that women engineers in the Midwest U.S. region may have different experiences than women in other U.S. regions. Furthermore, women of different races may have differential education and work experiences, not only as individuals, but also as members of their races.

Definition of Terms

Sex: "a biological description of two types of people—females and males" (Shakeshaft, 1989, in Shakeshaft, Nowell, & Perry, 1991).

Gender: A cultural term (Shakeshaft, 1989) that "describes characteristics we ascribe to people because of their sex—the ways we believe they behave or the characteristics we believe they possess, based on our cultural expectations of what is male and what is female"(Shakeshaft, Nowell, & Perry, 1991).

Hegemonic masculinity: "a pattern of practice (i.e. things done, not just a set of role expectations or an identity) that allows men's dominance over women" (Connell & Messerschmidt, 2005).

Stereotype threat: The study of how stereotypes that imply intellectual inferiority of minorities and females may result in low self-efficacy within these groups, thereby resulting in low achievement and achievement gaps between these groups and groups such as white males who are stereotyped as intellectually superior (Aronson, 2004).

Summary

My research addressed the problem that there is little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. The purpose of this study was to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. As technology becomes the driving force of the economy, it has become essential that science, technology, engineering, and mathematics (STEM) are areas that

more U.S. citizens should pursue. Although engineering is a very lucrative profession, many Americans, particularly women and minorities, are not choosing engineering as a profession. Through a phenomenological qualitative approach, this study examined the essence of the experiences of women engineers in industry to understand the sociocultural contextual meaning of gender roles and its influence in career planning of women engineers. The intention of this study was to further research concerning the issue of why fewer women than men pursue engineering careers. It is hoped that the findings of this research will assist educators as well as engineering employers with recruitment and retention of women engineers.

There are six chapters in this study. Chapter one presents an introduction to the study of women engineers, the problem of disparity, the significance, and the purpose of this study. Chapter two discusses research and literature related to the subject. The literature review discusses the history of women engineers, social cultural factors of gender roles that influence career decision-making in engineering, and the social cultural and feminist theories in relation to women engineers. The methodology used in this study is discussed in chapter three. The qualitative phenomenological research will be detailed. Chapter four describes the researcher's story of finding participants. Chapter five explores the analysis of the qualitative study, and chapter six concludes with a discussion of the findings, limitation, implications, and recommendation of further research.

CHAPTER II

LITERATURE REVIEW

My research addressed the problem that there is little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. The purpose of this study was to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. As women are broadening their career options in the once male-dominated fields of business, law and medicine, it is evident that they are proving competent and making great contributions. The field of engineering however, has not changed in parallel to these fields, as it remains a male dominated profession. The issue of the shortage of women engineers has been examined from many aspects for the past thirty years. In regard to academic competency, studies have proven no academic deficiencies of women in their mathematics and science abilities in comparison to men (Marx & Roman, 2002; Spelke, 2005; Metz, 2007). This research is relevant, as mathematics and science are requisite subjects in engineering curricula. Engineering is also identified with hands-on technical abilities. Researchers mention that while hands-on experience improves the interest of all students in engineering, curriculum in this field is often found to be too

male-gender constructed, with emphasis on machinery and physical technology (Burke, 2007; Powell, Bagilhole, & Dainty, 2007). Female engineering students on the other hand, are generally more attracted to the social aspects of engineering, where helping others and improving the environment are considered more appealing (Mills & Ayre, 2003; Beder, 1989; Thomas; 1990). Although the engineering profession offers wide opportunity for social responsibility, environmental consciousness, and meaningful connection, in addition to its technical areas, literature shows that stereotypical social cultural factors regarding male and female gender roles in career decisions seem to continuously negatively impact the numbers of women attracted to this field.

To this end, the research questions of this study related to the literature review. In general, participants of the study were asked what contexts or situations have typically influenced or affected their experiences as women engineers. Specifically, the research questions answered in this study were a) What issues and barriers did/do women engineers in this study encounter in the engineering workforce? b) How do/did these issues and barriers shape their career decisions? c) How do/did these issues and barriers shape how women learn to be engineers? d) What successes and supports did/do women engineers in this study encounter in the engineering workforce? e) How do/did these successes and supports shape their career decisions? f) How do/did these successes and supports shape how women learn to be engineers? and g) What is the overarching essence, or meaning of the experiences of being women engineers?

In regard to the research questions of this study, the following literature review discussed the issues related to the disparity of women engineers, with specific focus on social cultural issues, barriers, perceptions, as well as successes. The review began with a

historical perspective of women's education and career options in the United States, followed by a transition into the mathematics and science education and opportunities for women, as mathematics and science are academic gatekeepers to the engineering profession. This topic leads to the history of women in engineering. Following, social cultural factors were further discussed in reference to women's self-efficacy in learning science, technology, engineering, and mathematics (STEM) subjects, as well as women's roles and responsibilities in family and work relationships. In this context, the feminist theoretical perspective and its relationship to women engineers were discussed. Finally, the literature review concluded with the social cognitive career theory as it applies to women's career decisions, particularly in engineering. Understanding the historical perspective of women's access to education, with emphasis in math, science, and engineering provides awareness of the roots of disparity of women engineers, and the pervasive problems that exist today, resulting from past as well as current socially constructed gender roles.

History of Women's Education and Career Options in the United States

The history of women's education and career options in the United States has been and largely remains socially constructed by gender-linked roles. Since the field of engineering has been socially constructed as a masculine domain, it results in an historical disparity of women engineers. The field of engineering can be credited for creating much of the conveniences that form our modern civilization. Although greatly needed by society, engineering has not commonly been acknowledged as a prestigious career, like medicine or law (McIlwee & Robinson, 1992). However, as technology is rapidly advancing, the world economy is becoming more dependent upon the work of

engineers. Therefore, the engineering career field is becoming more desirable and viewed more prestigious. Along with prestige, the engineering field offers competitive salaries, and variation in career opportunities.

Once viewed as dirty, outdoor, mechanical work, engineering today has evolved to include indoor office and laboratory research, as well as the utilization of technology to create computer aided designs. Higher prestige, lucrative salaries, and changes in work climate of this male dominated profession attracted more women to the field of engineering from the 1970's to the late 1990's. From 1983 to 1998, the percentage of women in engineering rose from 5,8% to 11.1%. Yet in 1999, the number of women engineering declined to 10.6% (Society of Women Engineers, 2001).

Starting the new millennium, the number of women engineers increased very slightly. By 2002, women engineers represented 11.6% of the U.S. engineering workforce, (U.S. Department of Labor, 2002). By the year, 2007, the percentage of women engineers returned to 11.1% (U.S. Bureau of Labor Statistics, 2008). Efforts to increase women engineers continue as programs are developed from K-12 schools, to higher education and industry. Despite these efforts, numbers of women in engineering remain low. It is questionable why this phenomenon pervades, how it began and what can be done to change it.

Understanding the history of women in mathematics and science education is critical to the understanding of the lack of women in engineering, as mathematics and science are core subjects of study in engineering education. McIlwee and Robinson (1992) found that women who chose engineering as a career based their decisions primarily on their mathematics and science abilities. Similarly, a supportive study of 139

students that was conducted by the U.S. Department of Education and the National Institute for Science Education revealed that women entered engineering college with slightly higher (although not significantly) mathematics profiles than men. In essence, the research showed that women and men who reach the threshold of the engineering path have comparable high school academic backgrounds (Adelman, 1998).

The historiography of women's education in science and mathematics is a relatively new area of research. Studies regarding women's education in general have developed over the past two decades, and more recent investigation of women in mathematics and science has surfaced. This recent focus can be attributed to the concern of the disparity of women in mathematics, science, and technical fields. Studies have shown that the higher level of education of males and females, the greater the ratio of males to females in mathematics and science subjects. This means that college women choose fewer mathematics and science courses than their male counterparts, which creates what is termed a "critical filter" of career choices for women (Sells, 1976, p. 3). As a result, women are challenged in finding occupations related to these fields, which may in turn result in lower paid jobs that often fail to meet their financial needs. (Brush, 1980).

In order for women to be more competitive in the technological workforce, they must be encouraged by educators to complete higher levels of mathematics such as pre-calculus and calculus in their high school and college curriculum. It is therefore important for educators to study the factors that influence the decisions of girls and women regarding mathematics, science, and engineering education, and to understand the social cultural historical perspectives which lead to such decisions. In this light, this section of

the literature review will focus on a) the history of women in mathematics, science, and engineering, beginning with general historiography of women in education nationally, and b) the challenges which still exist for women in these education fields.

History of Women's Education in the United States

For the purpose of this study, education is defined as knowledge and skill acquisition from both informal and formal settings. Informal settings include home, family, and communities. Formal settings include schools, colleges, and training institutions (Merriam & Brockett, 1990). This section will begin with the history of the education of women in the United States from the construct of the patriarchy of Western society. History that dates to Colonial New England finds that in the Puritan society of the seventeenth century, patriarchal norms viewed formal education as more of a priority for males than females. In 1642, The Massachusetts General Court ordered that parents should be responsible for educating their children either in the home and/or for boys, through public schooling. Girls were not permitted to attend public schooling (Tyack & Hansot, 1990). To date, such views about gender roles in education contribute to the attitudes toward women's education in Western society in terms of what is considered suitable education for them.

By the late 1700's, in the name of republican motherhood, it became more relevant for women to become educated in order to educate their children, while husbands provided for the family. Girls were therefore formally schooled in subjects of history, poetry, and moral essays, in addition to their conventional subjects of music, dance, and art (Mintz, 2004). A key element to the historiography of education for women is access. In order for women to attend college, access became a necessity. From

1790 to 1850, college education for women became more accessible, a result of efforts by advocates such as Emma Willard, who emphasized the importance of women's education in her *Address to the Public* in 1819 (Solomon, 1985).

History of Women's Education in Science and Mathematics

The years from 1780 to 1830 are known as the postcolonial period in America. Some postcolonial Americans maintained that young girls' education should focus on subjects that supported home responsibilities. The postcolonial period transitioned into the European influence of the Age of Enlightenment, also known as the eighteenth century Age of Reason. This era brought interest in and support for girls and women to learn about science. Contrary to popular belief, the early nineteenth century afforded girls, sometimes more so than boys, access to science subjects such as astronomy and chemistry in addition to the subjects of reading, writing, and arithmetic (Nash, 2005). Furthermore, girls' performance in science matched their male peers (Tolley, 2003).

In the mid-1800's, science became more prevalent in girls' school curriculum, while marginal in boys' schools. In fact, from 1790 to 1849, boys schools, especially in the southern states, emphasized studying the classics, particularly Latin and Greek literature over science (Tolley, 2003). By the mid 1800's, as science prevailed in girls' schools, differentiated science topics became available to them when higher mathematics was introduced. Prior to 1840, science curriculum for girls focused on conceptual science until mathematics allowed for understanding scientific principles and more rigorous science content. The subject of mathematics was introduced through science, thus creating more challenging curriculum and gaining importance in education seminaries and academies for females (Nash, 2005).

As females became more educated in fields of science and mathematics, not all citizens approved of females in these fields of study. It was believed that girls neither had the aptitude nor the need for mathematics in terms of their futures in motherhood or career options. Parents feared that mathematics could lead their daughters to vocational interests such as navigation and surveying, which were typical interests of males (Tolley, 2003).

Not only females, but African Americans were not welcome to equal opportunity education. In fact, law in some institutions prohibited higher education for minorities. African American women in these institutions faced what is called the *double-bind* of oppression, as they were denied access to education and careers based on both their race and gender (Seymour & Hewitt, 1997). Like Caucasian women, African American women yearned for higher education and professional careers. Through support from some Caucasian citizens, African American women were admitted to some colleges, such as Oberlin College in the 1830's (Nash, 2005).

Professionally, women in general were more welcome into K-12 teaching careers, yet their salaries were lower than their male counterparts. During the antebellum years, 1784 to 1860, school teaching was a common profession for African American women as well (Solomon, 1985). Collectively, women of all backgrounds were primarily restricted from administrative positions in education, thus narrowing their opportunity for higher salaries. Such negative perceptions of females and minorities in mathematics have contributed to today's disparity of diversity in fields that require mathematics expertise, such as engineering.

Despite the popular belief that females were not as competent as males in mathematics, comparative scores of girls and boys in 1873 New York City Grammar Schools revealed that girls showed slightly higher scores than boys in arithmetic (Tyack & Hansot, 1990). In this time period, it became more acceptable to teach girls arithmetic for its practical use in home economics. However, the study of mathematics for girls was less acceptable as it was viewed as too profound for girls (Tolley, 2003). By the late nineteenth century, more women were graduating college with undergraduate as well as graduate degrees. Yet colleges were reluctant to hire them as professors. Higher education professional positions in teaching were therefore predominantly male occupied (Eisenmann, 2001). It is important to mention this phenomenon, as it served to protect the male hegemony in higher education, thus preventing the possibility of female role models to develop and be emulated in higher education. The lack of female role models in higher education perpetuated the sociocultural gender roles and negative implications regarding women's competency in education.

While access was denied to higher education and administrative careers, vocational job-training opportunities for women increased, and their access to blue-collar and white-collar jobs became more accessible. Such jobs ranged from working in print shops to accounting and secretarial occupations, and offered competitive wages. Critics considered these jobs as less feminine, counter to women's domestic roles, and threatening to male roles in society (Tyack & Hansot, 1990).

Resulting from mass criticism of the role of higher mathematics in girls' education, and the consequent changes in female societal and vocational roles, a major academic shift occurred. In the late 1800's, female roles returned to domestic duties,

which led to a decrease of girls' enrollment in mathematics and mathematics-related science. Domestic science, which included cooking and sewing, became the primary science curriculum offered to girls in order to professionalize homemaking. Teaching careers opened for women in this area, and home economics for women reinforced the male dominated career world of mathematics related sciences and technology (Tyack & Hansot, 1990). Home economics provided a venue for the use of women's scientific knowledge as well as an opportunity for professional careers outside of the home. Further, home economics gained social and political recognition in the 1910's to 1920's, with the founder of the home economics political movement, Ellen Richards (Stage & Vincenti, 1997). Although the movement stood for social change in women's education and employment, it did not pose direct threat to the masculine identity associated with the science field (Bystydzienski & Bird, 2006).

Although the field of science was widely considered a masculine domain, Oldenziel (2001) argued an alternative viewpoint from a feminist perspective, regarding the relationship of home economics to science and technology from the late 1870's to the early 1900's. She discussed how manufacturers tapped into the needs of women homemakers who were the consumers of technological housekeeping appliances. In essence, Oldenziel (2001) examined the myth and paradoxical notion that men made the machines that are used by women, when in fact, women provided technical input and scientific expertise to the production of household appliances. Some women were inventors but were denied patenting rights, an issue that was protested by activist Jocelyn Gage, in the 1870's (2001).

Returning to the topic of education in the early 1900's, the curriculum in the United States changed from what was known as classical curriculum, which included subjects such as Greek, Latin, mathematics, science, philosophy and English, to a liberal arts curriculum, which encompassed the subjects of engineering, home economics, modern languages, and sociology. In addition to the curricular changes during the early 1900's, colleges and universities reformed to offer coeducational programs. College academic programs, such as modern languages, became more attractive to women than men, and as a result became less valued by higher education administration. Therefore, the concept of feminization emerged when women showed preference toward certain disciplines (Stage & Vincenti, 1997), while subjects of mathematics, science, and technology maintained a male identity.

The historical struggle that women endured to gain and maintain access and status in mathematics, science, and technology is testimony to the social cultural perceptions and barriers of women in these fields still today as we enter the twenty-first century. It appears that the early twentieth century societal values contribute to the current challenges in encouraging females to pursue these fields, for it remains a popular belief by females and society in general that these subjects are not desirable areas of study for girls and women. To illustrate this point, an empirical study of 79 male and female Yale University undergraduate students was performed to identify how gender constructed preferences in academic subjects related to preferences for math. The study showed that male and female gender roles do influence mathematics preferences, whereas female participants identified less with mathematics, and showed more negative attitudes toward mathematics than male participants. This attitude reinforced the stereotype of

mathematics as a subject suitable for males and not for females. It also confirmed that interest in and selection of mathematics and science subjects are influenced by social gender role constructs (Nosek, Banaji, & Greenwald, 2002).

In an effort to regain the interest and confidence of girls in mathematics and science, some scholars believed that mathematics and science classes in public schools should be taught in same-sex classrooms. Streitmatter (1999) contended that same-sex schooling enabled gender equity in terms of academic achievement and self-esteem issues. Studies by Lee and Bryk (1986) revealed that both boys and girls of single-sex classrooms score better than those of coeducational classrooms in the subjects of reading, mathematics, and writing, and are more likely to enroll in mathematics and science courses. Girls in single-sex classrooms earned higher scores in reading and mathematics, and carried higher academic expectations into their college education. They were also less prone to sex-role stereotyping in terms of academics. As a result, girls in single-sex classrooms viewed themselves positively as learners of mathematics and science. The concept of single-sex classroom instruction is still supported in the twenty-first century. A study by Parker and Rennie (2002) of single-sex instruction found that teachers discovered that they were better able to incorporate gender-inclusive methods in their science instruction.

However, some advocates of women's rights oppose same-sex classrooms. For example, in 1996-97, Ann Connors, President of the New York City chapter of the National Organization of Women (NOW) posed that separating the sexes in the classroom did not foster equal opportunity. Connors believed that an alternative to the single-sex construct is to improve existing strategies within coeducational schools, such

as programs on gender equity, parental involvement, increased funding of public schools, and in-service training for teachers regarding classroom equity. She also suggested the implementation of inclusion within curriculum of mixed-sex classrooms, to add accomplishments of women and minority groups' achievements. Connors also advocated affirmative action regulation in schools and funding for girls' sports to create a more positive education environment for girls (Streitmatter, 1999). The quest for inclusion remains prevalent in education research, as the need for cultural competency in both the classroom and workforce are recognized in order to recruit more women and minorities to STEM fields (Chubin, May, & Babco, 2005).

Whether in support of coeducation or single-sex schooling, the argument remains clear that social cultural influences in the classroom effect girls' educational experiences, particularly in the subjects of mathematics and science. As aforementioned, these subjects are core to preparation of engineering college curriculum. Inadequate preparation and/or disinterest in these subjects carry over to women's college years and career decisions. The lack of knowledge of how mathematics and science are applied to both everyday life and careers, such as engineering, may perpetuate women's lack of preparation and contribute to the problem of the disparity of women in engineering careers. By contrast, understanding the importance of science and mathematics, and the history of women in STEM careers, such as engineering, can enable girls and women to recognize the value of these subjects and encourage them to take more mathematics and science courses through high school and college. In effect, their interests in these subjects may motivate them to pursue STEM-related careers, and further the legacy of women engineers. In this regard, the next section will cover the history of women engineers to

understand the roots of the disparity as well as the strides and accomplishments of women in this profession.

History of Women in Engineering

The history of women in engineering has shown a consistent trend of disparity. A field historically recognized as a male-dominated profession (McIlwee & Robinson, 1992; Powell, Bagilhole, & Dainty, 2009), women represented only three percent of the engineering population until the mid-twentieth century (Oldenziel, 1997) and has shown minor improvement since. In 2008, women comprised only 13.5% of United States engineers (U.S. Dept. of Labor, Bureau of Labor Statistics, 2008). This percentage remains low, and according to Frehill (2004), is only as high as it seems due to the decline of male employees in the field since the 1970's. One of the reasons for the low numbers of women engineers is the lack of public awareness of the engineering profession in general, and specifically, the history of women's existence in this profession. Burke and Mattis (2007) maintained that public awareness of what engineers do must be improved in order to recruit and prepare more citizens for the profession.

In order to attract more women to the profession, the perception of engineering by students from elementary school to college must be socially reconstructed to emphasize the societal benefits engineers provide. Studies have shown that people commonly associate engineering careers with hands-on mechanical work, involving outdoor dirty and sometimes heavy lifting duties (Oldenziel, 1999; Bix, 2004). Girls and college women more commonly recognize such descriptions as men's work. By contrast, girls and women often indicate career interests in fields that are geared toward the improvement of society or the environment (Burke, 2007). Understanding the social

aspects of engineering may support more positive perceptions of engineering among women, and therefore help resolve the issue of the disparity of women engineers.

In addition to the need for understanding of the social attributes of engineering, there are other perceptions as to why the disparity of women engineers exists. For example, researchers have found that some believe women lack the technical spatial skills to perform engineering (McIlwee & Robinson, 1992). As previously stated, another misconception for the shortage of women is that they lack the mathematics and science competency required in engineering education (Marx & Roman, 2002). But by and large, the overarching explanation for few women in engineering is the perception of engineering as a male profession. Masculine hegemony dominates the engineering profession. Connell and Messerschmidt (2005) describe hegemonic masculinity as a "pattern of practice (i.e. things done, not just a set of role expectations or an identity) that allowed men's dominance over women to continue" (p. 832). The notion of engineering as identified with men's sense of masculinity, when characterized by technical ability, is threatened by the concept of women honing similar skills (Cockburn, 1985). In this regard, the social constructs of masculine hegemony historically negated the competency of women in this area.

Because engineering is identified with male hegemonic associated physical labor tasks that are considered rigorous and sometimes even dangerous, historically women were not encouraged to pursue this field. Dating from the eighteenth to the early twentieth century, socially constructed influences existed through the distribution of technical toys, such as erector sets, for boys in order to gear them toward engineering,

while girls who were interested in science were generally not offered such toys, but instead encouraged to pursue home economics (Oldenziel 1999; Bix 2004).

The period of 1893-1920 was a significant period in understanding the hegemonic masculinity building of engineering, as it marked the time of expanding the urban-industrial system. President Theodore Roosevelt, who was a scientist and engineer, further reinforced the masculine image of engineering. He believed in outdoor activity, hard labor, and wilderness exploration. The engineering field was characterized by Roosevelt's masculine persona, through its contribution to agricultural work in U.S. farming (Oldenziel, 1999).

From a historical perspective, the engineering profession originated as a skill and trade-based career before it became a professional career that required a formal education. After the Civil War, from the years 1870 to 1890, the number of U.S. engineers increased from 7,374 to 43,239 (U.S. Census Bureau, 1975). The engineering fields evolved from agricultural to civil engineering structures of buildings, railways, and roadways. Manufacturing mandated an increase of engineers in industry. Such growth in career areas resulted in redefining engineering from skill building to technical training and education (Frehill, 2004).

Resulting from the legislation of the Morrill Land Grant Act of 1862, by the early 20th century a few women began entering engineering college programs. Although they were not entirely welcomed, women attended Universities such as Massachusetts Institute of Technology (Oldenziel, 1999). According to Frehill (2004), as the demand for engineers increased, women interested in the field were typically hired as tracers (described as those who go over with pen to make permanent the final original design,

sketch, or drawing of the draftsmen) and those who performed lower level mathematics, while men were recognized as draftsmen and engineers. Female tracers were paid less than male draftsmen, and they were considered incapable of acquiring the technical skill level of drafting. Typically, women were used for easier, less technical tasks that were regarded as "feminine," or usually held by working class, as engineering maintained its masculine identity of white, middle-class male employees with technical training.

The engineering characterization as masculine, with emphasis in outdoor, practical training and manual labor, reinforced the social barriers to recruiting women to the field. In this respect, girls were excluded from field trips to machine shops and discouraged from playing outdoor sports—activities that were made available and encouraged of boys (Oldenziel, 1999). This in effect served to recruit boys and not girls to engineering, which explains the history of the continuous disparity of girls' preparation and recruitment for engineering, and the perpetuating masculine hegemony of engineering.

The 1920's brought forth a major boost to engineering employment via the automotive industry and the industrial era (Kim, 2007). Post World War I reconstruction of Europe called for recruitment of American engineers as well. To meet the military demands, some college graduates enlisted shortly after graduation, while others deferred military enlistment until after graduation. Frehill (2004) argued that women and non-white men could have met the need for more engineers, but more often were not considered.

Despite the obstacles, women gradually began to enter the engineering field in the early 1900's, as engineering became more professional through education and training.

The attitude of women as invaders of engineering subsided at the onset and during World War II, 1939 to 1945, when men enlisted in the military, leaving a shortage of U.S. engineers. It was during this time that icon Rosie the Riveter appeared, representing women in manufacturing. Likewise, women with mathematics and science skills were more welcome to the engineering field, to fill the void. During this time, approximately 300,000 women were recruited to engineering related training and jobs through government agencies and aircraft corporations. (Oldenziel, 1997). Women were recruited to engineering college programs through federal sponsored courses of the Engineering, Science, and Management War Training (Tallmadge, 1944). Through the Engineering Cadet Program in 1942, the "Curtiss Wright Cadettes" emerged, which was a program consisting of 600 women from seven colleges—Cornell, Iowa State, Minnesota, Penn State, Purdue, Rensselaer Polytechnic Institute (RPI), and the University of Texas (Bix, 2004). Through this program, women experienced the value of performing patriotic services, and demonstrated their academic competency. Faculty members acknowledged the women's high academic achievement as well as their technical skill performance with equipment in machine shops. A second sponsor, Radio Corporation of America (RCA) also endorsed the Cadette Program, which resulted in 20 percent of women employees in RCA plants (Tallmadge, 1944). Their engineering skills and services were applied and welcomed during the crucial time of World War II, where many men who were in these fields were serving military duties. It was during this time, that conventional social cultural norms and expectations of women as housewives and mothers were eased in order to maintain production in wartime manufacturing of goods and technical services.

In essence, women in STEM fields were welcomed in business and industry, but only to fill the absence of men who were in the military during wartime.

After World War II ended in 1945, the conventional expectations of women's roles resurged, as men returned from the war to resume their technical careers. During this time, gender roles of marriage and family dominated norms for women (Frieden, 1963). Girls who displayed interests in technology were discouraged from it by family and teachers and were redirected to pursue home economics in college (Tolley, 2003).

At Georgia Tech in the 1940's, the notion of women in engineering was shunned and deprecated. Some administrators and faculty feared that female students would be a distraction to the male students. Resulting from this, a court case occurred in 1948 to support the admission of a female engineering student. In spite of the resistance of faculty, staff, and alumni, then President VanLeer conceded to admit women to Georgia Tech, while the Women's Chamber of Commerce of Atlanta enacted a resolution to require the state to allow female student admission to Georgia Tech. The board of Georgia Tech approved the resolution in 1952 (Bix 2000).

Realizing the need for solidarity, in 1950, the Society of Women Engineers (SWE) emerged throughout Universities and industry nationwide. The mission of SWE then and now is to establish "… engineering as a highly desirable career for women through an exciting array of training and development programs, networking opportunities, scholarships, outreach and advocacy activities, and much more to "orient new women students in the division" (SWE 2009).

During the 1950's, SWE members assumed the responsibilities of representing women in the engineering profession, while maintaining their feminine social cultural

identification and expectations as wives and mothers. They did so by providing career planning and tips on balancing work and family obligations. Although the efforts of SWE were merited, acceptance of female engineering students remained a struggle throughout the 1950's and early 1960's (Bix, 2004). Women with skills to enter the engineering workforce needed a larger support venue to open doors.

The Civil Rights Act of 1964 provided such means to open more doors, as it banned discrimination, thus promoting equal opportunity for education and employment regardless of sex or race. Furthermore, in 1972, Title IX was enacted, which prohibited discrimination based on gender (Barber, 1995). These federal mandates assisted with enabling more equitable education and employment opportunities for women. As the demand for engineers increased during the 1970's and 1980's, women who earned engineering bachelors' degrees increased accordingly, from nearly one percent in 1970 to 5.8% in 1983. By 1998, the percentage of women in engineering rose to 11.1%. Yet in 1999, the number of women engineering declined to 10.6% (Society of Women Engineers, 2001).

Starting the new millennium, the numbers of female engineers remain relatively low in comparison to male engineers. By 2002, women engineers represented 11.6% of the U.S. engineering workforce. But by the year, 2007, the number of women engineers declined to 11.1%, then rose to 13.5% in 2008. As women compose approximately half the population of the United States, as well as half of its workforce, these statistics demonstrate an obvious negative disproportion of women in the field of engineering (Bureau of Labor Statistics, 2008).

African American women in engineering are a unique subset of the overall population of women engineers. Currently research exists regarding women and minorities in STEM, but less research can be found in direct reference to African American women in engineering. Of related studies found, Hanson (2004) researched African American women in science, and noted that African American women showed interest and engagement in science through their high school years. This information is contrary to stereotypical belief that African American women may be disinterested and perform poorly in STEM. Yet Hanson stated African American women encountered racism and sexism in the science programs and occupations, which researchers believe may give reason to why a shortage of African Americans exists in this field (Hanson, 2004, Mau 1995). Although there is limited research in this area, Hanson indicated that it is wrong to assume that women and minorities lack interest in science, although they may face challenges and barriers. She believed that African American women in STEM subjects face educational barriers from teachers with low expectations in integrated school systems, and receive more support from teachers in Historically Black Colleges and Universities (HBCU's). Hanson believed that the low number of African American women in science may also be attributed to the lack of information regarding the contributions of historical African American women in science, engineering, and technology, as well as the disparity of African American women role models since there are few in these areas (Hanson, 2004).

Although the numbers of African American women engineers are few, there seems to be a measure of satisfaction among them according to recent research. Editor Boroshok (2005) interviewed fifteen rising African American engineers working in

various industries, such as Intel, DuPont, Deere, and NAVAIR. In general, the participants reported satisfaction and happiness with their career choices. They accredited their college preparation, internships, and cooperative education (career-related work positions while earning their degrees) as key to their success. In addition, they indicated that their participation in the National Society of Black Engineers (NSBE) student organization and mentors assisted them in their transition from college to the workforce.

Membership in the National Society of Black Engineers is a strategic network for African American engineers. "NSBE's mission is to increase the number of culturally responsible black engineers who excel academically, succeed professionally, and positively impact the community." Currently NSBE has more than 10,000 members, and is the student-managed organization in the country, with two hundred seventy chapters on college and university campuses, seventy-five alumni extension chapters nationwide, and seventy-five pre-college chapters (NSBE, 2012).

In addition to NSBE support, one participant of Boroshok's (2005) study indicated that activities on the job that were geared toward minority groups helped to retain employees and support diversity in the workplace. Finally, most of the engineers stated that they felt no particular pressure or challenge resulting from their African American race in their workplace. Instead, they reported perceptions of their work experiences in terms of feeling acceptance the same as the other employees. Boroshok's (2005) study involved both male and female African American engineers, and gave no specific difference between the genders in terms of their perceptions.

Despite the barriers and challenges of the history of all women in engineering, women have made great contributions to this field such as pioneer engineer, Nora Stanton

Blatch Barney (1883-1971). Blatch was the first woman to earn a civil engineering degree from Cornell University in 1905. Unlike typical early twentieth century female engineers who were tracers, Blatch began her professional career as a drafter for the American Bridge Company and the New York Board of Water Supply. She later became an architect in 1914. Nora Blatch was well noted for her advocacy of woman suffrage as well as her engineering and architectural professionalism (Allaback, 2008).

Another historical engineer, Lillian Gilbreth (1878-1972), was known for her technology called "Kitchen Efficient" which enhanced the household appliances in 1950's. Although Gilbreth's area fostered the stereotypical gender constructed role of women in the kitchen, it provided an ideological place for women in engineering that did not compete with the place of men in engineering in the 1950's era. As a result she became an iconic figure for the founding of the Society of Women Engineers. Alternatively, Dr. Maria Telkes (1900-1995), received the Society of Women Engineers Achievement Award in 1952 for her research in solar energy (Pursell, 2001). Julia Brainerd Hall (1899-1925), the sister of Charles Martin Hall, assisted in the manufacturing and marketing of aluminum for their company called ALCOA (the Aluminum Company of America). Although she was not acknowledged for her accomplishments, she was very influential in the research and development, and patenting of aluminum as well as the company success (Hatch, 2006).

More historic and recent accomplishments from a diverse spectrum of women engineers as highlighted in an historical book entitled, *Changing Our World: True Stories of Women Engineers (Hatch, 2006)*, include the following:

Dr. Mae Carol Jemison (b. 1956), African American chemical and biomedical engineer, is president and founder of BioSentient Corporation. The company designs the "MobileMe" garment which measures vital signs of human health through sensors. Dr. Jemison is also a medical doctor and astronaut. She is famously known for her 1992 flight on the Space Shuttle *Endeavor* as a science mission specialist (p. vii).

Saw-Teen See (b. 1954), a structural engineer, was instrumental in the design of the Cleveland Rock and Roll Hall of Fame and manager of the design of the Shanghai World Financial Center in China (p. 43).

Mechanical engineer, Alma Martinez Fallon (b. 1958), a native citizen of the Dominican Republic, is a superintendent of hull structural construction for a massive aircraft carrier called CVN-21. She works design and building of nuclear-powered aircraft carriers and warships (p. 96).

Sandra Begay-Campbell (b. 1963), a Navajo Native American civil engineer, helped her community to receive solar energy through the Navajo Tribal Utility Authority (p. 139).

Such representation of diverse women engineers supports the argument that inclusion of women and minorities provides creativity in engineering design and production to serve the needs of various populations and environments (National Academy of Engineering, 2002). In addition, it illustrates the historical evolution of the contributions of women in engineering.

Despite the numerous programs for female recruitment in engineering, the number of women engineers is still few in comparison to their male counterparts in the new millennium. In 2008, women engineers and architects represented 13.5% of the U.S.

engineering workforce, which represented an increase of less than 3% since 1999 (U.S. Department of Labor, 2008). Social cultural influences on gender roles and career fields continue to characterize engineering as a masculine career, and therefore not suitable for women. New avenues in engineering involving the environment and community development are areas that many girls and women may find more appealing. Yet the numbers of women engineers remain low. To this end, the social cultural influences must be examined in reference to the engineering work culture and climate, family and community expectations regarding women's career choices, and work and family spatial relationships. The next section will discuss research in reference to these social cultural influences.

Gender Roles and Social Cultural Influences Regarding Women's Career Decisions and Opportunities

Characteristics of Women Engineers' Career Choices

The purpose of this study is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. In this regard, previous research in this area was reviewed. Numerous studies were found that recognized how gender influences within family and society, particularly influences of parents and educators, affect women's career decisions in both conventional and non-conventional career areas. In relation to family values and career choices, a longitudinal study by Ware and Lee (1988) found a negative correlation between women who place high value on homemaking and choosing a science-related career. A related study found that women in female dominant careers, such as teaching, secretarial, and paralegal, are recommended by their mothers and teachers to choose these

careers because they are considered family friendly in terms of shorter work hours. The study also found that women in gender-neutral careers, such as business, law, or medicine are more influenced by their fathers, and make career decisions later in their career paths in comparison to women in female dominated occupations, such as teaching, secretarial, and paralegal fields (Whitmarsh, Brown, Cooper, Hawkins-Rodgers, & Wentworth, 2007). McIlwee and Robinson noted that women engineers' career choices also tend to be more influenced by males which include their fathers, professors, and boyfriends (1992). Similarly, Jagacinski (1987) performed a descriptive empirical study of 1,961 U.S. bachelor degreed engineers. The study involved a national survey to learn the characteristics of female engineers as compared to male engineers. The survey found that in general, women engineers are more highly educated than male engineers. Women engineers' parents are likely to have high level education and professional careers, and are supportive of their daughters' engineering career decisions (1987). Like Jagacinski (1987), other researchers found that women who selected engineering careers were supported by parents (often a father who is an engineer), teacher, counselor, or boyfriend (McIlwee & Robinson, 1992; Mau & Domnick, 1995; Mattis, 2007). It is important to understand education, parental, and environmental influences as important sociocultural factors in gender roles and expectations as they pertain to engineering career planning.

Another related study to environmental and sociocultural factors was conducted by Farmer, Wardrop, Anderson, and Risinger (1995). They performed a longitudinal study in Illinois from the years 1980 to 1990, starting with 2,082 high school students in 1980, where 1,500 of them were tracked to college level in 1990, of which 505 responded to the researchers' mailing. The purpose of the study was to compare persistence in

STEM career choices between men and women, using the social cognitive theoretical model. The social cognitive theory posits an interaction between self and environment that influence career decision-making. The social cognitive theory considers the fact that socialization is not constant but a dynamic process, and thereby has changing influences on self-concepts and behavior throughout life (Bandura, 1978).

Independent variables of the longitudinal study by Farmer et al. (1995) included demographic measures (race, age, and gender); cognitive measures (home, aspiration, career, independence, mathematics self-efficacy, and mathematics-science ability); environment measures (parent, school, society, and financial support); and behavior measures (number of mathematics and science course electives). The dependent variable was persistence in science, mathematics, or technology career interest. Results of the Farmer et al. study showed that women had a negative correlation between persistence and commitment to science-related careers, whereas a higher correlation was found in men. Unlike the descriptive of Jagacinski's (1987)study regarding the parental support of women who choose engineering careers, environmental measures such as parental and school support in the Farmer et al. study had no significant impact on women's persistence in this study. But like Jagacinski's (1987) study, the Farmer et al. study found a negative significant impact for women in the 1990 period of the study regarding their commitment between home and career ($r = -.50$, $p < .001$). There was no significant impact between home and career commitment for men in this study, which again supports the notion that women face a greater challenge than men in balancing home and career values, and this challenge has an impact on women's career choices, which include women engineers.

Of all variables, the behavior variable of science elective courses taken was the most important variable regarding women's persistent interest in science-related careers. This variable was not found important to men. The researchers assumed a reason may be due to men selecting science elective courses more frequently; therefore women may be making more conscious science-related career choices when choosing science electives.

Researchers of the Farmer et al. study expected the younger women in their study to have higher-level interest in science-related careers than the older women, resulting from the longer effects of affirmative action. However, their results did not find this so. The researchers assumed the results may be due to either the age differences of only three years were too small to show a difference, or perhaps because there was a plateau in the numbers of women selecting science careers between the 1970's and 1980's, which impacted the findings. In any case, career access based on affirmative action had no prominent effect on the science career interest of women in this study (1995). Effects of affirmative action on women's career choices in science-related fields seem more evident in recent years, as the year 2008 data showed representation of 52.9% in biological science, 52.3% in the medical science profession, and 33.1% in chemistry and material science. Yet engineering has not shown such an increase, as women represented only 13.5% of its employees (U.S. Department of Labor and Statistics, 2008). This data is important to my study as it verifies the fact that continued research effort is needed to understand the reasons for the disparity of women choosing engineering careers.

As discussed in Chapter One, in the year 2000, Gill conducted a qualitative study of thirteen Canadian undergraduate college women in their first two years of study in mathematics, science, and engineering examined interpersonal, intrapersonal, and

contextual factors that influenced their decisions to pursue engineering. The study concluded that the intrapersonal factors of enjoyment of mathematics and science were the primary influence on their decision. Self-efficacy also played a role in their continuance as well as intrinsic rewards. Interpersonal factors, such as relationships with teachers, peers, and parents were secondary influences, and contextual factors, such as special programs, labs, and collaborative learning were tertiary influences. Gill (2000) applied a social psychological perspective, using the cognitive social learning theory and gender (Bandura, 1978). Sex-role stereotyping is also discussed in terms of education and employment.

Another study that related to this topic used quantitative methodology, with United States undergraduate college women participants (Choudhuri, 2004). Using a hierarchical linear model quantitative approach, Choudhuri examined multiple social cognitive variables, personal and contextual, that influence women's' decisions to major in engineering. Data retrieved from the Women's Experiences in College Engineering (WECE) from 1999-2001 provided a sample of 3,902 undergraduate women from twenty-six United States colleges and universities. Results of Choudhuri's study showed that factors such as self-efficacy, interest in engineering, and environmental influences are not independent, but rather interrelated influences on women engineers' career decisions (2004).

Recent qualitative research based on women engineers in industry was not found in reference to this current study, which reinforces the need for qualitative research in order to understand the breadth of information through the voices of women engineers regarding the social influences involved with their career decisions, challenges, and

rewards. For this reason, this current study was performed through a phenomenological qualitative analysis of women engineers to gain an understanding of the essence of their experiences.

In addition to studies regarding STEM related career choice, research regarding additional characteristics of women engineers, such as academic and social learning have been conducted in search of causes for the paucity of women engineers. As in the study by Farmer et al. (1995), Adelman (1998) also found that competency in mathematics and science had primary influence on women engineers' career decision. Adelman's research showed that women and men who reach the threshold of the engineering path have comparable high school academic backgrounds. Women's SAT scores were slightly higher than men's scores, and on average, their college academic performance was higher than men's, regardless of major. This research reinforces the fact that there are no academic deficiencies that prohibit women's access to engineering (Spelke, 2005). Therefore academic competency in terms of learning mathematics and science has not been found to be causal to the disparity of women engineers. Spatial skills, or hands-on learning is also an important component to engineering career decision. In this regard, McIlwee and Robinson (1992) found that women chose engineering as a career later in life than men, possibly due to how childhood socialization is more likely for boys than girls to introduce them to spatial skills, such as tinkering with mechanical things which may lead to interests in engineering. In this reference, childhood socialization plays an important role to how boys and girls learn, as well as adapted learning styles in adult life. The following section discusses the women's learning styles as they relate to learning to become engineers.

Women's Learning Styles

Some researches contend that women have different learning styles than men (Gilligan, 1982; Belenky, Clinchy, Goldberger, & Tarule, 1997; Hayes, 2002). This issue will be discussed in reference to how women as compared to men learn through situated or context-based learning in the engineering work culture. Gilligan (1982) theorized that women's identity of self and human development is judged by masculine values. For this reason, she recognized the importance of validating women's voices and moral values as critical to their sense of selfhood and development. According to Belenky, Clinchy, Goldberger, & Tarule (1997) women learners acquire knowledge based on their concept of truth from their subjective standpoints, and through application of their own authority which branches from within themselves. Known as their inner voice, their own thoughts carry their sense of knowing, which integrates with their outer world experience to define their subjective truths. Subjectivism then for women "redefines the nature of authority" (Belenky, et al., 1997, p. 68) from their outer world to their inner world. Through subjectivism, female adult learners construct knowledge. Therefore, in order to construct knowledge within the male hegemonic work environment, women engineers must first discern what they consider truth. Hayes (2002) posited that women use their voices to establish connection to the subject they are learning as well as to others with and from whom they learn. In the context of the engineering workplace, there are situations by which one may learn an engineering skill or develop an engineering design in collaboration with others. This issue relates to what is recognized as situated learning that is discussed in the following section.

Situated Learning

Social contextual or situated learning is related to Vygotsky's theory that assumes that knowledge is created through social interaction and characterized by "the sociocultural origins of mental functioning, the mediation of intellectual functioning by tools provided by culture, and sociocultural methodology" (Miller, 1983, p. 368). Situated learning then, occurs when there is an interaction through a community of learners who share common values as they participate in the learning experience (Lave and Wenger, 1991). Hayes (2002) supported the notion of engaging learners through providing women voice in the classroom. She claimed that women use conversation to establish a connection with the subject and their peers in the learning situation. Unlike men who use their voices through reporting information, women apply a conversational approach of asking questions and discussing relationships between the subject to real life. The concept of learning through making a connection with the learning situation is called connected knowledge (Hayes & Flannery, 2002). Connected knowledge in the context of women's learning styles relates to the concept of situated learning. From classroom laboratory experience to on-the-job training, engineers learn the technical skills required for the field. In this perspective, learning occurs through real world experience, which Hansman (2001) refers to as learning that is context-based.

Understanding women's learning styles, especially in context-based situations of science, technology, engineering, and mathematics (STEM) is a relevant area of research to the study of the disparity of women engineers. Two other important factors when considering women enrolling in STEM course subjects are self-efficacy and achievement. These factors are often influenced by learning styles and learning environments. A recent

empirical investigation by Cavallo, Rozman, and Potter (2004) was conducted to study the relationship between motivation constructs and men and women's abilities in science. A regression analysis was performed, with 290 undergraduate non-physics majors in a yearlong period. The methodology applied a questionnaire and pre-and-post tests to measure variables of "learning approaches, motivational goals, self-efficacy, epistemological beliefs, scientific reasoning abilities, and understanding of central physics concepts" (p. 288). The study found that both sexes showed interest in learning and understanding physics. The study also found a positive correlation between self-efficacy and achievement for both sexes, with meaningful connection to the subject positively correlating with self-efficacy. No significant correlation was found for males or females between reasoning ability or learning and motivation constructs.

In addition, results of the Cavallo et al. (2004) study found that women's interest in physics and continuation in course enrollment improved in high inquiry learning classrooms. In contrast, this was not found in male students. However learning by rote had a negative impact on women's self-efficacy, and men's understanding of the concept and achievement. Implications of these findings suggest that instructors should consider diversifying teaching methods and academic learning environments in order to accommodate different learning styles and needs of students (Cavallo et al.). Relating to Hayes' research (2002), high inquiry classrooms engage the voices and communicative learning styles of women learners. Therefore in reference to the how women learn engineering, the learning environment for women in context of science, technology, engineering, and mathematics should provide access to social engagement.

A study pertaining to learning styles from the teaching standpoint was performed

by Henze, van Driel, and Verloop (2009) regarding training for in-service science teachers on innovative instruction techniques. Through a qualitative analysis, science teachers reported their experience using two learning styles. The Type I learning style was application-directed, where the subject matter was delivered in a way that provided meaningful connection to everyday life. The Type II learning style was from a social constructivist perspective, where classroom activities and social interaction were the method of instruction. Results of the in-service training showed that teachers may incorporate their own learning styles within their teaching methods, thereby recognizing the importance of both Type I and II learning styles in order to diversify teaching classroom instruction. In this way, teachers may thereby impart this knowledge in the classroom through considering their own as well as their students' diverse learning styles and needs. This study is pertinent to how students learn and perceive science based on the ways they were taught. In reference to how women construct knowledge based on their subjective truth, Belenky et al. (1997) stated that, "when truth is seen as a process of construction in which the knower participates, a passion for learning is unleashed" (p. 140). This statement may be relevant to how women engineers learn their skills, based on their perception of truth of knowledge, and their decisions of whether they perceive authority to lie within themselves and/or their teachers and colleagues. Thus, women engineers may find a passion for learning engineering when they find themselves as part of the experience, and considered by teachers and colleagues as competent participants.

Relating to the study from Henze, van Driel, and Verloop (2009), both the learning style that integrated subject matter with daily life (Type I), and the learning style that integrated classroom activities with sharing of knowledge (Type II) could be applied

toward how women learn engineering as they both incorporate diversity in constructed learning situations. The Type II learning style is cultivated from Vygotsky's theory of social contextual or situated learning. Situated learning occurs when there is an interaction of shared activities, beliefs, and learning tools among humans within a social environment (Lave & Wenger, 1991).

Smith, Sheppard, Johnson, and Johnson (2005) contended that women engineers express interest in engineering aspects that involve contextual meaning and social impact. They posited that women's interests needed to be captured in the classrooms and laboratories as a means of enhancing and engaging women's technical skills and self-efficacy associated with technology. In this regard, Smith et al. (2005) advocated reformation of engineering which would involve less competition and more teamwork approaches to learning engineering concepts and technology, in order to engage the learners and foster their diversity.

In this context, it is important to understand the meaning of the situations that enable women engineers to connect and construct knowledge, while developing and maintaining their own gender identities within a male hegemonic engineering work environment. In reference to this study, understanding women adult learners and how they construct knowledge is imperative to engaging women in engineering learning situations that include technical skill training in the workplace.

Although engineering is broadly known for its use of technical skills, the full role of an engineer is not as widely acknowledged. As mentioned earlier, technical skills are commonly associated with masculinity, and may therefore disengage some women. This issue is likely a contributing factor to the disparity of women engineers as some may

either perceive themselves as inferior to men's skills in this area, or perceive technology as a "male" interest. However in actuality, there exists a partnership in engineering between the objective technical aspects and the subjective social aspects of engineering (Bucciarelli & Kuhn, 1997). As the objective world relates to the technological component of the field, the social world relates to the fact that engineering involves the creation of designs to serve society. Therefore much of the engineering field calls for strong communication skills to convey information to users or buyers of the engineering product or design. Relevant to women learners' use of conversation and voice to establish meaningful connection to the subject (Hayes, 2002), researchers (Adelman, 1998; Mattis, 2007) suggest that perhaps if more women were made aware of the social component of engineering, they would be more attracted to the field. They stress the importance of recruiting more women engineers by introducing them to the cultural and personality effects of design criteria used to create real world solutions to engineering problems in order to enable a connection to engineering. Gilligan (1982) theorized that social interaction, relationships and attachment, are conducive to the learning styles of women.

Within the context of this current study, the situated learning theory seems to compliment Gilligan's (1982) theory of women's learning styles, where for instance an engineering technical experience may involve shared learning and team-building to produce a particular design. Through team building, relationships develop among teammates, which apply to Gilligan's (1982) theory of attachment, whereas attachment implies a sense of caring and community that women bring to the team. Shared learning occurs during the social activity, which applies to the situated learning theory. Through applying these theories, engineering seems a viable career choice, from a sociocultural

standpoint, for women who enjoy social interaction and creativity.

It is important to note that some researchers and feminists caution that searching for distinctive attributes of women may lead to assertions of deficiencies. For example, Hayes (2001) contended that focus on women needing relationships may "fuel stereotypes that women are not, or cannot be, competitive, autonomous, or self-directed" (p. 37). Rosser (2006) posited that stereotypes with implications of a lack in competitiveness might result in fewer career opportunities for women. Literature that strictly supports relational learning behaviors for women negates the fact that certain situations call for certain behaviors, such as relational practices. For example, engineering involves group problem solving in teamwork, as well as independent problem solving. In this case, the proposed male or female generalized learning behaviors that describe males as independent and females as relational do not apply. This belief supports the argument that there are not only differences among women learners, but differences in types of relational practices in both classrooms as well as workplace cultures (Fletcher, 2001; Hayes & Flannery, 2002). In this context, relational practices in the workplace have meaning in terms of social cultural factors. For this reason, sociocultural factors that contribute to women's learning styles in the workplace are important to the purpose of this study to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession.

It is therefore important that teachers incorporate diverse teaching methods to reach the needs between and within genders as well as ethnic groups. In addition to the influence of learning styles on self-efficacy, female and minority students may also be

influenced by others' perceptions of their efficacy. Negative perceptions may result in what is known as stereotype threat, which is discussed in the next section.

Stereotype threat

Stereotype threat is the study of how stereotypes that imply intellectual inferiority of minorities and females may result in low self-efficacy within these groups, thereby resulting in low achievement and achievement gaps between these groups and groups such as white males who are stereotyped as intellectually superior (Aronson, 2004). It is important in this literature review to discuss the concept of stereotype threat and its effects on women and minorities in mathematics, as mathematics is proven to be a "critical filter" to fields such as science and engineering (Sells, 1976, p.3). In this context, stereotype threat relates to the achievement gap in mathematics and science academia between white males and the performance of girls, women, and minorities. Like a self-fulfilling prophesy, some females and minority students internalize the negative expectations of their instructors and peers regarding girls' mathematics and science aptitude, thereby creating anxiety which contributes to lowering girls' academic performance in these subjects (Aronson, 2004).

Studies have shown that stereotype threat may contribute to a fixed or entity-theory of intelligence for the groups effected, whereas positive intervention may allow for incremental theory to prove that intelligence is malleable (Dweck, 1999). For example, in a study by Good, Aronson, and Inzlicht (2003), college mentors were used to encourage seventh grade girls and minority students in preparation for a standardized reading test. The mentors helped students to consider their past low performance as non-pejorative. As a result, their scores increased through their belief in incremental learning

and malleable intelligence. Similarly, stereotype threat may also occur for women in engineering classrooms as well as workplace learning situations. For example, McIlwee and Robinson (1992) stated that some college women feel inferior to their male peers in the engineering classroom laboratories, lacking self-confidence in their technical skills. On the other hand, they found that women engineering students tend to excel in their academic performance, which professors value in the classroom. Positive reinforcement from professors may counteract stereotype threat, thus inducing positive self-efficacy in women engineers in such learning situations. Positive self-efficacy is critical to parity of women in engineering industry, and thereby important to this study.

The next section discusses the experiences of women who have entered the engineering industry in the terms of salary differentials, work climate, and balancing work and family relationships that affect women's career paths.

Work Culture of Women Engineers

In general, the engineering profession offers variety of career paths and options, opportunities for advancement, and competitive salaries. However, within the workplace culture lie gender inequities in career advancement and salary. Literature regarding the issue of the engineering workplace culture and climate is relative to this study in understanding of the experiences of women engineers and the disparity thereof. In this reference, McIlwee and Robinson (1992) cited that women engineering graduates were quickly hired with comparable salaries to male engineers. Yet despite their comparable education, talents, and work patterns, engineering fields offered to women were sometimes lower status than males, with fewer opportunities for supervisory and management positions. Consequently, a wage gap existed at the time of their study

between male and female engineers, and may have contributed to the problems of recruitment and attrition of women engineers.

Salary inequity remains a critical issue for women engineers. In 2006, the National Science Foundation statistics showed a 24% salary gap between men and women in science and engineering, whereas the median annual salary for women was $53,000 compared to the median annual salary of $70,000 for their male counterparts. The reported causes of the differential salaries were attributed to women working in educational institutions as opposed to industry, non-managerial positions, and lower levels of experience (NSF, 2006).

Salary differentials are reflective of variations between engineering fields and levels of experience, as well as the aforementioned challenge that women face of balancing work and family responsibilities. Specifically, some women take lower level positions or periodically take time off to care for children or older parents and/or in-laws. As previously mentioned, these care giving responsibilities are typically handled by women more so than men, which in effect, enable men to accept higher level careers that may require long hours, travel, and relocation (Rosser, 2006; Mattis, 2007). Understanding salary differentials and the causes thereof is essential to the understanding of the disparity of women engineers.

Another factor that influences engineering women's career opportunities and their disparity is the lack of networking opportunities, as women often experience isolation in the male-dominated engineering workplace culture (Seymour & Hewitt, 1997). It has also been found that employees at workplaces with strong concentration on innovation are more autonomous and empowered, and utilize peer judgment as part of their corporate

survival. In such environments, women engineers are less likely to attain equitable technical-related career advancement. This is believed to be due to the perception of women showing less technical self-confidence. In addition to the technical competency issue, women engineers are less likely to receive technical career advancement because they are perceived as less competitive than males, and received less support in terms of peer judgment, where the peers are predominantly male in the engineering work climate (Rosser, 2006).

Fletcher (2001) argued that the majority group establishes the meaning of the climate, and in the engineering work world, males are the dominant group who establish meaning. Thus, women engineers in this work culture are often required to conform to the male engineers' perceptions of technical ability and confidence in hands-on skills. Furthermore, women engineers are expected to conform to the male hegemonic construct of rules, responsibilities, and promotions (Frehill, 2001). Conforming to male hegemony in effort to assimilate to the work environment does not enable women to maintain their authentic selves (Price, 2003). Kanter (1977) cautioned that these measures for assimilation fail to challenge the masculine dominated work culture in effort to create a more conducive and equitable environment for both genders.

An opposing argument claimed that perceiving women as less competitive is a negative stereotype which hinders women's assimilation in the engineering workforce (Rosser, 2006). In fact, Powell, Bagilhole, and Dainty (2009) found there are some women who are as competitive as their male colleagues and choose engineering not only because they enjoy the work but also prefer to work with more males than females. These women engineers are acculturated and feel accepted in the male environment.

The study of Powell et al. (2009) also noted that some women applied their gender as agency in certain work situations. For example, they were more apt to ask questions and receive assistance from male counterparts. They also take advantage of finding engineering employment when companies are striving to meet affirmative action requirements. The two options discussed attest to the conflict that some women face known as a double-bind, whereas they are challenged to either choose to deny their feminine identity for assimilation and career advancement, or accept their feminine identity which may result in being invisible in the work environment or considered incompetent (Fletcher, 2001). Powell et al. concluded that the gender construct can be situational, whereas women engineers learn when to apply their tactics that may be characterized as male (such as assertiveness, competitiveness), and when to apply their effeminate characteristics (such as giving and receiving help, teamwork, mutual empowerment) in effort to establish assimilation in the male hegemonic engineering workforce.

Similarly, Fletcher (2001) described women as social carriers who bring characteristics of caring, nurturing and making connections to the workplace. Fletcher's description of social carriers in the work place parallels Gilligan's (1982) theory of attachment in terms of how women develop relationships. Fletcher (2001) identified these traits as the "female advantage" in the workplace (p. 12). As a poststructural feminist, Fletcher believed these attributes can be beneficial to the work climate when women combine traits whether innate or learned that are stereotypically characterized as masculine, such as rationalism, power, and influence. McIlwee and Robinson's (1992) research stood in agreement, as they stated that emotional sensitivity and interpersonal

communications are assets in certain managerial situations. Yet they contended that in the engineering industry, financial gain overrides relational practices, which thereby place social constructs as second priority. As women are viewed as more social than rational, they are therefore perceived as less competitive as their male counterparts (Rosser, 2006).

Related to this discussion, poststructural feminists such as Fletcher (2001) maintain that it is important to clarify that not all women meet the stereotype of being less assertive, with effeminate characteristics of being nurturing, and caring of others more than themselves. Feminists are concerned that these stereotypes could be counterproductive in some contexts. Likewise, some men are more nurturing and less assertive than their stereotypical characterizations (Fletcher, 2001; Rosser, 2006). And furthermore, both genders can display both characteristics based on situations and individual personalities. For this reason, Powell et al. argued that gender is not constant, but dynamic and calls for new methods of creating equality in the workforce. Studying women in the engineering work culture with reference to social cultural gender-linked roles are essential to the purpose of this study, which is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. An additional essential criterion that must be considered in this study of women engineers is the responsibility of balancing work and family. As afore mentioned, women more than men bear the role of primary caregiver in families. This role often presents a challenge to women's career motives and decisions as discussed in the next section.

Balancing Work and Family Relationships

Women engineers experience similar challenges to other workingwomen with

balancing career and family relationships. Rosser (2006) contended that women in male dominated fields, such as science and engineering have even greater challenges than other career fields due to the male hegemonic climate where men typically have wives who bear the primary responsibility of family care.

In general, social cultural gender roles in the United States and most countries dictate that women are the homemakers and caregivers of their spouses, children, and elderly parents. Because of this expectation, many women pursue careers considered "family friendly," meaning careers that offer work hours that allow them time to spend with family, limited traveling, and base level responsibilities. These careers are also more conducive to the need to take leave and return to work due to childbirth and childrearing. Such jobs include secretarial and teaching, where there are more female than male employees. The hours are regular, and the teaching career may not only offer a work day that ends in early afternoon, but also includes summers off, where mothers can spend vacation time with their families (Jackson & Sharman, 2002).

Related research by Hakim (2006) discussed preferential theory. Preferential theory acknowledges how equal opportunity in the workforce enables women to make choices of careers, as determined by three basic lifestyles of women. The three lifestyles are a) home-centered women (20% of women), described as those who prefer not to work and place family values as top priority; b) adaptive women (60% of women), who combine work and family values; and c) work-centered women (20% of women), who typically are childless and place work value as their top priority. Work-centered women can afford to be more competitive and able to travel or work long hours, which are sometimes required in high-ranking professions.

Hakim (2006) noted that the preferential theory offers some explanation to the salary gap between men and women, in terms of how women more than men face the challenge of balancing work and family. As the conventional primary caregivers of the family, women may choose to forego higher-ranking career opportunities that require travel and long hours. The higher-ranking professions are more likely higher paying jobs. Lower ranking positions are more frequently found to be more family-friendly, with shorter hours or lower level work responsibilities that allow for balancing family responsibility. Consequently, the salary levels may be lower, commensurate with level of responsibility.

By and large, social cultural genders roles for men allow them opportunity to focus more on their careers with the expectation that married men may rely on their wives to care for their families. In this respect, male engineers are better enabled than female engineers to work long hours, to travel, and to attend graduate school or job training in addition to other efforts to gain career advancement (McIlwee & Robinson, 1992; Rosser, 2006). Women in this field may experience difficulty in maintaining their competitive edge with their male colleagues when they choose to leave work for childbearing. They face the double standard to weigh and balance career advancement opportunities with care-giving responsibilities that result in work and travel compromises. Temporary leaves from work for family purposes are often interpreted (or misinterpreted) by organizations as lack of commitment to careers (Hakim, 2006; Whitmarsh, et al., 2007). Work cultures and values regarding balancing work and family relationships effect the recruitment and retention of working women, which is why this topic is important to the study of the shortage of women engineers.

Related research regarding women's work and family relationships also states that women in engineering are commonly unmarried, or married to engineers. Male engineers, on the other hand, are more likely to marry, and to marry homemakers, which enables them to climb the career ladder. For this reason, women engineers are more likely to be challenged with balancing work and family relationships. This issue contributes to the fact that male engineers tend to have further career advancement than women engineers (Jagacinski, 1987).

More specifically, of those who are married, 62% of women in science and engineering careers are married to men in science and engineering (Rosser, 2006), whereas the majority of men in science and engineering are not married to women in their field (Sonnert & Holton, 1995). Like many career women, some married women engineers sacrifice their personal goals to support their spouses' goals, by providing the primary care giving duties while husbands pursue their career aspirations (Rosser, 2006). Married women may find themselves relocating or declining promotions for the sake of their husbands' career needs, perceiving their career aspirations as secondary to family care. McIlwee and Robinson (1992) cite that as some women engineers place their careers second in priority, they may face career stagnation or abandon their engineering careers completely. These facts are indicative of the complexity of balancing work and family for women engineers. Furthermore, as aforementioned, the gender role expectations undoubtedly have an effect on the salary differentials between males and females (Rosser, 2006; Mattis, 2007). Issues such as barriers to career advancement, salary differentials, and conflicts between work and family responsibilities are factors that negatively influence the problem of disparity of women engineers, which is the why

this research is relevant to this current study.

It is important when discussing work and family responsibilities to acknowledge that not all families fit the traditional nuclear family structure of husband, wife, and children (Baber & Allen, 1992). There are single mothers, same-sex couples with or without children, and single women and men without children. Employment needs are different for each group in order to accommodate the balance between work and outside-of-work responsibilities. Regardless of different family structures, the need for flexibility and salary equity in the workforce are common denominators for career women. As the purpose of this study is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession, work and family issues are integral topics of interest in this study. It is intended to learn how women engineers experience their family structures, balance their work and family social environments, and what these experiences mean in terms of their career decisions. These issues are examined from a feminist lens regarding the relationship between work cultures and women's identities, as well as their work and family relationships, as discussed in the next section.

Feminist Theoretical Perspective

Work place culture is a social environment, and like in any social environment, individuals strive to find a balance between conformity and maintaining one's individual identity. In context with this study, women engineers not only strive to conform to a work environment in general, but specifically a male-dominated work environment. Within this culture, women engineers may find it challenging to balance social cultural gender roles and identities of women with the expectations of a work culture that asserts male

hegemonic agency (Powell, Bagilhole, & Dainty, 2009). And like many working women, the challenge is often further complicated with juggling work and family relationships. The phenomenon of women in engineering, their social cultural experiences and career decisions will be explored in this study through a feminist research framework.

There are several related descriptions of feminism that were found in this study, and are explained as follows. Schwandt (2001) explained that there are three primary categories of feminist epistemology: feminist empiricism; feminist standpoint epistemologies; and feminist postmodernism. According to Schwandt (2001), feminist empiricism is defined as, "a defense of experiential or observational data as the only legitimate basis for the testing of hypotheses and theory" (p. 93). He defined feminist standpoint epistemology as the belief that "inquiry should begin and be tested against the lived sociopolitical experiences of women because women have a more complete and less distorted vision of real social relations unavailable to men insofar as they benefit from the exploitation of women" (p. 93). Schwandt (2001) defines feminist postmodernism is as "a catch-all phrase for an incredibly rich variety of perspectives that in one sense 'come after' the first two epistemologies noted previously. Postmodern epistemologies are in part characterized by debates between standpoint perspectives and defenders of deconstructionism and postmodern notions such as the suspicion of all universalizing claims, the rejection of truth as an oppressive illusion, and the relativizing of experience to local micro politics" (p. 93).

Bogdan and Biklen contend that the feminist method allows for more "participatory role for subjects in research" (2003, p. 259). Researchers Olesen (2005) and Stewart (1994) add that feminist research approaches "the goals…to establish

collaborative and nonexploitative relationships, to place the researcher within the study so as to avoid objectification, and to conduct research that is transformative" (in Creswell, 2007, p. 26).

Feminism also takes multifaceted views that reflect differences between and among groups of women. Feminist thought interplays with oppression based on race, class and gender, which are areas that most affect African American women. It is important to remain cognizant of "traditions of knowledge among women of color" (Collins, 1992, p. 77). Other factors that play into feminism include age, religion, and sexual orientation.

Feminist Postmodern Perspective

Within the multitude and complexities of feminist definitions and perspectives, my goal in this research is basic: I want to give women engineers' voice. Specifically, in my research regarding women engineers, I am seeking to find how social cultural gender roles effect their career decisions. I plan to learn how the events in the workplace and family interface and make meaning in the lives of women engineers. I want to know about their challenges, but also their successes. How have they dealt with their environment? How do they maintain their identity in the male dominated workforce? What are their achievements? What gives them pride and satisfaction in their work world? And what do their experiences mean to them? I believe these stories are missing and the feminist perspective of women in engineering may contribute to the constructed knowledge that educators need to attract more women to the field. Therefore, I believe the feminist postmodern perspective is most applicable to this study, because it seems to allow for flexibility in finding "truth" in the voices of the participants of the study,

without objectivity. Truth will be described from the subjective standpoint of the participants and therefore notwithstanding the fact that their truths may or may not be generalizable to all women engineers in all situations.

The postmodern perspective encompasses the poststructural feminist perspective, which relates to this study. Poststructural feminism is a means of deconstructing the socially constructed characteristics such as race, class, and gender that shape our identities. It examines the power relations associated with race, class, and gender, while acknowledging the dynamics of individuals' truths as they evolve throughout their life journeys (Tisdell, 2002).

Feminism and Women in Engineering

As a researcher, I am mindful of the caution that some feminists hold that maintains the importance of recognizing certain differences between male and female genders in learning and/or workplace situations while not perpetuating stereotypes that imply that women are not suitable or competent for engineering professions. This caution is of great importance to my research and my belief that women *are* competent and suitable for engineering. I also understand why feminism has more than one definition, more than one viewpoint, and various arguments for and against certain aspects of the female experience. I agree with Collins (1990) who recognizes the various aspects of feminism based on factors that interact with women's life experiences, as well as their individual personality traits. In addition, the evolution of advancement of feminism from colonialism to postmodernism has its effect on the status of women's rights, interests, needs, and opportunities. These factors and possibly more affect the subjective truths that define the phenomena of each of our life experiences.

I hope my research will open new doors for more women to become engineers, with equal opportunity, accessibility, and competitive salaries with their male colleagues. I want more women and men to know of the challenging situations that need to be improved upon, as well as the accomplishments that need to be more publicly known in order to attract more women to engineering fields. Further, I hope this study will aid in deconstructing oppressive stereotypes of women that deter them from engineering fields, and transform their self-identities in such a way that they see themselves as fitting into the engineering workplace.

Similarly, this study is intended to provide information to enable a transformation of the male hegemonic engineering profession to become a more inclusive work world. This transformation would intentionally have a trickle-down effect to engineering education in high schools and colleges. Feminist pedagogy, described by Tisdell (2002), "encourages personal transformation of individual knowers by attempting to expand consciousness, capacity for voice, and self-esteem as knowers construct and express new knowledge and become more fully authors of their own lives. It encourages social transformation by inviting knowers to be actors in the world through participation in social change movements and public policy discussions that keep the interests of women in mind" (p. 155). In this reference, feminist pedagogy applies to this study to facilitate a transformation of social gender role constructs that would change constructed knowledge of what is means to be feminine, what it means for girls and women to be talented in mathematics and science, what it means to hone technical skills, and what it means to be a woman engineer.

Social Cognitive Theory and Social Cognitive Career Theory Perspectives

In addition to the feminist theory, the social cognitive career theory (SCCT) developed by Lent & Brown (2008), framed this study as it relates to women engineers and their career decisions. Social cognitive career theory was derived from Bandura's social cognitive theory. Social cognitive theory is based on the social learning theory that "analyzes behavior in terms of reciprocal determinism" (Bandura, 1978, p. 345). Social cognitive theory assumes that a person interacts with and through his or her individual cognition to alter the environment, which in turn influences the person's behavior (Bandura, 1978).

Based on the social cognitive theory, the social cognitive career theory (SCCT) "focuses on several cognitive-person variables (e.g., self-efficacy, outcome expectations, and goals), and on how these variables interact with other aspects of the person and his or her environment (e.g., gender, ethnicity, social supports, and barriers) to help shape the course of career development" (Lent, Hackett, & Brown, 2000). Self-efficacy is an important factor that plays an important role in reference to human agency and career choices. Bandura (1994) described perceived self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives. Self-efficacy beliefs determine how people feel, think, motivate themselves and behave" (p. 71). Self-efficacy can serve as either a motivating or an inhibiting contribution to decision-making.

Other variables include outcome expectations, which are one's beliefs that certain behaviors will prompt certain consequences or outcomes, and goals which involve an intentional action in order to attain a particular outcome (Lent, Brown, & Hackett, 1994).

Additional variables that relate to self, context, and learning include gender, race, ethnicity, ability, social support, and external barriers. All of these variables effect one's career decision making. These variables were used in a quantitative study by Lent, Brown, Schmidt, Brenner, Lyons, & Treistman, (2003) to explore the relationship between social support and barriers to choice of goals and actions of engineering college majors. Participants of the study were 328 engineering students from a large Eastern University, predominantly freshmen, 80% male, with 63% European, 9% African American, 4% Hispanic, and 18% Asian, and 6% reported other races/ethnicities. Results of the study found that the relations of both choice goals as well as choice actions, i.e. persistent behavior to pursue engineering were self-efficacy. In addition, self-efficacy had a positive effect on outcome expectations as well as interest. Self-efficacy also created a direct path to goals, and an indirect path to goals through interests. However, the Lent et al. (2003) study did not find a significant relationship between the support and barriers to the prediction of academic persistence.

It was noted that the Lent et al. study may not be generalized to women and minorities due to the primarily white male composition of the participants. However, research regarding career development of women of color in reference to the social cognitive theory indicated that their career and academic self-efficacy significantly predicted their academic success and career decisions (Hackett, Betz, Casas, & Rocha-Singh, 1992). Specific to engineering, research has shown that women in general, in non-traditional careers tend to have perceived self-efficacy that enables them to believe in and achieve success in areas such as science and engineering (Whitmarsh, et al., 2007). These studies support the results of the Lent et al. study that found a positive relationship

between self-efficacy and career choice, particularly in science and engineering.

Preference of Careers

As a final note of reference, it should be acknowledged that engineering is not for everyone. While most studies reason that the shortage of women in STEM career fields may be due to gender bias in some form, there are studies that examine an alternative explanation. Such studies consider whether women simply opt out of certain careers based on their own interests or preferences. In this reference, there are those who contend that some women are simply not attracted to or interested in science or engineering careers. As the job market becomes more equal between men and women, women have more choices of which fields suit their personalities, as well as their work versus family values.

For example, in 2008, Rosenbloom, Ash, DuPont, & Coder discussed the disparity of women in information technology. Their goal was to find whether there were personality preferences that determined whether males and females choose information technology careers. Applying a quasi-experimental design, Rosenbloom et al. (2008) surveyed 567 individuals, who consisted of both IT and non-IT professionals. The two-part surveys included the Holland General Occupational Themes and the Strong Interest Inventory. Results of their research indicated that more men than women showed interest in IT careers, based on their perceptions of the IT job characteristics. More specifically, the men enjoyed the characteristics of working with things, i.e. tools and mechanics, whereas women more preferred working with people. The researchers recognized that their findings support a stereotypical concept of gender preferences, but implicated a possible element of truth to the concept. Again, feminists and other researchers caution

this type of implication, as it tends to justify underrepresentation of women, without consideration of factors such as stereotype threat or negative work experiences such as harassment as possible deterrents of women in some fields (Fletcher, 2001; Rosser, 2006).

Summary

In summary, the various studies within this literature review discuss the research that surrounds the topic of the disparity of women engineers and the social cultural influences in their career choices. This supporting research provides a basis to this study, whereas the intention of this study is to acknowledge the voices of women engineers as they discuss their experiences, challenges, and successes of life and work in the world of engineering. From the historical perspective to present times, women have made great strides as professional engineers, and as a result have made significant contributions to society. Yet there remain sociocultural gender-linked barriers that deter more women from considering engineering. For this reason, the purpose of this study is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession using a phenomenological methodology. The following chapter will discuss the phenomenological methodology of this study.

Chapter III

Methodology

Statement of the Problem

This research study addressed the problem that there is little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. Research has been conducted regarding sociocultural gender-linked influences on high school and college level students' academic performance in STEM (Lee & Bryk, 1986; Thomas, 1990; Marx & Roman, 2002; Heyman, Martyna, & Bhatia, 2002). There is little research known that involves college graduated women engineers in industry (Mattis, 2007). There is a need to further the research beyond the college years into the workforce, to better understand the disparity of the number of women engineers. Therefore to add to the research pertaining to the education of college women in pursuit of engineering, the purpose of this study is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession.

As previously mentioned, most of the past quantitative research studies have focused on the experiences of high school girls in mathematics and science, and college

women majoring in science, technology, engineering, and mathematics (Lee & Bryk, 1986; Thomas, 1990; Marx & Roman, 2002). As discussed in Chapter One, a qualitative study of thirteen Canadian undergraduate college women in their first two years of study in mathematics, science, and engineering examined interpersonal, intrapersonal, and contextual factors that influenced their decisions to pursue engineering. The study concluded that the intrapersonal factors of enjoyment of mathematics and science were the primary influence on their decision. Self-efficacy also played a role in their continuance as well as intrinsic rewards (Gill, 2000). External factors that included teacher, peer, and parental supports as well as collaborative learning were additional influences. Gill applied a social psychological perspective, using the cognitive social learning theory and gender (Bandura, 1978). Sex-role stereotyping was also discussed in terms of education and employment.

Another study that related to this topic used quantitative methodology, with United States undergraduate college women participants (Choudhuri, 2004). Using a hierarchical linear model quantitative approach, Choudhuri examined multiple social cognitive variables, personal and contextual, that influence women's' decisions to major in engineering. Data retrieved from the Women's Experiences in College Engineering (WECE) from 1999-2001 provided a sample of 3,902 undergraduate women from twenty-six United States colleges and universities. Results of Choudhuri's study showed that factors such as self-efficacy, interest in engineering, and environmental influences are not independent, but rather interrelated influences on women engineers' career decisions (2004).

Recent qualitative research based on women engineers in industry was not found in reference to this current study. There is a need for such research in order to understand the breadth of information through the voices of women engineers regarding the social influences involved with their career decisions, challenges, and rewards. For this reason, this study was performed through a phenomenological qualitative analysis of women engineers to gain an understanding of the essence of their experiences.

Purpose of the Study

Years of research regarding women engineers have confirmed the existence of the problem of disparity (McIlwee & Robinson, 2002; Frehill, 2004; Powell, Bagilhole, & Dainty, 2009), but unfortunately a solution has not yet resulted. For this reason, research in this area must continue until the issue shows improvement. As previously mentioned, much of the past quantitative research studies have focused on the experiences of high school girls in mathematics and science, and college women majoring in science, technology, engineering, and mathematics (Lee & Bryk, 1986; Thomas, 1990; Marx & Roman, 2002). Mattis cited that little research has been performed involving women engineers in industry (2007). Studying women engineers could provide insight on how and why they decided to become engineers, as well as the challenges they have faced. To this end, the purpose of this study was to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. Studying the meaning of the sociocultural gender-linked influences on the experiences of women engineers was intended to provide a better understanding to educators and employers. It is hoped that this understanding will

enhance the recruitment of more women, by providing insight on how to meet the needs of twenty-first century women who may consider engineering academia and careers.

In this study, I sought to find how social cultural gender roles affect women engineers' career decisions. In doing so, I learned how the events and experiences in the workplace, family, and community have meaningful connections to women in engineering. A phenomenological study was appropriate for my research because there is little research found in the literature that explored the lives of women engineers' professional career experiences after college. The phenomenon of women in engineering, their social cultural experiences and career decisions were explored in this study from a feminist as well as a constructivist perspective.

The intention of this research is help educators, employers, and prospective women engineers better understand the experiences of women engineers once they enter the profession. Ultimately, it is hoped that the understanding of the successes, challenges and barriers of women in engineering may help to transform the engineering climate to accommodate the interests, talents, and needs of women, thereby attracting more women to the profession. This research is also intended to transform the societal perception of who is suited to become engineers in reference to more inclusiveness of both genders. Branching from the historical perspective highlighted in chapter two that discussed how women were first denied access to education, then were gradually permitted to learn and pursue math, science, and technology, women have made great strides in today's related fields, including the male hegemonic world of engineering. But more progress is needed to increase the numbers of women engineers, which is my intention of furthering the research in this area.

Rationale for Phenomenological Methodology

As studies have shown that no significant or inherent differences exist between males and females in mathematics and science competencies (Marx & Roman, 2002; Spelke, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; McQueen, Clark, & Rumsey, 2008), it is reasonable to assume that further analysis is needed to understand which factors that contribute to the shortage of women engineers. The factor in which I am interested in exploring is the social cultural gender effects on career choices whereas there is an apparent social deterrent to women entering engineering. Related studies found in this area involved quantitative studies to discuss the disparity of women engineers.

Social cultural factors are not as easily quantifiable as mathematics and science skill competencies. Rather, it is a subject matter that requires testimonials of those who have had experiences of this particular human nature. Qualitative studies are particularly suited to investigating human experience. Through a phenomenological study, insight was gained into not only the experiences of women engineers, but what meaningful connections they found through their experiences. Described by Merriam and Associates, "…a phenomenological study focuses on the essence or structure of an experience. Phenomenologists are interested in showing how complex meanings are built out of simple units of direct experience" (2002, p. 7). Phenomenology applies to social constructionism. Social constructionism describes how humans create structure and make sense of their social world and life experiences, actions, thoughts, and behaviors based on preselected thoughts and constructs (Shutz, 1962 in Embree, 2009). Embree (2009) further researched how humans apply "…sociocultural dimensions of the USA, namely:

ethnicity, generation, gender, nationality, and status" (p. 128). He analyzed what he termed

> "basic culture, which is to say how individual and collective selves, others, institutions, situations, and things have belief characteristics, values, and uses constituted subconceptually in habits and traditions of believing, valuing, and willing that are acquired from others as well as in personal efforts" (p. 128).

Associated with the philosophies of Husserl and Shutz, phenomenology "attempts to make meaning of experiences and events of ordinary people in a particular situation" (Bogdan and Biklen, 2003, p. 23). In reference to this research, the particular phenomenon studied was women, including women of color, in the predominantly male work world of engineering.

I first began research in this area in 2006 through a pilot study of African American women engineers. I chose this topic because engineering is an unconventional career choice for African American women especially, and I wanted to learn about their experience.

The pilot study was a qualitative narrative approach. The research crossed several conceptual frameworks, namely postmodern, feminism, critical theory, and social constructivist perspectives. Through purposive sampling, three participants were selected who were engineers I had met professionally. They were chosen from my professional networking with the National Society of Black Engineers (NSBE). As a researcher, I wanted to learn through their reported experiences whether they perceived equity and comparable support to their male counterparts during their college years and in their engineering career worlds.

In retrospect, I found the pilot study to be an interesting and pivotal starting point for my overarching research interest of women in engineering. The narrative approach provided stories about African American women engineers' experiences that provided great insight. My broad view of conceptual frameworks, postmodern, feminism, critical theory, and social constructivist in my pilot study was very general. In the current study, I decided to narrow my conceptual frameworks to feminism and social constructivism. After all, the feminism framework overlaps with aspects of critical theory through the concept of gender and the consideration of differences among women with regards to race, ethnicity, etc. (Collins, 1992).

Social constructionism as a secondary framework maintained the focus on creating change in social constructs of women's roles, of which this research is intended. Regarding the philosophical framework, I found that I wanted more specific research than the narrative methodology provided that told only of the experiences of the African American women engineers, but not what their experiences meant to them. For this current study, the phenomenological methodology of women engineers, including women of color, not only allowed participants to tell what happened, but also what the experiences meant to them. I believed the essence of the experiences was important to providing deeper understanding of women engineers' experiences. The meaningful connection is what is needed to be shared with young girls and college women, who may or may not consider the engineering profession. I also want to research women engineers from different races to provide more diversity in the details of human experiences. For these reasons, I chose the phenomenological approach, in effort to understand the essence of the experience of diverse women engineers.

Philosophical Assumptions

Ontology

This study was performed from an ontological philosophical assumption. According to Creswell, "the ontological issue relates to the nature of reality and its characteristics" (2007, p. 16). For this study, I acknowledged reality as subjective with multiple viewpoints from the perspectives of reality of each participant. Through broad-based questions, I enabled the participants to respond with their descriptions of their experiences. The method of phenomenology is designed to study individuals' lived experiences with the acknowledgment that the experiences were conscious experiences (van Manen, 1990), and to formulate meanings of these experiences beyond basic analyses (Moustakis, 1994).

Worldview

My study was shaped through the paradigm or worldview of social constructivism because the participants' perceptions were multifaceted based on their viewpoints of their situations. Through social constructivism "individuals seek understanding of the world in which they live and work. They develop subjective meanings of their experiences…negotiated by social interactions with other people" (Creswell, 2007, pp. 20, 21). The theory of social constructivism also relates to this study as the notion of making change in social roles and expectations of women (Bogdan & Biklen, 2003, Schwandt, 2001). From the social constructivist paradigm, the acceptance of women in STEM fields contributes to social capital and empowerment of women, as these fields are of high demand in the twenty-first century.

Structural and Poststructural Philosophical Assumptions

The phenomenon of women engineers can be viewed by two philosophical assumptions, namely the structuralist and poststructuralist contexts. In the next section, the structural philosophy will be discussed from the prospective of Michel Foucault, and the poststructural philosophy will be discussed from the prospective of Henri Lefebvre.

Structuralist Context

Michel Foucault was a French stucturalist philosopher and historian. His studies involved two areas that relate to the study of women in engineering. One of these areas is the examination of codes and concepts by which societies operate, especially the "principle of exclusion," which implies that those with power decide who is included or excluded from certain situations, opportunities, or rights of power, by which society defines itself. Foucault theorized that by surveying social attitudes in relation to institutions such as hospitals and prisons, one can examine the development and omnipresence of power (Foucault, 1980). In the context of women in engineering, the issue of power can be examined in the workplace where gender-linked roles dominate the workplace culture. When men dominate the engineering workforce, they control the power of the work environment. Therefore, men defined the culture of the workplace as power through aggressive behavior in displaying technological skills and top-down management. Foucault (1980) theorized that everyone in the workplace does not occupy the same position, as certain positions are superior to others, thereby establishing a construct of classism. In the case where female engineers are not promoted as equitably as male engineers, they face the possibility of being perceived as second class employees

in this context, thereby being excluded from power and influence as compared to their male counterparts.

Conversely, where organizations strive to recruit more women engineers and promote them to managerial positions, power and influence of women engineers improve their agency both in the workplace as well as in the social construct by the nature of their increase in numbers as well as their access to advanced positions in engineering industry. Through agency, the increase of women engineers who identify with and remain in the engineering workforce may enable them to transform the engineering work environment to be more conducive to their employment needs and thereby reciprocally increase the recruitment and retention of women engineers. This notion relates to Foucault's belief that citizens' identity and expected behaviors are created through their professions (Foucault, 1980).

A second area of Foucault's study focused on language and the use of discourse. In the 1960's, Foucault considered discourse, which defines how historically and culturally located systems of power and knowledge construct subjects and their worlds. Discursive practice, which involved real-time interactive discourse was also known as the Foucauldian analytics. Foucault used the concept of discourse to describe how people make meaning of words and conversations in ways that create and define social practices and power (Gubrium and Holstein, 1997).

Central to structuralism is the study of the group of rules, and perceptual descriptions of statements. Literary structuralism views literary texts as dependent systems that interlock and exclude one another, and transform in meaning (Foucault, 1972). Fletcher identified terms that include empathy, mutuality, and teamwork that are

characterized in meaning as effeminate in workplace relational practice. Such characterization thereby creates negative implications in the male dominated engineering culture. Furthermore, the limits of language, such as strong descriptive words, i.e. competence, skill, and knowledge were identified as masculine. By contrast, affective descriptive words such as nurturing and caring were identified as feminine. Meanings attached to the stronger words that identify with masculine characteristics tend to overshadow the meanings of words that identify with feminine characteristics in the male dominated work environment. This type of language coding influenced the roles and expectations of women engineers in workplace settings in ways that perpetuate exclusion and inhibit career advancement (Fletcher, 2001). Therefore, Foulcauldian analytics applies to the study of women engineers and the discursive practices which influence their relationships in the workplace from a structuralist point of view.

Post-structuralist context

A second philosophy related to this study is from a post-structuralism context in terms of relationships between work and family. Post-structuralist, Henri Lefebvre studied practices that are described as the modes in which people move through everyday life. An analogy of his philosophy on how physical and social spaces are assembled may be applied to the organization of workspace.

Lefebvre believed that structuralism is too rigid in terms of meanings of language. He believed that meanings are continuous and change over time (Lefebvre, 1995). Similarly, Bogdan and Biklen describe social construction in reference to "the fact that how we think about society and various aspects of it are not fixed or essential, but rather are produced by social interaction and exist in people's mind" (2003, p. 262). Perhaps

then in this context, as women's space in engineering evolves, the meanings of the words identified by Fletcher (2001) as feminine (nurturing, caring, sensitive) may change in meaning through social interaction by becoming less gender-linked and more generalized and complimentary to the meanings of the words such as competency and skill.

Lefebvre also urged the need for change in intellectual approaches and tools. This theory can be applied toward the need for change in the social construction of gender roles in reference to technical careers. The evolution of women's spatial relationships in engineering also relates to Lefebvre's use of the word "we" as it defines all parties concerned. He maintained that the social life in its global capacity possesses power, or the lack thereof (Lefebvre, 1995). The notion of "I" versus "we" brings to mind the question, "What does competitiveness mean in the workplace? Is it competitiveness of engineers within the workplace, i.e. the "I's" or competitiveness between organizations, i.e. the "we's" as in teamwork within the organization against outside organizations? It appears that both concepts of "I" and "we" play distinctive roles in the engineering workplace. Coupled with the overlap between family and work relationships, women engineers like many other professional women must also balance their professional goals, or "I-ness" with their family values and goals for the sake of the "we-ness" of their families.

Theoretical Framework

Feminist Theoretical Framework

This study was guided by the poststructuralist/postmodern feminist perspective. From this, I perceive the social constructed gender roles in the family, community, and workplace are challenged by today's changing demographics, the globalization of the

economy (which is creating significant gaps between rich and poor), and the advancement of technology (which demands a new outlook on the world of work). Women compose 47% percent of the United States workforce and are thereby needed in all areas of work, including science, technology, engineering, and mathematics (U.S. Dept. of Labor Women's Bureau, 2010). Through the poststructural feminist theoretical perspective, this phenomenological study gave voice to women in the male hegemonic engineering climate. It is hoped that their voices will lend insight to their employers.

Applying Foucault's philosophy of the use of language to gender-linked discourse (Gubrium & Holstein, 1997), it seems common in general conversation that people often misuse the words "sex" and "gender" synonymously. However, the two words have separate definitions. According to Shakeshaft, Nowell, and Perry (1991) sex is the distinction of whether one is biologically male or female, whereas gender relates to the roles, characteristics, and behaviors assigned to males and females by society or cultural influences. Discourse about gender assigns particular roles that males and females tend to behave in compliance, which lends itself to stereotyping. These behaviors and expectations affect career paths for men and women.

Creswell (2007) contends that our sense of selves is imbedded in gender roles. Feminism examines how women comprehend their gender, and related social issues such as agency, affirmative action, and equality. The goal of feminist framework then is to "correct both the invisibility and distortion of female experience in ways relevant to ending women's unequal position" (Lather, 1991, p. 71).

In light of the aim of feminine research, it becomes an obvious framework for which to build the study of women engineers. Fletcher discussed how women are

sometimes invisible, or "disappeared" in the engineering workplace (2001, p. 3). Based on Fletcher's views, I was curious about the subjective reality of the participants chosen for this study. I wanted to understand their perceptions about their agency, and sense of being either acknowledged or invisible among their colleagues, subordinates and super ordinates of their profession.

As stated in chapter two, within the multitude of complexities of feminist definitions and perspectives, my goal in this research is basic. I want to give women engineers' voice. Specifically, in my research regarding women engineers, I learned a) how the events in the work place, and family interact and make meaning in the lives of women engineers; b) about their challenges, but also their successes; c) how they dealt with their environment; d) how they maintained their female identity in the male dominated workforce, and whether it mattered; e) what were their professional achievements, and what gave them pride and satisfaction in their work world? Just as importantly, I learned what their experiences meant to them. I believed these stories are missing, and these stories may create a feminist perspective of women in engineering that may contribute to the constructed knowledge that educators need to attract more women to the field. Therefore, I believed the feminist postmodern perspective was most applicable to this study, as it seemed to allow for flexibility in finding "truth" in the voices of the participants of the study, without objectivity. Truth was described from the subjective standpoint of the participants and therefore notwithstanding the fact that their truths may or may not be generalizable to all women engineers in all situations.

Social Cognitive Career Theoretical Framework

In addition to the feminist theory, the social cognitive career theory was used to analyze the data in terms of career choices. Based on Bandura's (1989) social cognitive theory, the social cognitive career theory explores how self-efficacy influences career development, decision-making, and performance (Lent & Brown, 2008). As discussed in chapter two, how women learn math, science, and engineering, and the perception of women's self-efficacy in these fields was explored from a social learning theoretical perspective. The social learning perspective is also known as a social cultural theory. Socio-cultural theory applies to the social and environmental effects on the issue. The philosophy of the socio-cultural theory is that knowledge acquisition is affected by the "social, cultural, and physical contexts in which human cultures find themselves" (Case, 1996, p. 79). Related theories that were used in this study were the social cognitive theory as it pertained to gender roles (Bandura, 1984), the social cognitive career theory, as it pertained to women's career choices based on social influences (Lent and Brown, 2008), and situated cognition, as it related to how women learn through interaction and social context (Hansman, 2001).

Research Questions

The issue of women engineers and the sociocultural factors that influence their career choice is significant to the status of the engineering profession as well as to the population of women engineers. Applying the procedure of Moustakis (1994), the central question designed for the purpose of this study asked, "What are the experiences of women engineers, and what contexts or situations have shaped their experiences as women engineers?" Sub questions were designed to understand the context of the

experiences, search for themes, and capture the essence of what the experiences meant to the participants. Specifically research questions for this study explored the following:

1. Regarding issues and barriers:
    a. What issues and barriers do/did women engineers in this study encounter in the engineering workforce?
    b. How do/did these issues and barriers shape their career decisions?
    c. How do/did these issues and barriers shape how women learn to be engineers?
2. Regarding successes and/or supports:
    a. What successes and supports did/do women engineers in this study encounter in the engineering workforce?
    b. How do/did these successes and supports shape their career decisions?
    c. How do/did these successes and supports shape how women learn to be engineers?
3. What is the overarching essence or meaning of the experiences of being women engineers?

Research Methodology

Phenomenological Research Process

Transcendental phenomenology

The type of phenomenology I applied in this study is Moustakas's (1994) transcendental or psychological phenomenology. This type does not focus on "the interpretation of the researcher," but rather the "description of the experiences of participants" (p. 59). Through transcendental phenomenology, bracketing, also what

Husserl terms as epoche (a Greek term meaning to refrain from judgment), was used (Moustakis, 1994, p. 33), where the researcher does not consider her own personal experiences, but instead gathers data based solely on those who experienced the phenomenon. Also known as transcendental-phenomenological reduction (Moustakis, 1994), the researcher reduces the data to pertinent statements to searches for themes from their varied perspectives, quotes and expressions (Creswell, 2007). In other words, the "researcher derives an overall description of the general meaning of the experience" (Ary, Jacobs, & Sorensen, 2010, p. 473). The collection of quotes and themes was also termed horizontalization, which enabled me as the researcher to find clusters of meanings from the participants' statements. The following step, known as textual description was used to emphasize the told experiences. The textual description explained what was being studied about the phenomenon of women engineers. The imaginative variation or structural description considered the context, situation, or condition of which the experience was influenced (Merriam & Associates, 2002). This description explained how the phenomenon of women engineers was being studied. Finally, I developed a composite description or invariant structure (or essence), which was a culmination of the participants' experiences and my own experiences to find and discuss their common experiences (Creswell, 2007; Ary, Jacobs, & Sorensen, 2010). The composite description is intended to allow the readers to believe that they can better understand the experiences of others (Polkinghorne, 1989), which in this study are the experiences of the women engineer participants.

Participants

Through purposive sampling, this transcendental phenomenological methodology involved nine participants. The selected participants were women engineers ranging from their twenties to forties in age, who have earned a minimum undergraduate engineering degree from Midwest universities, and have or had a minimum of three years of work experience in their engineering field. Some of the participants selected were currently employed as engineers, while others have left engineering. Participants were selected from my professional affiliations with university alumni, university colleagues, and referrals from professional colleagues. Selecting participants both in and out of the engineering career field added breadth to the study, in understanding factors related to retention and attrition of women engineers. The intent of the research was to provide an in-depth analysis of women in engineering by using a collection of self-reports through interview. Their voiced experiences of events in the workplace, family, and community provided meaning into the related prior researchers' quantitative studies.

Internal and External Validity

Internal Validity. Internal validity refers to the measurement of whether the research addressed the questions that were intended to be addressed. Merriam and Associates (2002) assert that this issue rests on the concept of reality. They contend that reality in qualitative research however, is based on the "researcher's interpretation of participants' interpretations or understandings of the phenomenon of interest" (p. 25). To strengthen the validity of this study, I used the postmodern concept. The postmodern concept utilizes crystallization, whereas I relied on participants' interviews. I also utilized member checks, whereas I asked each participant's feedback on the transcription of her

individual interview. After receiving feedback from each participant, I entered the suggested corrections, additions, or deletions accordingly on the respective transcripts. Member checks allowed for trustworthiness of the research (Merriam & Associates, 2002; Ary, Jacobs, & Sorensen, 2010).

External Validity. External validity, or generalizability relates to the degree to which results of a study can relate to other situations (Merriam & Associates, 2002). As the researcher of this study, I planned to "provide rich, thick descriptions" to allow for generalizability (Merriam & Associates, 2002, p. 29). However, as the concept of reality relates to generalizability, it is recognized by researchers that qualitative research involves the perceptions of reality, or subjective truths of the participants. For this reason, generalizablity in the context of qualitative research may be considered established by case-to-case, allowing the reader to decide whether the findings may apply to his/her situation (Firestone, 1993 in Merriam & Associates, 2002). Therefore, in terms of validity, the researcher provides the study, and the reader determines whether the study is validated by her or his own subjective truth.

Researcher's Bias

In my research, I maintained awareness of my positionality as it posed potential for researcher's bias. I am in the profession of higher education administration that involves engineering student recruitment and retention. My female gender provided me knowledge and experience of feminist perspectives, and my profession brings a sense of familiarity to the profession of engineering and the disparity of women engineers. In effort to control for my bias, I employed bracketing, also what Husserl terms as epoche, "a Greek meaning to refrain from judgment" (Moustakis, 1994, p. 33), where the

researcher does not consider her own personal experiences, but instead gathers data based solely on those who experienced the phenomenon. Despite my positionality, I committed as a researcher to perform an ethical study, by not employing any assumptions or predictive outcomes, but instead being open-minded and eager to learn of the experiences of the participants of the study.

Interview Questions

The interview questions were designed with the intent to address the validity of the research with consideration as to whether what was meant to be measured was actually measured. Specifically, the interview questions of this study addressed whether sociocultural influences on gender roles affect the career decisions, academic, family, and work experiences of women engineers. The questions were developed to enable each participant's interpretation and response. Realizing that the quality of questions affects the answers, the questions were developed in effort not to enter biases or lean toward a particular response. In this regard, prior to implementation, the interview questions were first reviewed by my advisor and methodologist to provide feedback regarding the wording of the questions. In order to gather rich data during my interviews with the participants, I sometimes needed to clarify a question, or ask them to elaborate about a particular situation within the phenomenon in order to "develop a thematic description of the human experience" (Pollio, Henley, Thompson, & Barrell, 1997, p. 104) of women engineers. Questions developed for the interview in this study are listed in appendix A.

Data Collection

In consideration of the protection of confidentiality of the participants, and to comply with ethical standards, this study was submitted for approval by the Institutional

Review Board (IRB) for Human Subjects in Research at a Midwest University. Demographic information of the participants, explanation of how they were selected, a project description, and explanation of how the data was secured was indicated in the IRB application. Included in the application was a listing of the survey questions, along with an Informed Consent Form. After receiving IRB approval, two Informed Consent Forms provided to each participant for her signature prior to the conducting of the interview. One form was submitted to me and one was retained by each participant. Each participant was interviewed individually for approximately one hour in a mutually agreed upon location and to the convenience of the participant's schedule. I as the interviewer took notes and tape-recorded the interviews to ensure accuracy. Each participant was given a pseudonym in the transcription in order to protect her confidentiality. In addition to the pseudonyms, the actual names of the participants' colleges, universities, and places of employment were not disclosed in order to further protect confidentiality, as well as to maintain the focus of the stories on the participants and not on the educational institutions or specific companies or industries in which they were employed. I transcribed the taped interviews and cross-referenced with notes from my researcher's journal. I contacted each participant separately for their review of the transcripts. This allowed the opportunity for each participant to revise, clarify, or delete any information. Following their input, I revised transcripts accordingly before beginning my analysis of the data.

Data Analysis

Upon gathering the data from interviewing nine participants for this phenomenological study, I sorted and organized the data. Secondly, I coded themes, and described each participant's personal experiences. My aim in the coding and describing

was to search for the essence of the women engineers' experiences. Following the descriptions, I then classified the descriptions by identifying specific statements, and clustering them into units based on common meanings. Classifying the descriptions prepared for the next step, whereas I interpreted the clusters to identify textural and structural descriptions that allowed me to then find the essence of what and how the experiences occurred.

Summary

The purpose of this study was to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. Prior related research that was found involved college women in pursuit of engineering degrees. The intention of this study was to further research by performing a phenomenological study of women engineers in industry. Through a transcendental phenomenological methodology, nine women engineers who have graduated from Midwest Universities were selected through purposive sampling. Data was collected through interviews of these participants. The data was analyzed in order to answer the primary research question, "What are the experiences of women engineers, and what contexts or situations have shaped their experiences as women engineers?" The intent of the research was to gain an understanding of the essence of their experiences, with hope of providing information about women engineers' issues, barriers, challenges and supports that may assist educators and employers with the recruitment and retention of women engineers. The next chapters will discuss the researcher's story of finding participants (Chapter Four), followed by the analysis of the

data in this study (Chapter Five), and finally discussion and recommendation (Chapter Six).

Chapter Four

Researcher's Story of Finding Participants

Participant Selection Process

Initially, my plan was to interview ten women engineers for this study. However, qualitative research aims to continue interviewing participants until data becomes saturated. It became evident after interviewing nine participants that saturation had been met, and common themes emerged from the interview data. For this reason, a total of nine participants were found to be sufficient for this study. Of the nine participants, four were of African American descent and five were Caucasian. Age groups consisted of three participants in their twenties, three in their thirties, and three in their forties. Four participants were married with children, and five were single with no children. Six participants were practicing engineers at the time of this study. Three participants had left the engineering field to work in more traditional female dominated careers in education. Table 1 displays the demographics of the participants of this study.

Each participant was interested in sharing her story and was very generous with her time and information. Their responses revealed remarkable strength and tenacity in terms of their career aspirations and achievements. Whether the women of this study had chosen to remain in or leave the field of engineering, overall, they expressed high regard

for the engineering profession, and the situations that shaped how they learned as well as their experiences as women engineers.

Table 1

Participant Demographic Data

Pseudonym	Age Range	Race	Marital Status	Currently an Engineer?	# Years Worked as Engineer
Erica	40's	AA	M/C	No	6 years 1980's to 1990's
Sherry	40's	C	M/C	No	10 years 1980's to 1990's
Natalie	30's	AA	M/C	Yes	12 years 1990's to 2000's
Debra	40's	C	M/C	No	17 years 1980's to 2000's
Terra	20's	C	UM/NC	Yes	3 years in the 2000's
Meghan	20's	C	UM/NC	Yes	3 years in the 2000's
Marie	30's	AA	UM/NC	Yes	9 years in the 2000's
Jamie	20's	AA	UM/NC	Yes	4 years in the 2000's
Pat	30's	C	UM/NC	Yes	5 years in the 2000's

Note. AA = African American; C = Caucasian; M/C = Married with children; UM/NC = Unmarried with no children.

Data Gathering

Data for this study was gathered from nine women engineer participants. Each participant was interviewed for one-to-two hours. There were nineteen questions asked of each participant. Seven of the nine participants were interviewed in-person at a mutually agreed upon location. Due to inclement weather, two of the nine participants were interviewed by telephone. The data was analyzed with the goal to answer the central research question, "What are the experiences of women engineers, and what contexts or situations have shaped their experiences?" The intent of the research was be to gain an understanding of the essence of their experiences, with hope of providing information about women engineers' issues, barriers, challenges and supports that may assist educators and employers with recruitment and retention of women engineers in the workforce.

The data analysis in this study was written in the voice of the nine participants, with exact quotes from their interviews and compared to the related research and literature reviewed in chapter two. Before discussing the voices of the participants in this study, the following presents my voice and thoughts as the researcher's perspective regarding my quest to meet the participants through my occupation and engineering professional affiliations.

I remember starting my journey and preparing to find and interview participants for the study. Initially, I thought it would be relatively easy to find participants, since I regularly interact with engineers in the course of my work as an education administrator in an engineering college. I thought I knew many engineers to ask to participate in this study. I also thought the interview process would be something I could accomplish rather

easily, since I regularly talk to people for a living in my capacity as a higher education administrator. It was the end of spring semester 2010 when my first three chapters were approved by my dissertation committee, and I was therefore permitted to start the interviews. As summer began however, I thought perhaps it was not a good time for me to try to contact prospective participants. They simply were not as accessible in my daily work interaction. That is when I realized that perhaps participants actually were accessible, but it was I who was unsure of how to start. I had my questions ready, but had to simply prepare myself to become an interviewer. Being an interviewer is much different than just talking to people. I came to respect the process as a structured method of seeking information for the purpose of gathering data—a skill that I realized I had not honed but needed to learn, as evidenced in my interviewing of participant number one.

Participants of the Study

Interview of Erica, Participant Number One

I purchased a new tape recorder, batteries, and a pack of cassettes specifically for the purpose of interviewing participants for my study. Prior to the interview I practiced with the recorder and made sure the cassette tape was working. With interview questions prepared and tape recorder in hand, I felt I was ready to contact the first person on the list I had previously made of women engineers that I knew I would like to ask. To my great fortune, my first prospective participant gladly agreed to an interview.

I next needed to find a mutually agreeable location for interviewing. To my advantage, I was informed of a collaborative study room in the library of the university at which I am employed. The collaborative study room was designed specifically for

students to meet in a closed room for quiet study purposes. Use of the room required reservations and permission for a key to enter.

The first interview went well. Participant number one, Erica, is an African American engineer, married with children, and currently employed as an educator. I have known Erica professionally for many years, but never knew her detailed career and life history. As she spoke, I was in awe of her eloquent tone and inflection in her voice when she shared personal anecdotes about the community support she received as a student, her work experiences, and family. Her details about her situated learning experiences were amazing. She discussed how she learned to use equipment such as lathes, as well as her work on designing projects.

I left the interview very impressed by her intelligence and experience. I wondered how I could justly tell her story and do a good job of expressing her concerns and achievements.

I went home that night, and listened to the tape recording. Her story flowed. Her information was captivating. Then suddenly in mid-sentence, the tape stopped. "What???" I exclaimed. "No way!" Could this really have happened? I had lost some of the data during the interview by not turning the tape over soon enough. I was flabbergasted. I realized that I would have to contact her again and ask for more of her time. I needed a chance to re-do parts of the interview, to repeat some of the questions to retrieve lost portions of data.

I contacted participant number one the following week. I apologized humbly and hoped she would understand that she was my first interview participant, and I had not quite perfected my craft. Fortunately, Erica understood, and was willing to meet me again

to repeat a part of her interview. Although it resulted from a mistake of losing data, I later realized that this process of contacting a participant a second time was part of my member-checking, a required process whereas the data collector checks with participants when necessary to ensure that all data has been accurately collected and transcribed. The participants are thus provided the opportunity to make any additions, deletions, or revisions to their recorded interview or transcript.

During the second interview with Erica, again, she spoke with great eloquence and full recollection of her experiences. I found her story even more compelling than the first time I heard it. And at the end of our second interview, it occurred to me that everything happens for a reason. I realized that it was necessary for me to hear her story a second time in order to better understand the meaning of her message, as well as how I was to tell her story and those of the other women engineer participants to follow.

Interview of Sherry, Participant Number Two

Sherry, the second participant was easily accessible just as the first. Like Erica, I also knew Sherry from my professional affiliation. Sherry is a Caucasian engineer, married with children, and also currently employed in the field of education. I contacted Sherry by phone, and she agreed to participate. For this interview, we decided to meet at her office at 7:30 a.m. before the workday began. This time, I was definitely more cautious of the tape recorder and carefully watched the timer to turn the cassette tape from side A to side B on time.

Like Erica, Sherry was very interesting. Both women thus far expressed great confidence in their sense of self, and their decision-making. Participant number two

discussed her self-directed learning style, which she defined as "nature" in terms of her self-motivation to seek out resources and achieve.

During the interview, I noticed how her answers segued into the next questions. So I allowed her to talk. But as I listened to her taped interview, I was not definite as to whether I had clear answers for a couple of the questions. For this reason, I contacted Sherry a second time to review the areas where I needed clarification. This process was another example of member checking. At this time, I presented her with a transcript for her reference. She obtained the transcript from me, made slight revisions and returned it to me. Later that day, she met with me to add answers to the couple of questions I wanted to revisit. She also mentioned that after reflection, she had more information that she wanted to add regarding her career choice and experience. We therefore scheduled a follow-up interview session, and met a third time to allow her to add more information to her interview.

Interview of Natalie, Participant Number Three

Summer turned to fall as I prepared to contact prospective participant number three. The third participant, Natalie, was someone whom I had known professionally for years. Natalie is African American, married with children, and currently employed as an engineer. As a busy engineer, wife, and mother, I knew she would be difficult to reach. I emailed her, and we played phone tag for a couple of days. Then I called once more and she answered. Again, I was fortunate to have another willing participant. It seemed that so far, that each of the engineers was eager to tell her story and have an opportunity to contribute to research that may in turn contribute to increasing the number of women engineers.

We met at her home on a Saturday afternoon. Her interview was a little different than the first two, in terms of her answers being more direct with less detail, thus taking a little less time than the interviews of the first two participants. Again, the confidence of being an engineer was evident as her responses revealed power in her perceived ability to be a good engineer and conveyance of what it took to be one.

Interview of Debra, Participant Number Four

Participant number four, Debra, was someone whom I had met from my professional affiliation. Debra is Caucasian and married with children. Like Erica and Sherry, Debra was a former engineer who had changed her career to an education profession. I emailed Debra and asked her to give me a call. Despite her busy schedule as an education administrator, she contacted me. "Another willing participant," I thought. I felt fortunate to have four "yeses" in a row. The willingness of these participants meant more to me than sheer convenience, but instead was confirmation that my research topic *is* a good topic, and that women engineers find this study important and useful to the extent that they would like to contribute as participants.

I scheduled the interview with Debra for the following week in the university library. What a cold, rainy day it was for someone to come to my environment for an interview. I wished on that day that I had found a place closer to Debra's location for her convenience. But despite the inclement weather, she arrived on time and we were able to proceed.

Another impressive interview! I was very appreciative of the stories I was hearing from the participants. Ranging from their confidence as women engineers, to how their

statements compared with the literature review, I was already beginning to see the emergence of themes.

Recruiting Participants through Social Events

After the first four interviews, I had to seek other resources to find more participants. Through my daily occupation in engineering academia, I often receive notices of speakers and events. In this light, I received an emailed invitation for a social event for engineers. I decided I would attend. I generally consider myself a sociable individual who can venture to different events with little trouble meeting new people and starting conversation. The occasion was a happy hour networking event after work, and those in attendance were engineers and educators. As I walked through the club, I felt somewhat like an outsider in terms of seeing a sea of unfamiliar faces. And I was not sure how to approach people to ask whether they were engineers, and if so, would they participate in my study. The emailed invitation came from Terra, an engineer whom I knew professionally. Terra is Caucasian, unmarried with no children, and is currently employed as an engineer. I saw Terra shortly upon entering the social club. Prior to the event, I had spoken to her by phone. During our phone conversation, I had briefly told her of my dissertation subject, and she too had agreed to participate. She and I had already set a date to meet in the library. However, I wanted to attend her event for the purpose of supporting her in her efforts of holding a happy hour function for the mission of engineering networking and recruitment. In addition to supporting her efforts, I was searching for more engineers whom I hoped would attend, so that I could ask them to participate in my study as well.

Interviews of Terra and Meghan, Participant Numbers Five and Six

Fortunately another engineer, Meghan, whom I had known professionally, also attended the engineering happy hour. Like Terra, Meghan is also Caucasian, unmarried with no children, and a current practicing engineer. That evening, we networked and shared contact information. Days later I called Meghan to inform her of my dissertation topic and asked her to participate. Meghan also agreed. Like the others, we scheduled her interview at the University library.

Meghan provided answers that were much quicker and concise. It became apparent to me that some people provide more data than others. Nonetheless, her data was equally as relevant, just shorter responses.

I had decided to interview Terra and Meghan because they are in their mid-twenties. Of the first four interviewees, three were in their forties, and one was in her thirties. I wanted to learn the experiences of younger women engineers, in their mid-twenties, to have a recent purview of experiences, in order to analyze whether there were any changes in their gender-related perceptions and experiences as compared to women engineers in their thirties and forties.

As it turned out, there was a major difference in their reports, where apparently Terra seemed to not be affected by perceived gender differences, but emphasized that her young age seemed to be more of a factor of concern among older engineers and her clients. Clients seemed more concerned about her length of experience and competency in reference to quality of their products. But she seemed almost unaffected by the gender-based questions I posed. She had no details to share. Her nonverbal language seemed to

imply that she was not diverting from telling stories about gender issues and barriers, but rather she simply did not have any related situations to discuss.

Meghan mentioned how she perceived her gender to her advantage, when there were clients who wanted to be inclusive by using the expertise of a diverse engineering population. The interviews of women in their twenties led me to wonder whether their perceptions were an indication that gender issues and barriers are not as pervasive for women engineers of the twenty-first century, or whether the young engineers simply had not yet encountered any gender-related issues or barriers due to their relative newness in their careers.

Transcription Break

I took a break from finding more participants in order to transcribe the taped interviews I had attained thus far. The transcribing process enabled me to hear stories more than once, and thus better understand and analyze the meaning of their responses, as well as to formulate themes. While listening to the stories as I transcribed, I realized that I am not only writing a dissertation to help educators recruit engineering students, but also to educate engineering employers regarding what is needed for retain women engineers in the workforce. The stories reported in my research will provide companies suggestions for improvement of the work environment for women, such as recognition of their talents, and acknowledgement of their voices.

Another lesson learned from transcribing interviews was from a technical standpoint. I learned that transcribing recorded interviews requires rewinding, stopping, and starting the tape recorder repeatedly, which results in a lot of wear and tear on the tape recorder. As previously mentioned, I had purchased a new tape recorder for the

purpose of my study. Well, my new tape recorder broke from overuse during my transcribing, so I resorted back to an old tape recorder I had previously owned. It served the purpose of allowing me to continue transcribing until I was able to buy another one.

I had interviewed six participants and completed the transcriptions. As another aspect of member checking, each transcript was shared with each respective participant, either delivered in person, or sent by email. The participants approved the transcripts, some with slight revisions, and returned them to me.

Searching for More Participants

Still in search of more participants, I attended another engineering event on an October Saturday morning. This event was presented by the National Society of Black Engineers (NSBE), with the mission of mentoring engineering college students. At the event, I met Marie, an African American engineer who was from another Midwestern state. Marie is unmarried with no children, and a current engineer. At the end of the NSBE event, we shared contact information. I wanted the opportunity to tell her about my research and ask her to participate. I had noticed at the event, that Marie was very open and conversational with students and professionals, telling many anecdotes about her cooperative education and entry level engineering experiences. She seemed very confident and poised. Following the event, I contacted her by email and phone. I really wanted to include Marie as a participant. Based on the content of the stories she was sharing at the event, I knew she would really enjoy the subject of my research. Marie was one whom I would possibly interview by phone since she lived in another state. But if necessary, I would have gladly driven to the state where she resided to meet her on a Saturday for the purpose of an interview for my research. After several calls, I was able

to reach Marie, who fortunately also agreed to participate, as I had hoped. I offered to drive to her state to interview her, but the weather was becoming very wintry. So we agreed to schedule a telephone interview instead.

The season of my interviews drew close to the end of year holidays. I realized that soon it would become difficult to gather participants, as they would be focusing on these holidays. Not to mention that I wanted to have all interviews completed, transcribed and approved by mid-December so I could use my holiday break to analyze data.

To find another participant, I attended yet another engineering event. This event was held on a college campus. Its mission was also professional networking. I did not meet success this time in searching for an engineer for my study. I was truly an outsider at this event, with no one I knew in the room. I did not know how to introduce myself to an engineer, and ask for her participation. I felt it would have been difficult and awkward at best, notwithstanding the possibility of interrupting the true reason the engineers were there. Finding participants were paramount to my research. However, it was also of utmost importance to first and foremost be respectful of the purpose of any event, and the time that engineers committed as well as their purpose for attending. If timing and situations were appropriate, then it became possible to start conversations with prospective participants. But this particular occasion did not warrant such an opportunity. So I left the event without finding an eighth participant.

As I continued my journey, a colleague who knew of my research recommended a prospective participant named Jamie for my study. So I emailed Jamie to request an interview with her as participant number eight for my research. In addition to this lead, I recalled another engineer whom I had met through the Society of Women Engineers. I

planned to contact her after Thanksgiving to ask if she would also be a participant. In the meantime, Jamie replied to my email request, and confirmed her interest in participating.

Finding participants was becoming challenging. I had two prospects that I was contacting, and running out of time to secure their participation and complete all interviews before the holidays. While waiting for return calls and the scheduled telephone interview of Marie, I decided to utilize my time by researching how to analyze data.

Interview of Marie, Participant Number Seven

A snowstorm in the Midwest caused postponement of the scheduled telephone interview with Marie, participant number seven. The storm lasted for days, resulting in two more postponements of the interview. Finally, after three postponements, the interview with Marie was successfully completed. Marie's interview proved well worth the wait, as she delivered another compelling story for my study. Interviewing Marie was such a unique opportunity. She is the kind of engineer with very well rounded experience and wisdom beyond compare.

Interview of Jamie, Participant Number Eight

To my fortune, participant number eight, Jamie lived close to me. So we agreed to interview her at my home on a December Saturday morning. What a fascinating engineer! Jamie obviously had natural technical talent with a combination of education and teaching skills.

With Christmas right around the corner, I decided to postpone the interview with Pat, participant number nine until after the holidays. In the meantime, I continued to transcribe more interview tapes. Once again, I burned out the motor of a tape recorder. The end of tape recorder number two resulted in a need to buy yet another.

Using tape recorder number three, I transcribed the telephone interview of Marie. During the transcription, it became evident that due to electrical interference between the phone and the tape recorder, the tap- recorded interview of Marie did not successfully record in its entirety. Some of the recording was either muted or masked by a buzzing sound, so I was therefore unable to transcribe the entire interview. The winter season had turned out to have an unforeseeable effect on my research, by requiring a need for telephone instead of in-person interviews. Although it was my preference to do so, I was not able to reasonably schedule a day drive to Marie's residence in order to repeat portions of the interview. Fortunately, I found that the vast majority of her interview had been successfully recorded, and the data I was primarily seeking was retrieved. I believed that some of the details were lost but did not affect the outcome of the data I was seeking. To be certain, I decided to send the transcript to the participant and ask her to complete any sentences that were missed. This was another instance of member checking, to ensure that my transcripts were complete and accurate.

During the continuation of transcribing taped interviews, I began to realize how our career lives interact, affect, and are affected by our other life experiences, our personalities, our self-discoveries, our family lives, and the lives of the people around us. I became ever more impressed and amazed by the women engineers of this study. Each of them brought unique data. From comments of being "authentic selves," to "giving themselves permission to succeed" and more, they shared such tenacity, confidence and hope for the study.

Many common themes were found. Within the themes were examples of how the women learned to be engineers, how they seemed to know when to lead, and when to

follow, when to be assertive, and when to be open to listening to the voices of others. Several of the women discussed the challenge of needing their voices heard. Perhaps valuing the importance of their own voices yielded to their empathy and willingness to listen to the voices of others, such as technicians, or customers who use their products. Related to that topic, they knew the true meaning of teamwork in learning situations. They also knew how to set egos aside for the greater good of the team, or the work at hand en route to a successful end product.

After interviewing eight participants, I noticed the data was becoming saturated, meaning that similar responses were being stated among the participants, and themes had already emerged. After consulting my methodologist, it was agreed that ten participants would not be needed as initially planned, but rather nine participants would suffice. For this reason, I contacted my ninth and final participant.

Interview of Pat, Participant Number Nine

December 2010 through January 2011 was very snowy in the Midwest, causing school closings and resulting in several postponed in-person appointments for Pat and me, participant number nine. After numerous emails and several failed attempts to meet in-person, we conceded to scheduling a telephone appointment. Like all the other participants, it was also well worth the effort to schedule (and reschedule) Pat's interview. Her story was very interesting and her contributions were invaluable.

I feel extremely honored that the women of this study have allowed me to tell their stories. I greatly admire their achievements, and how they have worked through their challenges and successes. In writing this dissertation, I hope I have paid homage to how special, strong, persistent and talented are the women engineers of this study. I hope

this dissertation gives them the respect they deserve. It is not my intention to slight male engineers and all of their achievements. Rather, it is my intention to acknowledge women engineers as vital contributors to the engineering workforce, and by doing so, provide information that may facilitate the recruitment and retention of more women to the engineering profession. The following chapter, Chapter Five, Findings and Analysis, will examine the findings and analysis of this study.

Chapter Five

Findings and Analysis

The purpose of this study is to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. This research addresses the problem that there is little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. A qualitative research approach was used for this study to investigate the human experience of women engineers. Through transcendental phenomenological methodology, insight was provided into not only the experiences of women engineers, but the understanding of the meaningful connections they have found through their experiences. The primary theoretical framework applied to this study was poststructuralist/postmodern feminism (Creswell, 2007), to give voice to the women engineers of this study as they work in the male hegemonic engineering climate. The secondary theoretical framework used in this study was social cognitive career theory (Lent & Brown, 2008) to explore the relationship between the women engineers' self-efficacy and their career decisions and experiences.

The role of intentionality is significant to the method of phenomenology. Intentionality refers to the meaning that an individual constructs of a situation or

experience based on his or her view of the world. In other words, the intention is an interpretation of a person's point of view as he or she relates to him or herself in the engagement of a situation. According to Pollio, Henley and Thompson (1997), "We learn and relearn who we are on the basis of our encounters with objects, ideas, and people—in short, with every different kind of 'otherness'…What we are aware of in a situation reveals something important about who we are"(p. 8).

The reports of the experiences of the women engineers of this study reflect their intentionality, in other words, their perceptions and subjective truths of the situations. It should be noted that in this study, none of the women reported blatant discriminatory experiences or comments by any employees. No one reported being denied promotions, or overt comments or allegations of being incompetent based on their gender, age, or race. Without such direct statements or experiences, this research only describes perceptions of the women engineers' intentionality within situations discussed.

In the workplace of the women engineers, certain perceptions are based on their subjective truths, meaning their experiences were subject to their interpretation. Storytelling is a way to bring perceptions to light, so that they may be considered by all parties as to how certain actions or words may be received or interpreted.

Research Questions

The central question that related to the purpose of the study is, "What are the experiences of women engineers, and what contexts or situations have shaped their experiences as women engineers?" The following sub questions were designed to understand the context of the experiences, search for themes, and capture the essence of what the experiences mean to the participants.

1. Regarding issues and barriers:
    a. What issues and barriers did/do women engineers in this study encounter in the engineering workforce?
    b. How do/did these issues and barriers shape their career decisions?
    c. How do/did these issues and barriers shape how women learn to be engineers?
2. Regarding successes and/or supports:
    a. What successes and supports did/do women engineers in this study encounter in the engineering workforce?
    b. How do/did these successes and supports shape their career decisions?
    c. How do/did these successes and supports shape how women learn to be engineers?
3. What is the overarching essence or meaning of the experiences of being women engineers?

The questions derived for the interviews of participants were open-ended and intended to address the research questions.

Coding Themes

In accordance with the methodology discussed in chapter three regarding transcendental phenomenological qualitative research, I entered the interviewing process of the participants mindful of the notion of bracketing. As discussed in chapter three, bracketing is the researcher's means of understanding that she is to place no judgment from her own experiences on the stories told by the participants, but rather to describe the participants' experiences as intended by their subjective truths (Moustakis, 1994). As

previously mentioned, I interviewed each participant individually and privately to protect their anonymity. Prior to the interview of each participant, I read them the Informed Consent Form. Each participant agreed to the terms by signing their copy and my copy to retain in my records. I proceeded to record the interviews as I also took written notes. Taking notes enabled me to write their responses as I heard them. The notes later provided me a medium of comparison against the transcriptions and my identification of themes. Sometimes my notes provided me clarification of a point that was made, while other times revisiting my notes served as reminders of information or details that were discussed.

The transcription of interviews followed. During the process, I played back portions of their stories repeatedly, in order to type their responses word-for-word. This action enabled me to hear their stories more than once, which facilitated my understanding of the meanings that were conveyed through the words, pitches, and tones of their voices. As emphasis would be placed on certain statements by participants, I was able to capture the significance and meaning of their experiences. Responses to certain questions became same, similar, or opposing among the interviews, which gave credence to themes that I noticed were emerging. As I recognized themes, I added them to my journaling. This process is known as transcendental phenomenological reduction (Moustakis, 1994).

Once interviews were transcribed, I re-read the data, searching for consistencies and making sure not to miss relevant data. I then color-coded responses that were formulating themes. Part of the process I used to code themes was to cut and paste responses from participants per question. In other words, I placed all answers to interview

question one in a separate document, and repeated this process for each question. This process provided me general knowledge of how each interview question was answered. As a result, five major themes thus emerged, and sub-themes were identified that fit within the five major themes. The color-coding also enabled me to weed out information that did not fit within any of the themes. Using the documents that represented responses for each interview question, I was able to cut and paste certain responses under the five themes in order to place relevant data below each theme. Through the process known as horizontalization (Merriam & Associates, 2002), I narrowed down and clustered quotes and themes based on the meanings from the participants' responses.

The data within each theme yielded textual descriptions that showed what actually was being studied in this research regarding the women engineers. From this information, I was able to glean structural descriptions that placed the context and situations into account (Merriam and Associates, 2002), such as the contextual situated learning experiences of women engineers. Finally the composite description of the essence of the experiences of being a woman engineer resulted from the analysis of the themes derived from the participants' stories (Creswell, 2007; Ary, Jacobs, and Sorensen, 2010).

The following is the analysis of the data gathered from the nine women engineer participants, and the five themes of the study.

Theme One: Gender Roles and Social Cultural Influences Regarding Women's Career Decisions and Opportunities

According to the literature review, numerous studies were found that recognized how gender influences within family and society, particularly influences of parents and educators, affect women's career decisions in both conventional and non-conventional

career areas (Ware & Lee, 1988; McIlwee & Robinson, 1992; Mau & Domnick, 1995; Mattis, 2007). The findings of the studies from the literature review were in agreement with the findings of the data analysis of my study, whereas parents' and educators' influences did affect participants' engineering career decisions. For example, researchers found that women who selected engineering careers were supported by parents (more often a father who is an engineer), teachers, counselors, or boyfriends (McIlwee & Robinson, 1992; Mau & Domnick, 1995; Mattis, 2007). The similar study also found that women in gender-neutral careers, such as business, law, or medicine were more influenced by their fathers, and made career decisions later in their career paths in comparison to women in female dominated occupations, such as teaching, secretarial, and paralegal fields (Whitmarsh, Brown, Cooper, Hawkins-Rodgers, & Wentworth, 2007). Results of this study of women engineers supported the past research and found that mothers provided the participants with positive reinforcement regarding their interest in pursuing challenging careers, which in effect was encouragement for them to pursue engineering. Male family members who were engineers were also supportive. It is important to understand how education, family, and environment influenced the engineering career planning of the women in this study. These influences became one of the themes that emerged.

Influence of Parents

Like the research findings of McIlwee & Robinson (1992), Mau & Domnick (1995), and Mattis (2007), the data gathered from the interviews of the women engineers of this study revealed that their parents, teachers, counselors, and friends were influential and supportive of their college and career choices. Although none of the mothers of the

women engineers of this study specifically advised their daughters to pursue engineering, they strongly encouraged their daughters to earn college degrees to enable them to pursue professional careers. But unlike the findings of Whitmarsh, et.al (2007), the mothers did not persuade their daughters to pursue conventionally female chosen careers, such as teaching, nursing, or secretarial. Instead, like the findings of McIlwee and Robinson (1992), the participants of this study who discussed their mothers reported their mothers to be encouraging of them to pursue their own interests. In the case of the women of this study, their interests lie in engineering careers.

Debra, who worked as an engineer for seventeen years between the 1980's to the early 2000's, recalled the positive influence of her mother's encouragement to pursue her dreams:

> My mother firmly believed that her children…could do anything we wanted to do as long as we put our minds to it. She was insistent that we all obtained college degrees. I think she was also concerned or interested in influencing us to pursue degrees that would allow us to be self-sufficient.

Having support from her mother was very important to Debra. She described what her mother's encouragement meant to her decision to become an engineer. Debra stated,

> It certainly influenced my decision. Having my mother repeatedly, daily, telling me that I could do anything I wanted to do was very influential. It was like being given permission…do what you want to do, and you will do it well.

Although Terra's mother did not specify engineering as a career option, she recalled during her high school years her mother always saying, "You need to challenge yourself." Therefore Terra, who was currently in her third year as an engineer in the

2000's, sought engineering because she believed it would offer a great challenge, such as her mother advised.

Natalie, who was in her twelfth year as an engineer in the 2000's, remembered the similar advice she received from both her mother and father, where she was encouraged to be inquisitive when she informed them of her interest in learning about engineering as a career area.

> My parents were very supportive… Where I should go in that area [of engineering] they really couldn't advise me. But they taught me always to kind of seek it out… It was just one of those things to keep seeking out your interest in engineering. And you know, seek out answers…

In addition to parental support, some of the women engineers mentioned other family members—both male and female—who were supportive and positively influential in their engineer career choices. Brothers, sisters, and other family members greatly influenced the women in this study regarding their career choices.

Influence of Family Members on Engineering Career Planning

Debra's older brother had a direct positive influence on her career decision because of his own decision to become an electrical engineer.

> I remember he was so interested in...engineering at the time, that he used to build things. And he would call me in if something wasn't working and ask *me.* He didn't necessarily expect me to understand, but because he used to *do that*, I learned a great deal. So I think my interest in the specialty is because I was familiar with it from my brother.

Meghan, an engineer for three years in the 2000's, reflected on the time she informed her family of her interest in engineering. "My family was very supportive… One of my grandparents [her father's father] was an engineer."

Debra and Meghan's reflections are in direct agreement with the research of McIlwee and Robinson (1992) who contend that many women engineers are influenced by the male engineers in their families in making their engineering career decisions. It is important to add that Debra also mentioned support from her mother as well which reinforced her decision to become an engineer.

Similarly, Jamie, who was a current engineer in her fourth year in the 2000's, found encouragement to become an engineer not from male role models, but from the advice of females in her life. She stated, "I chose [engineering] because my guidance counselor said I have really strong analytical skills, and very strong grades in science and math." In agreement with her guidance counselor's advice, was the advice of her eighth grade teacher, Miss Jones, and Jamie's aunt. Jamie laughed as she recalled the evening when Miss Jones spoke to her aunt during a parent/teacher conference about Jamie's academic potential. "She's really smart…You should put her in this [University pre-college summer] engineering program," Jamie's counselor advised her aunt, according to Jamie's recollection. Jamie had hoped to work during summers, but her aunt was insistent that she spend her high school summers applying her academic skills toward learning about engineering. She was confident that Jamie would benefit better by spending her time in a pre-college STEM program. Jamie attended the engineering pre-college program every summer of her high school years, and as a result, continued her pursuit toward engineering throughout her college career. The support of her eighth grade

teacher and aunt meant a lot to her, as she still credited them for beginning her path to engineering. In fact, her family as a whole was very supportive of her career decision. She remembered them saying, "Hey go for it! Whatever makes you happy."

I asked Jamie what it meant to her to have so much family support. To this, Jamie reflected,

> I always looked to them for advice, even though the decision was ultimately mine… Just to get their buy-in and then go from there. So their opinions weighed heavily, even now, on the decisions that I make.

Research of McIlwee and Robinson (1992) found that some fathers who were engineers had positive influence over women engineers' career decision. However some fathers who were not engineers, such as the fathers of two engineers of this study, Marie and Pat, were more cautious of their daughters entering a male dominated profession. In this case, Marie and Pat reported their mothers as supportive, but their fathers as more concerned about their daughters' choices of engineering careers, because they believed engineering was more suited for men. Like Jamie's aunt, Marie's mother made sure that Marie, a current engineer of nine years in the 2000's, was able to participate in Saturday and summer pre-college science, technology, engineering, and mathematics (STEM) Programs and events during her high school years. But her father was concerned about her interest in STEM. "My dad wasn't crazy about it. Just because my father…was born in the '30's...—the time where women did not have that place…—My mother was very supportive. It meant a lot to me that she was very supportive."

Pat was a current engineer with five years of experience in the 2000's. Her comments regarding her parents' attitudes regarding her choice to become an engineer

were similar to Marie's. She thought her father was somewhat concerned but said, "My mom…would have been supportive no matter what I decided to do…"

The findings of this study revealed that the participants with employment histories ranging from the 1980's to the 2000's received similar levels of parental and family support regarding their career decisions in engineering. This analysis showed that there has been consistency in women gaining support from their mothers to pursue their dreams (in this respect, engineering), and support from male engineers in the family to become engineers. Some of the participants also mentioned that fathers expressed concern regarding their pursuit of engineering careers, believing the profession to be more suitable for men.

Influences of Teachers and Professors

In addition to parents' influence on engineering career pursuits, are the influences of teachers. Marie acknowledged that she gained inspiration from a particular college professor who conducted the pre-college summer program for which she attended.

> He made [the high school students] defend their projects [like] Ph.D. students…That put my confidence and my competence [high] to be able to talk in any circle…And he prepared us for where we were going. ..So we had the discipline [to be good students] as we got older.

Both Sherry and Debra recalled male professors during their college years in the 1980's, who seemed to have challenged them more than their male peers in the engineering classrooms. Sherry contended,

> I remember being picked on more in the class...I remember the teacher calling on me and before I could even answer, he'd say to all the guys around me, 'Let *her*

answer this, don't help her.' And I remember saying to him, 'I don't *need* their help.'

Debra had a similar experience with a college professor for which she appreciated because she believed he prepared her for the real world of working in the engineering environment. She reflected,

> …there was actually a professor…he was pretty well known in the engineering program. He was pretty hard…And interestingly enough, he was very hard on me in class. But, it was because he wanted me to defend myself and be confident…Of all of my engineering professors, he was probably the one that sticks out the most in my mind as pushing me to be a good engineer and to be confident.

Clarifying what her experience with this professor meant to her, Debra replied,

> I'm grateful. I mean at the time it was horrible. You know, I was…the only girl in the class. And every day he would…have me come to the board and solve problems, and once I solved one he'd have me do another. And after a while, you don't worry about being embarrassed…I got really good thinking on my feet…He really built my confidence. He made me think and defend myself. And I have a tremendous admiration and gratitude for him.

Obviously, Debra's perception and reflection of this experience were positive. She perceived her professor as challenging when he called on her often in class and credited the learning situation as a confidence builder. Sherry and Debra had the experience of being called on often in class to report information. The notion of being called to answer questions in class gave voice to these female engineering students. Hayes and Flannery (2002) discussed this method of using voice to report information as

the way in which males learn. Their research contended that women learn by using their voices in conversation to make connection between the subject and real life. The experiences of Sherry and Debra in the classroom exemplified how women can also be able and may actually prefer to learn by using their voices to report information as well as the male students. These findings do not negate the notion of women's learning style, whereby women learn by using their voices in conversation, but rather shows versatility in how women can learn, in certain context-based situations. In the situated learning environment of an engineering classroom, Sherry and Debra assimilated with the predominantly male community of learners in the classroom, and hence utilized the male-identified style of learning, i.e. reporting information, the same as their male peers. These findings may be found useful to educators who strive to understand how women learn to be engineers.

Sherry, who was an engineer for ten years between the 1980's and 1990's, also shared a different experience in college in the 1980's, with a female engineering professor who taught mechanical drawing. In this situation, Sherry recalled how she noticed a difference between herself and her male peers' level of preparation, particularly in how the males in her class had previous mechanical drawing experience from having taken related courses in junior and high school—course experience that she felt was not encouraged for high school girls like herself.

> This is the same kind of class again, that girls didn't take…in junior high and high school. They [the males] breezed right through it. It was…visualizing in 3-D, and drawing it. And it just took me way longer…I was still new at it. So I remember this teacher working with me…And I do remember when I was graduating…[the

female mechanical engineering instructor]…giving me a hug…It was almost like…she probably thought I was one of those who wouldn't continue.

Although the professors of Marie, Sherry, and Debra were demanding, these women showed perseverance in their learning situations, which developed their positive self-efficacy and motivation to succeed. The concept that self-efficacy influences decision making is supported by the research of Bandura (1977, 1993, 1994) and Dweck (1999). In this case, Marie, Sherry and Debra developed their self-efficacy through their academic achievements from pre-college to college, which in turn maintained their direction toward engineering careers. Proving their strengths in their classroom learning situations may have also cultivated their leadership abilities in engineering and related fields.

Influence of College Advisors

Educational influences on women's engineering decisions occur not only in the classroom but with college academic advisors as well. Sherry recalled that she was initially aiming toward majoring in accounting, when her college advisor said, "You get really good grades in math and science. Have you ever thought of going into engineering?... And I said, 'Well, what do they do?' And he told me…I said, 'Okay.' And so that started me on my path to engineering."

Once deciding to major in engineering, women engineers need continued support from advisors throughout their college years. Strong academic advising is essential in engineering colleges, in order to aid in the retention of women in pursuit of engineering degrees. For example, Natalie stated that her college academic advisor helped to "create an environment of support" which provided her encouragement during challenging

moments. After receiving academic advice on college success strategies, such as seeking tutoring or joining study groups, Natalie recalled being able to reinforce her commitment to becoming an engineer by saying to herself, "Okay, I can do this."

Influence of Peers

An important influential group of women engineers' career decisions are their peers. As mentioned, some of the participants stated that although their parents and family did not know what engineers do, and therefore could not offer specific support of their engineering-related career decisions, their families were supportive in general terms of encouraging the women to be high scholastic achievers in order to earn college degrees and pursue successful careers. In such situations, participants of this study such as Sherry and Erica were more influenced by teachers, advisors, and peers, rather than family members, to pursue their engineering careers.

In regard to their social cultural supports and successes, participants of the study, including Natalie, Sherry and Erica discussed their influences of peer support during their college years, which not only enhanced their academic performance and motivation, but also prepared them for their engineering careers. During their college years, the women engineers received support from both their male and female peers. A recurring comment of the women engineers was that they felt well supported by their male peers during design competitions as well as in study groups. Such support is very important, as it provided a meaningful connection to their course subjects through hands-on design. Perhaps equally as important in terms of retention is the meaning of acceptance by their predominantly male team members or peer group.

Debra discussed how she felt no difference in gender relations with her study

group members neither inside nor outside of the classroom. In fact, during our interview, she clarified her viewpoint and self-concept, not as a "woman engineer" as my questions distinguished her, but rather she identified herself simply as an "engineer." She provided me an example of how she felt so comfortable with her male peers in the classroom, to the point that she shared her comfort level with the instructor as well, in order to put him at ease with her presence. She asked her instructor to address her in the same manner as her male peers.

> I would say that the successes that I've had…again, it's hard to describe it as a *woman*. I just see myself as an engineer. I'm one of the guys! I remember...one of the faculty wanted to be very politically correct [by] saying, 'Okay, now gentlemen.' And then say, no wait, '*Lady* and gentlemen.' And I would laugh and…afterwards…say[to the professor], 'You…don't have to…distinguish. I'm just one of the guys here!'

Although engineering is male dominated, it should be noted that there are also very strong and competent female engineering students that not only succeed, but also serve as positive role models for other engineering students. Heading toward a major in nursing, Erica, who was an engineer for six years between the 1980's and 1990's, came to a cross-road in college when she met a female upper-class level student in engineering who not only recruited Erica, but other students as well into the field of engineering. Erica recalled how this student "became the student recruiter for engineering…And she often would talk to us about...her understanding of the benefits of majoring in engineering… And she managed to recruit quite a number of us."

Similarly, Debra reflected that "So many of my classmates in high school were

pursuing engineering…and their parents and families were very supportive of their career choices. [So] there was never a question of, 'Should I do this?' It's do what you want to do."

Sherry, Marie, and Erica also recalled the tremendous support they received from their engineering student organizations, which provided them a feeling of acceptance and competitive challenge. The peer support described by the women engineers of this study contributes to the understanding of how women learn to be engineers. The understanding of how females assimilate with their male peers and feel not only acceptance but acknowledgement for their contributions plays a significant role in college retention of female engineering students. In addition, such peer support from both males and females during their college years prepared the women engineers for the male-dominated engineering workforce. Having years of coursework in classroom learning situations where they were one of few females, the women engineers of this study became accustomed to being in the minority group. However, the women engineers acknowledged their need for social and professional engagement with more women engineers for female support in and about the workplace. For this reason, Pat and many other women engineers sought peer support outside of their immediate work environment through her affiliation with the Society of Women Engineers (SWE).

Influence of Community

When Erica met her newfound friend in college who persuaded her to consider majoring in engineering, she was very impressed with what she learned about the successful rewards of being an engineer. The concept of how engineers serve communities established a meaningful connection to engineering for her. Looking back

on how and why she entered college, Erica talked about the meaning of the support she received from not only her family, but also her church and community at large. Erica was a young girl who showed promise of having a great future. Therefore, her community held high expectations for her, and she could see what her success meant to them.

> I was the child and product of a community…their feelings and opinions meant everything to me because after I went to college... I felt a great sense of responsibility. It wasn't as if I was embarking on this experience because it was something that I wanted to do. For me...it was something I *had* to do…And I think they played an important role in helping me to understand the importance of being in college, and it also gave me the strength to persevere…I felt that there were some people that were relying on me to be successful. So I never spent any time thinking about what I could *not* do. I was always focused on trying to do everything I *could* do so that I could graduate.

Success to Erica meant more than earning her degree for herself, but her opportunity to give back to her community. It meant allowing her family, neighbors, and church members to see the result of their efforts in raising an upstanding young lady, whom through their support, soon after became an engineer. Erica was then able to reciprocate their support through sharing her talents for the benefit of others.

In summary of this sub theme, overall the women engineers of this study received support from their parents, family, friends, teachers, advisors, and/or community regarding their decisions to pursue engineering careers. Combined with their outside support, women engineers of this study also showed inner strength and perseverance, particularly as they faced classroom challenges. For example, one of the women reported

not having engineering-related high school courses (in which the males seemed encouraged to enroll), such as graphics, which posed a greater challenge in her college experience. A lack of pre-college engineering skill building could attribute to the disparity of engineering college women. For this reason, the support and encouragement they received in high school and college years was found to be valuable in retaining the women's interest in pursuing engineering. Furthermore their ability to overcome their classroom challenges enabled them to be equally as tenacious in meeting the expectations they encountered in the engineering career world.

Association between Engineering Career Choice and Pre-College STEM Programs

The women engineers in this study learned about engineering and/or became motivated to pursue the field through the many influences of family members, teachers, advisors, and/or peers. Another influence that was revealed in this study initiated from extracurricular participation in pre-college science, technology, engineering, and mathematics (STEM) programs. As mentioned, participants Marie and Jamie participated in pre-college STEM programs that boosted their motivation to pursue engineering. STEM programs for high school students target youth who are interested and skilled in mathematics and science in order to motivate them to continue their interest in these areas. The STEM programs not only introduced them to technical fields, but provided peer support, mentoring and college preparatory guidance. Moreover, high school students in STEM programs often receive summer internships at companies as an opportunity to pre-test their career choice. Marie discussed the added value she received from her participation in a STEM program.

> There are so many summer programs now for high school students, and…through the [college] degree program. I…really encourage students [to join a STEM Program]…because you have students… who have been in…programs in high school [and therefore] exposed to engineering [before and during college]… I did that. And I got a competitive edge [as a result].

Association between Engineering Career Choice and Sports Participation

In addition to STEM Program participation, playing sports is another extracurricular activity that involves competition and teamwork. Engineering known as a male-dominated and competitive career, calls for positive self-efficacy, teamwork, and other characteristics that are also associated with sports participation. For this reason, one of the questions I asked the participants was whether they participated in sports during their lives and if they thought sports participation benefited the way they learned to be engineers or their experiences as engineers.

Meghan, who played competitive volleyball in high school, found an association between sports and engineering. She stated, "I played competitive volleyball. [In comparison to engineering] there's always competitiveness between you and your business competitors and companies."

Terra, who participated in competitive sports in college, responded in agreement regarding how sports participation prepares one for the competitive environment of engineering. She said, "Being comfortable with competitiveness is necessary. Because when we're bidding on [engineering] jobs…that's…a high stress, competitive atmosphere…And… there are people who [are] not used to that competitive environment. So they don't know how to handle it."

Erica, who played basketball in high school, also found an association between the teamwork ethic of sports and engineering. "…I was able to acquire the experiences that I gained from winning and being involved in sports in terms of commitment, team work, competitiveness, experiences of what it feels like to win, as well as what it feels like to lose."

Natalie played high school basketball and track, and added the value of playing sports in terms of learning multitasking and assertiveness. "It was just one of those things where, you know, being able to manage school, sports, and your homework. And… you are assertive, and doing what you need to do in order to be successful. Multitasking I think, definitely helped with that."

Those who had participated in sports unanimously agreed that sports played a positive role in preparing them for engineering careers. They valued their sports experience that prepared them for the competitive nature of the engineering environment, as well as leadership skills, and team playing abilities. Erica's comment on learning how to win and lose in sports is an experience that bears merit as a basic life lesson, both in and out of the workplace. Conversely, participants of this study who had no experience in competitive sports did not necessarily find an association between sports and engineering in their case.

Debra said, "I really was never involved in competitive sports. I was just never competitive in nature." Jamie and Pat's responses were quite the same. Their responses implied that it is not necessary to feel competitive in order to be successful in engineering, although like most businesses, engineering has competitive facets.

The perceptions of being competitive versus non-competitive as women engineers

align with the theory of Powell et al. They contended that the gender construct can be situational, whereas women engineers learn when to apply their tactics that may be characterized as male (such as assertiveness, competitiveness), and when to apply their effeminate characteristics (such as giving and receiving help, teamwork, and mutual empowerment). Knowing when to apply their various characteristics is an effective strategy for women to hone in effort to establish assimilation in the male hegemonic engineering workforce.

In summary, the analysis of theme one found that social cultural influences ranging from family, teachers, advisors, and communities served to provide support of pursuing engineering careers for the participants of this study. In addition, extracurricular activities, such as pre-college summer programs in science, technology, engineering and mathematics, proved to be beneficial for early exposure to engineering careers. College programs involving cooperative education and internships were found to provide early exposure to engineering careers. Sports activity was found by some participants to provide them a competitive edge that they believed benefited their character and prepared them for the competitive engineering work environment. The social cultural influences discussed by the participants described context-based learning. Context-based situated learning may occur in a classroom, on a competitive sports field, or in a work environment, as discussed in theme number two.

Theme Two: Context-based Situated Learning

Context-based situated learning involves social interaction within a community of learners. Engineering classrooms and technical labs are venues for context-based situated learning experience. By and large, the participants of this study voiced their interest in

mathematics, science, and hands-on learning as attributes that influenced their interest in engineering. These attributes formed their basis for entering engineering context-learning situations in college, and later in the workplace. I was interested in learning how the participants of this study learned to become engineers through their context-learning situations. In this regard, Erica provided a detailed recollection of her college years. She recalled how much after changing her major from nursing she enjoyed her newfound interest of engineering and developing her technical laboratory skills. She discovered that she was fascinated with the hands-on aspect of operating engineering equipment, such as a lathe and a drilling machine, and writing computer programs. Erica very enthusiastically described her early experience of engineering design.

> …We would get our piece of fiberglass that we would have to write a program for and work on inscribing our initials in this piece of fiberglass…the thought of learning and build (sic) on the engineering concepts, and then having an opportunity to use the equipment to see how you could produce and make something was really intriguing to me. And it kept me occupied, so I enjoyed it.

Erica's description of how she learned by applying theory to a concept is an example of what Hayes and Flannery (2002) describe as connected knowledge. In other words, Erica was able to find a meaningful connection to learning the technical skills in the laboratory to real life concepts. She continued her story with a description of a situated learning experience in her workplace after college.

> …we were looking at ways in which we could cut down on the amount of time it took one station to deliver the finished product to the next station. And we were using some of our skills we had learned in class in terms of … time motion

studies [and]…plant layout. .. So, we did a cost-by-cost account of reconstructing one of the stations. To conclude the project, we wrote a proposal requesting the cost of funds, to break down the cost to reconstruct the move the station closer to station number one. And then we looked at the amount of savings over a period of time. And that project was funded.

Erica continued to explain what the situated learning experience meant to her, with emphasis on teamwork and the dynamics between male and female engineers.

…what I gained from that project is learning how to rely on your colleagues and cohorts. Learning how to work together as a team. Because sometimes as an engineer you can get caught up into this mindset where you've spent so much time developing your… analytical skills, your problem-solving skills...You have to take the time to train your mind to be receptive towards others' ideas.

By finding her own voice and listening to the voice of others, Erica stressed the importance of communication and how she worked beyond gender in order to establish mutual respect between herself and her colleagues.

Internally you are making connections…And then it's learn (sic) how to work with that other person. And usually this other person is a male, so it's like, okay, how do you get to that point where you realize okay maybe this individual is not challenging whether or not you have the right approach. How to separate that male gender role from…interfering from…working together and getting the job done? Maybe this is just how to talk to women… how do you get beyond that so that you two can begin to talk to each other, respect each other, and work together?

From a different standpoint, Debra described the meaning of a situated learning experience she recalled in terms of valuing diversity in the education and professional backgrounds of colleagues. As an engineer working in a medical instrumentation environment, Debra experienced the difference of how engineers and chemists learn and work.

> Engineers are very much about…knowing the laws of nature and applying them, and about developing solutions, where scientists are more about discovery and discovering relationships. And so it was a little bit frustrating at first working with people who…didn't really approach problems from the same perspective that the engineers did. But interestingly enough, somehow, once we all realized from each other how we approached things…it was *very* easy to work together.

At the onset, Debra was unsure the professionally diverse group would work together. But through focusing on their portions of the project, they were able to embrace their diverse perspectives to complete the instrumentation project. Debra explained to me what the experience meant to her.

> People talk about valuing diversity, and you usually think of diversity in kind of standard terms. *Cultural diversity*. But in this case it was really more about *educational diversity.* In the sense of their training and my training were very different. And what seemed to be a barrier to working together really turned out to be a benefit and an advantage.

Another viewpoint was shared by Sherry when she recollected her college experience of designing a concrete canoe with her civil engineering peers. Her story was an example of how women learn engineering through context-based situated learning

with a competitive edge. "… Competitive sports for me was the concrete canoeing, and it was part of the engineering program…We built our canoes...it really was fun. We went to different schools and we raced." Sherry's experience of working with her college peers to design a canoe made of concrete, and compete with other engineering student teams provided her real world experience, which is an example of what Hansman described as context-based learning (2001).

From a feminist postmodern perspective (Fletcher, 2001), it appeared that the participants in this study navigated their male/female work relationships from both competitive as well as mutual empowering tactics. Sherry enjoyed the competitive edge of concrete canoe design and racing. Her perspective of the project drew from her sense of belonging in the situated learning context, whereas her gender was not an issue, but rather she felt a sense of being a visible team member with her male and female peers. Setting gender aside, she was mutually empowered and able to enjoy the experience of the concrete canoe competition.

Erica and Debra established their visibility in the situated learning context, by mutual empowerment as well. In the case of Erica, she worked through the process of developing positive communication with her male peers. Creating positive communication gives voice to all members, thereby establishing mutual respect, hence mutual empowerment. Empowerment gives each member presence and visibility, and acknowledgment of their contributions to the team (Fletcher, 2001).

Debra acknowledged the diversity of interdisciplinary professions and talents that created a team of experts to establish a goal. Her ability to focus on the work at hand enabled Debra to override gender perceptions and find the common denominator of the

purpose of team, which was the project at hand. By doing so, Debra felt visible, assimilated, and mutually empowered. The level of feeling acceptance and valued in a learning situation affects women engineers' senses of self in the workplace as further discussed in the next section.

Situated Learning and Perception of Self

Women engineers experience situated learning in various ways when working on team projects with their fellow engineers. The participants of this study emphasized that the essence of their experience of teamwork meant having their presence known, listening to their own voices and being heard, as well as listening to the voices of others. By doing so, mutual respect and empowerment can be gained and cooperation enhanced.

As mentioned, having a voice, being listened to, and getting feedback is a quality that women engineers feel is needed in the workforce in order to make them feel assimilated and validated contributors. To this end, Pat noted, "I think it's important to be heard as well as listen. And I think it gets really critical because… sometimes I notice feelings get hurt. So it's really important to be aware of what's going on. Giving credit where credit is due." Without the art of listening and giving credit to all members of the team, women engineers may feel isolated or devalued, which could lead to the attrition of this significant population in the engineering profession.

Natalie also talked about how listening to others is important, not only among engineers, but between other staff members as well, such as the technicians. Technicians are often assigned the duties of applying the theory of engineering, by putting the equipment or project into implementation. Listening to those who handle this level of responsibility facilitates mutual respect between the engineers and technicians, which

include the laborers and operators. Although the engineers are generally ranked at a higher level than the technicians, they depend on the work of the technicians. Therefore, the relationship between engineers and technicians is critical to the productivity of the working environment. To this end, Natalie explained how she used her personality as a young engineer to earn the respect of technicians in her workplace.

> You have to establish yourself…with folks that are *doing* the work…the operators and the laborers. There's mutual respect there. So you can't come in as a 'know-it-all.' That's not how you gain respect. So you kind of had to learn how to mutually respect each other and move forward…Starting out as a young engineer, I think I learned. And I think a lot of that has to deal with your personality in general.

Seeing herself as one who respected others enabled Natalie to work well with employees at various levels. In addition to showing mutual respect, Natalie also remembered how situated learning called for learning from others and acknowledging when help was needed. She recalled a teamwork situation for which she was involved, whereas within the eight engineers in the room, it was apparent that outside resources were needed to add diverse expertise to gain optimal results. She shared what the experience meant to her professional growth as an engineer.

> It's not sufficient to be status quo…In some cases people would try to put a square peg in a round hole…I think it takes some growth and maturity to realize…we can either continue spinning wheels, or we can go out and get help to move this process forward. I think what's helped me…is to understand that … in anything…you may *not* have all the answers and you shouldn't feel like you need

to make something happen. Look to reach out to get the resources that can help you to make the best decision.

Like Debra who valued the interdisciplinary expertise of a team, Natalie saw herself as one of the many experts at the table. Sharing talents allowed all members to feel a sense of value to the team with the open-minded wisdom to rely on talents outside of their own. This type of group dynamic allows a group to grow and mature as Natalie mentioned, and complete a project beyond the scope of any one individual, but through all participating individuals.

Pat shared related comments on mutual empowerment, acknowledging how group dynamics and communication are involved in trial and error during projects. The process of trial and error is a critical element in science and engineering, where experimentation is common practice. "…I've seen and been in situations [where] you need to learn from your mistakes as well…If something goes wrong, make sure to correct it… as well as communicate openly with others. So, there's always a group dynamic involved."

Similarly, in order to work together and foster effective group dynamics, group members must set their egos aside to focus on the project and the common good. In this regard, Meghan stated, "…it's very important to give each team member a role in the brainstorming, or a role in the actual work… to put the ego away (laugh). To [understand] that nothing can be perfect, but at least try and get close to it." In this situation, Meghan valued the relationship of co-workers, by emphasizing how setting egos aside enabled an even playing field for all members in the group to feel validated in brainstorming and learning situations.

Terra agreed that engineers can sometimes be very assertive, but could also benefit from a strong leader when they seem to all want to be heard at once.

> …We go through them [learning situations] all the time because we work on…facilities for customers…They are constantly competing to create a better product, a better widget. So they're always giving us changes. Oh it gets frustrating, actually. Because...engineers are hard to manage...Because we're all engineers and we're all…so stubborn and… think that we're right. So we need strong leadership.

Being a strong leader in a group of strong personalities can be a very challenging feat, especially when trying to gain cooperation and buy-in of one's ideas. The best way to do so according to the participants of this study is through authentic leadership. Authentic transformational leadership is described as the exercise of one's truth and morality in her behaviors as a leader (Price, 2003). In this respect, Marie has climbed her career ladder to reach a promotion to leadership responsibilities. She talked about her leadership skills in learning situations, and how she acquired the leadership opportunity based primarily on her talent. But Marie also expressed her appreciation and gave credence to the importance of having a supportive supervisor who enabled her promotion. Marie believed that she earned her supervisor's trust, as well as the trust of her customers, by being an authentic leader.

> I'm thankful that she [her supervisor] gives me that leeway, and that I spend a lot of time making sure that… I stay on top of current events…and that way always credible…Sometimes…they don't think you're credible. And [so] you have to be

> a person that is of your word… A person needs to be her authentic self, whether it is engineering or not.

Not only does Marie appreciate having a voice and being listened to by her supervisor, but she like the other women engineers of this study emphasized the relevance of listening to the voices of others. In Marie's case, her past and current customers are the voices who have used or currently use the engineering products of the company for which she is employed, and as a result provide critical feedback for quality control.

> …It is really important that I talk to the customer... I talk to engineers and everyday people…about how our products affect them… Subject-matter experts are *everybody*. [They] either use the product, or [they are] making the product. And I find that you [as an engineer] have to be open-minded. It is like I said before, the authenticity of self, where you are so not full of self, that you know you can learn from *anybody*.

Like Marie, Pat also stressed how women engineers benefit for being their authentic selves in learning situations. Her story discussed how some situations are more difficult for young women engineers to be acknowledged. In those situations, she expressed the importance of being one's self, i.e. authentic in order to stand out.

> Sometimes I think…being taken seriously, especially as a young engineer, it's hard to stand out. When you walk into a meeting room, [and] you're the only woman walking in…it's important to remain who you are. And show…what a woman engineer can be. Not everybody's the same…You know, we [women engineers are] all different.

From Pat's perspective, although feeling assimilated is sometimes difficult in a predominantly male climate, authenticity is necessary in order to leverage respect and acknowledgment especially from the male colleagues. In essence, Pat discovered her best way of being acknowledged in the workplace was to rely on her strength to remain true to her own self.

Self-perception affects how one constructs meaning of life and work experiences. In this regard, whether speaking or listening to others, leading or following, learning from successes and mistakes, the phenomenology of the women engineers in this study exemplified how one's perception of self and one's behaviors in situations were based on their world views. Moreover, their stories were congruent with Gilligan's (1982) feminist theory that stressed the importance of women's voices being heard in order to enhance self-identity as well as how they relate to the world around them.

As mentioned in chapter two, there is concern among some researchers and feminists (Fletcher, 2001; Hayes, 2001; Rosser, 2006) regarding the categorization of perceived differences between men and women's needs and behaviors in the workplace. Hayes (2001) cautioned that identifying women as relationship-nurturers may "fuel stereotypes that women are not, or cannot be competitive, autonomous, or self-directed" (p. 37). Such stereotypes can be contradictory to the characteristics of some women who are indeed independent and self-directed in the ways they learn and perform. They rely on listening to their own inner voices and relying on their intrinsic abilities to guide them through. For example, Sherry discussed the concept of nature versus nurture in terms of her self-directed construction of knowledge, self-reliance, and motivation that contributed to her success as a student and engineer.

> I got good grades…totally on my own. Nobody ever pushed me or made me get my grades. It…makes me realize that nature part of people's personality that you have it within you to just do on your own...all of that ability to study and to keep moving forward came from within *me*. You know, I didn't get a lot of support. I felt respected by the guys that were in my classes.

Sherry automatically reiterated her comment of feeling respected by the males in her class immediately after discussing her intrinsic motivation. Her comment exemplified social constructivism and how her self-validation was reflected in her worldview, i.e. her perception of validation by the males in her class. Sherry's sense of self-validation was also evident as she previously discussed her pleasure in competitive racing of canoes with her male teammates. Her competitive nature supported the stance of feminists such as of Hayes (2001) who cautioned that focusing too strongly on stereotypical gender differences could imply that women are less competitive than men. This belief could potentially result in negative perceptions of women in male dominated environments such as the engineering workplace. The negative perceptions could henceforth negatively affect the self-efficacy of women engineers, and thereby result in their attrition in the workplace.

Self-efficacy proved to be at the base of all the participants' stories, and seemed to be an essential ingredient to how the women chose engineering careers. For example, Erica received extrinsic motivation from her family and community which enhanced her positive self-efficacy and intrinsic motivation. Achieving her goal of graduating and becoming an engineer enabled her to reciprocate by becoming a role model in her community. Sherry's comments regarding the ways her intrinsic motivation guided her

toward academic success attested to her positive self-efficacy. Likewise, during Pat's interview, she discussed the importance of supporting oneself. The concept of self-efficacy in situated learning experiences also surfaced when talking to Meghan. Meghan stated: "Confidence is *very* big… I feel the [engineering] education taught me how to learn new things."

Throughout the interviews, it was evident to me that all the women participants benefited from various levels of both intrinsic and extrinsic motivation. The essence of being women engineers showed that whether through situations of feeling isolation or assimilation, self-acceptance and self-acclaim are keys to their personal and professional career successes. Whether fostered through internal values, or external supports, or the combination of both, each participant of the study expressed positive self-efficacy and its relevance in being a visible woman engineer.

Self-efficacy is a pertinent factor that affects career choices, according to the social cognitive career theory (SCCT). Social cognitive career theory "focuses on several cognitive-person variables (e.g., self-efficacy, outcome expectations, and goals), and on how these variables interact with other aspects of the person and his or her environment (e.g., gender, ethnicity, social supports, and barriers) to help shape the course of career development" (Lent, Hackett, & Brown, 2000, p. 36). As positive self-efficacy is theorized to lead to positive outcomes, women engineers in this study used their self-efficacy, i.e. their positive sense of selves, to achieve their goals of becoming engineers, and accept the challenge of working in the male hegemonic climate of the engineering profession.

Theme Three: Gender, Age, and Race at Work

Challenges

Research in the literature review has indicated that women engineers in the workplace experience certain challenges based on the male hegemonic climate of the engineering workforce. Such challenges include isolation (Seymour & Hewitt, 1997), and the negative stereotype assumption that women are technically inferior to men (Rosser, 2006). Some of the participants in this study were in agreement with this research, while others either did not report stories in agreement, or discussed their ways of overcoming challenges and disproving stereotypes.

Feeling of Isolation

Some of the participants of this study experienced assimilation with their male peers in college, but sometimes faced a different experience in the workforce. Some participants mentioned they perceived a noticeable difference in how they were treated in the workplace based on their gender when they first became employed engineers. For instance, Erica discussed the difference she encountered between college and the workplace, where unlike in college, initially she felt isolated by her male colleagues at work. “I always felt that there would be an indifferent treatment by males. They would interact a lot better with the male engineers as opposed to the female engineers,” she recalled.

Jamie’s perception of her work environment was similar to Erica’s as she stated, “My relationship with my [male] co-workers is kind of different. We don’t really have that much in common ...we’re just different.”

Feeling of Assimilation

The feeling of isolation is not all inclusive of women engineers, as not all of the women in this study experienced such feelings from their male colleagues. Sherry, an engineer who worked as an engineer in the 1980's and 1990's, worked with both sexes, although there were more males than females. It was apparent during her interview that she did not feel isolated as she responded, "I did have some females…probably one of my closest friends ended up working there too… We weren't in the same department. We were...nearby…I did like that. [And] the guys I worked with were fine."

In a more recent experience, Terra, who is a current engineer in the 2000's, did not express concern regarding being female in a predominantly male environment. When asked about her relationship with her male colleagues during her interview, Terra, currently employed as engineer at the time of this study, discussed the percentage of male and female engineers in her workplace, but did not remark about any particular perceptions of isolation. "I am about…on any project we've been working on, the only female engineer all the time…I would say we're about 90% male engineers, 10% female engineers."

I noticed through her eye contact and non-verbal cues as she spoke that she seemed to have a sense of ease about the fact that she was the only female engineer in her immediate work environment. To be certain, I asked her specifically, "You kind of just described the relationship of male/female ratios. And is there anything about the relationships that means anything to you?"

Just as her non-verbal cues suggested, Terra shrugged her shoulders, and simply replied, "No, I don't think [so]."

She remained poised and comfortable with her response. I slowed my pace before asking the next question, to see whether she would think of a situation that gave her concern. She did not respond as such, at which time I interpreted her response to mean that she had no perception of isolation, but rather assimilation with her male colleagues at her workplace. As a young Caucasian woman engineer in her twenties, apparently Terra felt comfortable in her male dominated work environment. Her experience either indicated that as a relatively new engineer, she had not acquired enough experience to encounter any gender-related issues, or perhaps from a positive analytic standpoint, the engineering work environment is showing more equity toward women engineers in the 2000's.

Quite similar was the response of Marie, who in fact, welcomed the challenge and saw the advantages of entering the competitive and male-dominated field of engineering. Marie is a young African American woman engineer in her thirties who is currently in the engineering workforce in the 2000's. She recalled the warnings of others regarding her career choice of engineering.

> 'You know that's a male-dominated field.'…[But] I didn't see it that way. I looked at it as an opportunity to bring a different feel in a male-dominated field. And I still work in a very much male dominated field…But you know, it has been very rewarding for me because I'm in a position where I work in a small group. So I've been able to learn a lot.

The findings of this research regarding women's feeling of assimilation in the male dominated engineering environment proved interesting results in terms of timeframe and race. Specifically, in comparing Sherry's and Terra's experiences of comfort in

working with male engineers implied that there were and are some comfortable work environments for women engineers in the 1980's, 1990's, and 2000's. In addition to timeframe, Terra's and Marie's experiences as currently employed young women engineers support the notion that race was not a factor in terms of the fact that they both perceived positive senses of comfort with their male colleagues. These analyses of timeframe and race cannot be generalized to all women engineers due to the nature of the qualitative research method and small number of participants. However, the research did reveal that individual work places and individual situations resulted in different perceptions of experiences, whereas some women engineers reported positive work relationships with predominantly male colleagues. It also indicated that not all male-dominated engineering work environments have been or are unwelcoming or not conducive to women engineers. In this research, the experiences of Sherry, Terra and Marie related to the theories of Rosser (2006) and Powell, Bagilhole, and Dainty (2009), who found that some women perceive themselves as competitive as their male counterparts, and thus enter fields such as engineering. Furthermore, some women may prefer to work with more males than females, feeling acculturated and accepted in the male hegemonic environment.

Perceptions of Having to Prove Their Skills More than their Male Colleagues

Some of the women engineers of this study expressed feeling as though they had to prove their skills more than their male colleagues. Erica reflected on her perception in this regard.

> From my own personal experience, I always felt that I had to prove myself worthy to be a part of the team. I had to convince them that I was knowledgeable of

> certain principles and concepts…[i.e.] the basic understanding of mechanical drafting... [and] the basic principles in terms of statics, dynamics, manufacturing processes.

Erica also mentioned the difficulty of feeling isolated during the experience, since there were typically no female footsteps to follow when having to prove her skills before her male counterparts. "Sometimes you're lucky, there may be another woman around that you can talk to…It's just very frustrating. There were no role models."

Not having enough women engineers to follow attributes to low expectations of male fellow employees when a new woman engineer arrives on the job. Marie discussed the first assumptions her colleagues, especially the older employees, made when they first met her. Realizing that she was not the new secretary, but the new engineer, her colleagues had a lesson to learn. Having a well-rounded educational background that included not only mathematics and science, but subjects such as literary studies and debate, Marie was proud that she was able to defend her position in otherwise awkward situations.

> I find what's difficult, is when people meet me, they assume, 'Well, when I saw you at my company, [I] thought you were the new admin.' So that sets the culture…the generations of my career and theirs too and they always have [to retract their statements and say] '…I feel so terrible, because I assumed…' You know all the assumptions that they made because they've seen me in the office. You really have to have a sense of confidence, because there are times where people will make you feel like you don't know what you're talking about. And that debate part of me helps. That's when being well read helps me.

Marie continued her explanation of how her debate skills and knowledge of several subjects enabled her to communicate well with employees of various ages and backgrounds. By doing so, the employees learned that she was not only the new "admin" but rather she was the new employee with a vast background, who also happened to be the new engineer. Her well-rounded education afforded her the opportunity to engage her new colleagues and establish credibility of her competency. Her experience however, attested to the problem of having too few women engineers in the workplace, such as when one is hired, she is not immediately acknowledged as being an engineer. Instead, she has to prove why she is there and what talents and potential she has to offer the workplace. As a researcher, it would be interesting to know whether this experience is as prevalent with new male engineers, or more so with new women engineers in a male hegemonic engineering environment.

Self-efficacy Enables Perseverance

Debra's recollection of male/female relationships in the engineering climate was quite interesting. She apparently recognized her position of being a woman engineer in a predominantly male environment, but like Erica and Marie, discovered a way of dealing with her environment by not focusing on gender differences, but instead focusing on the project at hand.

> I think that what I have learned over time is that if you stick to the data…it's not really about anything but being able to make your position or your claim and backing it up with data and facts. Stick to the facts and they will speak for themselves. And it's not within my control to make someone [or] to convert them

to believe that women can be engineers if they don't think so….That's not my job.

In other words, Debra's intentionality based on her subjected truth, allowed her to focus on her engineering expertise which she believed was the way that women engineers can establish credibility with their male colleagues and thus thrive in the male hegemonic work climate. Debra's attitude and approach to the challenge of establishing credibility among her male counterparts spoke of her positive self-efficacy, the sub theme that continued to resonate throughout this research. In fact, it seemed the challenges helped them to become stronger and more confident in their positions as women engineers and their sense of belonging in the engineering environment. Debra elaborated on what it meant to her to maintain her focus on her expertise, and not the opinions of others regarding her gender.

> For me, when I realized that, it was very liberating! In other words, I don't have to worry if someone doesn't think I can be an engineer. That's their opinion. I'm doing my job. I was hired to do my job. And…I know I know what I'm doing. .. So it really allowed me to focus on the assignment that I had. And then garnering success …completing my assignments *successfully* allowed me to take on greater responsibility.

Jamie's response paralleled Debra's response in terms of how embracing her knowledge and confidence in her skills resulted in overcoming perceived gender barriers.

> It taught me that I need to be more confident in my abilities and you know, not cocky or arrogant, or anything like that. But just, I know what I know. And I don't

need to let outside people try to make me feel inferior or less than, or that I can't do something.

There was a very similar response from Pat.

> I think it's important to feel like you're accomplished. To know that you know…that you're a good engineer. And that you work really hard. And… you set goals and want to accomplish them. It's really important to think positive and to always keep learning and stay ahead of the game... it's rare that others acknowledge you and pat you on the back. Somebody told me not all that long ago, that if you want to apply for an award, or if you would like to receive an award, you need to apply for yourself. Because it is rare that someone [will] go out of their way to acknowledge *your* accomplishments. I don't think it's because others don't care. I just think it's because [of] the hustle and bustle of everyday life.

I found the common responses of Debra, Jamie, and Pat, specifically their statements of "knowing what they know" intriguing, as they directly correlated to the theory of how women learn and acquire knowledge based on their subjective truths (Belenky, Clinchy, Goldberger, & Tarule, 1997). The essence of their testimonies spoke not only of their self-confidence, but also meant that through their situated learning environments, Debra, Jamie, and Pat constructed knowledge by establishing a connection between their technical skills and their work climates. In doing so, they were able to construct their own truths about their knowledge and competencies, and thus transcend any misperceptions of gender-related barriers between their male colleagues. Resulting

from their truths and tenacity, they were able to focus and deal with their work—not as women engineers, but simply as engineers.

Successes and Supports

The participants of this study discussed their successes and supports ranging from their colleagues to their supervisors in the workplace. Beginning with supportive colleagues, Erica described the time when she no longer felt isolated, but assimilated in her male-hegemonic work environment. She stressed the importance of acceptance and support within teamwork situations, and how it occurred for her.

> … how do you find that balance so that you're accepted by your male peers as being a team member without losing your own personal identity as a woman? It's finding that healthy balance without them feeling like they have to be on guard whenever you're around. Or without you projecting an image whereby they feel uncomfortable being around you.
>
> 'So for me it's when you're working on a project and, it is very subtle, and your input is welcomed. Or…you get feedback on your contribution to the project, and the feedback is positive. So to me that was a form of support…because it provided me with critical feedback that let me know that I was making a contribution to the company...it encouraged me to open up and want to take on more roles, and want to contribute more. And I felt a lot more confident in my skill level and it also increased communication between and amongst my peers, across the different units. So that was a positive.

In essence, Erica found a meaningful connection between her acceptance as a valued team member and her accomplishment of the engineering product. This

experience was a turning point in her engineering career and perception of assimilation. She added,

> …that's a wonderful feeling. Because…I felt vested…I've been involved in this project from the infancy stage throughout the maturation process through the end product, and now we're going out and we're sharing with the customer…the proposal and what we've accomplished and we're answering their questions and letting them know that this product is ready to be shipped out, or we're finished with this job. So that's a good feeling because it gives you an opportunity to take on different roles…and you feel more part of the company.

Erica's story of feeling acknowledged and valued supported her ability to learn more, grow, and accept new roles and challenges. Gilligan's (1982) theory proclaims the importance of women's voices being validated, which contributes to their sense of selfhood. In Erica's case, her selfhood developed through the experience of receiving positive feedback from her colleagues. As a result, she felt valued and vested in her career.

Natalie shared her meaningful experience and the value of having supportive bosses. She stated,

> I think [regarding support] it's definitely having really good bosses…who look beyond gender [and] ethnicity. And who see the potential that you have… I've been blessed to have very good bosses. ..who were very supportive, who see your work ethic [and] your potential. Who value that and show it. You know, whether they're looking for new opportunities for you… trust you… Where they give you a task and it's not like they're over your shoulder monitoring it. They know that

> when they give it to you, it's gonna (sic) get done. And it's going to be a high quality product…I think that means a lot.

Like Erica, Natalie found meaning in her experience based on her feeling of validation and as a contributor to the organization. "It validates…all the hard work… even though it's not that I'm doing it for recognition... But personally it validates the fact that…you know I'm a…good worker, and that I bring value to the organization."

Sherry also reflected on the value of having supportive male colleagues as well as a supportive boss who was also male.

> [Regarding] the guys, it wasn't competitive from that standpoint. They helped me when I needed help. My boss was excellent from that standpoint. I could go to him with any kind of questions. I did learn from him the idea of if I don't know it, let's go look it up. He was never afraid to say, 'I don't know.' And he would drop almost anything he was doing to go look something up for me or with me.

Marie expressed deep gratitude to her female supervisor who generously allowed Marie to receive the credit for her significant contribution to the company. Marie appreciated the fact that while many supervisors tend to take the credit for the accomplishments of their subordinates, Marie's supervisor gave her credit and acknowledgment for her idea.

Similarly, Debra expressed the importance of having a supportive female role model who was her manager at one particular time in her career. Although she valued the opportunity for having a professional role model who happened to be female, whether discussing challenges or successes, it was evident to me during her interview that Debra's meaningful connection seemed to maintain focus more on the task than on gender-

specific relations. Her responses were consistent with how she valued her expertise and the professional diversity of her colleagues. As a researcher, I believe that having female role models seemed to matter to Debra, but her expertise and the expertise of others regardless of gender seemed to matter more, as illustrated in her following statement.

> I think the supports of having female role models were very important to me. And I also had supporting managers. I actually had one manager who was a scientist because I was in a systems engineering division, and it wasn't always managed by an engineer. It could be managed by a physicist, a scientist, and because we were dealing with chemistries. There were multiple complications to what we were developing. But that the support was always about the task at hand. It was never about gender—it was rarely about gender.

Like each participant in the study, Debra's knowledge and perception was based upon her subjective truth. The importance of acknowledging her perceived experience as not gender-focused is to acknowledge the fact that individual experiences, as well as certain work climates are indeed more inclusive and project-focused, rather than distracted by perceived gender differences and similarities. It also demonstrates the relevance of what an individual can bring from her inner to her outer world. As Debra, like many women engineers in this study, focused more on being an engineer—rather than a woman engineer—she transcended any perceived gender-related barriers and focused on the challenges and successes of engineering.

It is important to note that the topic of having supportive supervisors transcended the timeframe of the 1980's, 1990's, and 2000's. Erica, Sherry, and Debra, who no longer work as engineers, reflected on experiences of having supportive supervisors dating as far

back as the 1980's until the 2000's. Natalie and Marie, who are currently employed as engineers in the 2000's, confirmed the value of having supportive supervisors as well. Through my analysis, the stories of both former and current women engineers indicated that there have been and still exist some positive work situations and supports for women engineers. It can therefore be stated that positive and negative engineering work experiences and perceptions can be based on individuals, i.e. subordinates and supervisors, and situational contexts. In this regard, perceived gender-related barriers as well as successes are variable according to circumstances.

Some research suggests that certain women in the workforce capitalize on their gender as agency when applicable (Powell et al., 2009). In this regard, Meghan considered her successes and supports as those occasions when she is consulted for business specifically because she is a woman engineer, and the client is looking for diversity in expertise. Terra was particularly excited about this question since she had just been offered a promotion. She emphasized however, that the promotion was based on her talent, not her gender. Finally Pat reinforced the significance of the support she found from her female colleagues outside of her organization through her involvement with the Society of Women Engineers. She also stressed the value of supporting one's self, by acknowledging and celebrating one's own accomplishments. Pat's comment regarding supporting one's self is related to the research of Dweck (1999), which states that intrinsic motivation is just as important as extrinsic motivation.

Youth and Gender

Some of the women of the study expressed less perceptions of challenges based on their gender but rather discusses challenges they perceived as age-related when they

began their careers as young college graduates. Both former and current women engineers of the study remembered how they felt when they first entered their professions as recently graduated, new engineers striving to earn their credibility and the confidence of older engineers in the workforce. They also recalled their need for networking with the older engineers in order to gain access to opportunities. In this context, Meghan, who has been an engineer for three years, shared her experience about how she had to learn to be open to the help of others who referred her to projects.

> For right now...what I've learned, it is not *what* you know, but it's definitely *who* you know. I used to hate that. Because I would be told, 'Oh, talk to so and so, he'll get you a good job.' But, being stubborn, I'd say, 'No! I want to get the job by myself with what I know.' But, what you know at a young age, there's nothing to prove that you know. You don't really have a portfolio or anything so it *is* who you know. So I definitely cherish every relationship that I meet for support.

In this situation, initially Meghan constructed meaning of networking as a negative experience, because she wanted to gain opportunities strictly based on her competency alone. But later Meghan realized that in order to demonstrate her competency, she needed the assistance of others who were in the power circle to gain recognition and acceptance. By conceding to being open to networking, Meghan then reconstructed her meaning of networking to perceive it as a positive experience.

Meghan's experience of needing someone to assist her in getting a job can be compared to both the structuralist and post-structuralist philosophies. As discussed in chapter three, Foucault discussed societal codes, such as the "principle of exclusion," whereas those in power of situations make the choices of who is included and who is

excluded (Foucault, 1980). Meghan's story implies that she realized her talents alone would not allow her to be included in the network of job opportunities, but instead she needed someone, i.e. a male engineering colleague, to bring her into the circle of power. From another viewpoint, one could identify the way she changed her constructed meaning of the experience from a negative to a positive as an example of Lefebvre's post-structuralist philosophy. Lefebvre believed that meanings are continuous and change over time (Lefebvre, 1995). Similarly, Bogdan and Biklen (2003) describe social construction in reference to "the fact that how we think about society and various aspects of it are not fixed or essential, but rather are produced by social interaction and exist in people's mind" (p. 262). As Meghan reassessed the experience, she no longer saw the suggestion of networking as perhaps a condescending remark, but rather she came to appreciate the privilege of knowing someone older who could bring her inside the circle of power. In other words, Meghan grew in her perception to realize that as a young (or new) employee, it is important to make connections with older, more seasoned employees in order to assimilate and gain access to opportunities in the work world. In this reference, age seemed to be more of a concern than gender.

Other participants who are currently employed as engineers remarked about the issue of being young engineers, but combined the issue of age with gender. For example, Natalie talked about a situation regarding the challenge of being a new or young engineer, and being likened to a daughter by older engineers.

> You…have to really earn respect and credibility. I think as far as my peers…for the most part there was mutual respect. But still you're the newbie, you're the young [one]. You don't know how many times I heard that, 'Oh, you're just so

> young. You remind me of my daughter'… And so definitely having support as a new person coming in, and as a younger person, where people wanna (sic) [treat you as], 'Oh you remind me of my daughter' so they kind of take you under wing…, if you gain that respect.

Pat's experience was similar, but she discussed both the positive and negative aspect of being likened to an older male colleague's daughter.

> They [older male engineers] look at me kind of like maybe I'm one of their children, perhaps a daughter. So they're really willing to help because they associate that way. But there's other times they look at you and they say, 'Well, you're kind of like my daughter.' And sometimes it's hard to get over, I guess the hump of, 'Trust me. I know what I'm doing,' kind of thing. So, it's kind of like a double-edged sword.

The phenomenon of youth versus gender had dual inferences in the contextual meanings derived by the women of the study. One interpretation might imply that the notion of older male engineers comparing young female engineers to daughters may have a double-meaning, whereas from a positive viewpoint, the older male engineers may see the young women as mentees. In this regard, they would mentor the young women by sharing expertise and showing confidence in the ability of the young engineer to learn and perform. In the early stage of a mentoring relationship, there can be parent-to-child role inferences, whereas a fledgling employee may benefit from an older role model who may provide direct instruction and nurturance (American Psychological Association, 2006). In this analysis, for an older engineer to be willing to take a parental role in a mentoring relationship may imply that the older mentor may have a high level of confidence in the

mentee so as to coach the mentee to be like him, and perhaps excel beyond him. In addition, the advantage of having an older engineer as a mentor is that he (or she) may enable the younger engineer to become included in the social climate where power reigns. However, from a different viewpoint, being perceived as a daughter may be interpreted as a lack of confidence in the mentee's ability to perform as well as the older engineer, and thereby be viewed with less confidence by the older mentoring adult. Comments by Natalie and Pat regarding the inference of being like daughters are supported by the research of McIlwee and Robinson (1992) who agree that while the mentoring is appreciated by young women engineers, the women also wanted to be acknowledged as confident and independent engineers.

In reference to this phenomenological study, positive or negative perceptions of the notion of being referred to as a daughter may depend on the situation, the interpretation by the woman engineer, and/or the intention of the older engineer (whether male or female for that matter). In addition, the younger engineer may determine through her intentionality whether she perceived the treatment as lack of trust (as though perceived as less competent as an older mentoring engineer), thereby excluding her, or supportive (as though treated like a young adult apprentice to an older adult's expertise), and thereby including her in the social climate of power.

In terms of intentionality of the phenomenon, the issue of communication becomes whether someone is speaking with the intention of being either patronizing, or caring, supportive and nurturing. This example demonstrated how intentionality pertained to both parties and their perceptions in a situation. In this case, the older engineer's and the younger engineer's worldviews determine the meanings they connect to the structured

situation. Furthermore, the situation may be perceived based on the climate, whether perceived as positive, negative, or neutral, which in turn affects their subjective truths.

During the process of interpersonal communication, sometimes the message of the sender may or may not be received as it is meant. In this case, perhaps an older male engineer believed that he was mentoring and did not mean to be taken as mistrusting of the woman engineer's abilities. Perhaps the intention of an older male engineer who tried to help a young engineer was to help them develop their skills, and not give them responsibilities for which they were not yet prepared. Perhaps the same older male engineer would treat a young male engineer with the same precaution as a young female engineer. It is not possible as a researcher to fully understand or construct meaning of the male hegemonic environment without interviewing the male engineers as well, in order to understand their subjective truths in given situations.

Debra, who left the engineering profession since the early 2000's, did not discuss an experience of being referred to as a daughter, but did speak about the ambiguity of whether a perceived barrier was attributed toward her gender or age.

> Well, obviously…sometimes there are barriers, and you don't really know if the barrier is [because] I'm a woman. And so you [the older male engineer] don't trust what I'm saying, or believe what I'm saying necessarily because I'm a woman, or because maybe I'm a younger engineer. And so… in the back of my mind, [I wonder]…is there a question based on my gender or my experience?

The importance of acknowledging the perceived barriers based on youth is that the participants were not always certain as to whether some perceived barriers were a result of their gender or age, or sometimes a combination of both. It should be noted that

if barriers were indeed age-related, then such barriers may affect young male engineers as well. Regardless of intent, how a message is received during a verbal exchange must be understood and validated by the sender of the message in order for behavioral change in the work climate to occur. In this respect, my intention as the researcher of this study is to bring forth awareness of perceived barriers in order to facilitate change in the environment. The goal of creating awareness is thereby to foster assimilation and inclusion of women engineers in the workplace. Women engineers need acknowledgment in order to share agency with their male cohorts.

Race and Gender

The issue of youth and gender was discussed as possible overlapping barriers. In addition to these two factors is the issue of racial differences, as engineering is a predominantly white male profession.

In this study of women engineering, the issue of race as a barrier in the engineering workplace was not voiced by three of the four African American participants. The reason may be attributed to the fact that the interview questions did not ask them about their experiences as African American engineers, but focused mainly on their experience as women engineers in general. Or perhaps like the participants of Boroshok's research (2005) discussed in the literature review, the African American women engineers of this study felt little difference from engineers of other races. Only one of the African American participants, Jamie, who is currently and has been employed as an engineer for four years, commented about feeling different, i.e. isolated from her colleagues in the workplace, for which she interpreted as a combined issue of her race, gender, and age, with more support from her younger than older colleagues.

> My relationship with my co-workers is kind of different. We don't really have that much in common because...we're just different. I mean they're white, I'm black. They're male, I'm female. They're forty-something. You know, married with kids in college who are my age. And I'm single with no kids…So they're very different.

Like the participants of the research conducted by Boroshok in 2005, the African American women in this study discussed the peer support found through their participation in the National Society of Black Engineers (NSBE). Participation in professional societies, such as NSBE serve to counteract the phenomenon of isolation by providing peer networking on-campus, as well as professional networking after college, in order to establish peer relationships and mentors. In light of this study and external validity, these findings cannot be generalized to all African American women engineers. The interview questions of my research on women engineers did not ask specific questions about racial perceptions, which might explain the reason for little race-related responses among the participants in this study.

The importance of understanding the experiences of race as well as gender, in this case African American women engineers is relative to the issue of their potential gain in social capital and empowerment through advancement in technical careers. Engineering is not only a challenging, but also a prestigious and financially rewarding career. Within the continuum of qualitative research methods, the interest of African American women engineers refers not only to the method of feminist theory, but also to critical theory which refers to race, gender, and power in society. In this regard, this study includes the experiences of a marginalized group, i.e. African American women. The method of social

constructivism also applies as this study approaches the notion of making change in social roles and expectations of women and minorities, particularly African American women (Bogdan & Biklen, 2003, and Schwandt, 2001). These qualitative methods enable researchers to understand how African American women engineers learn to become engineers, and the supports and challenges thereof. Furthermore, understanding the meaning of the experiences of African American women engineers, as well as all women engineers will hopefully facilitate employers' goals of recruiting and retaining more women engineers of all ethnicities to support and enhance a diverse engineering workforce.

In summary, the participants of this study recalled issues and barriers, as well as successes and supports in their work environment. Gender relations varied by participant, whereas some perceived more challenges and some more successes than others. Age and race were additional factors that may have attributed to feelings of exclusion. But in essence, all participants were able to identify successes and supports within the engineering work environment, ranging from colleagues to supervisors, to ones' self. Experiences seemed consistent in terms of participants valuing the essence of feeling accepted by their male as well as female colleagues. Assimilation proved critical to perceptions of feeling included as viable engineers in their organizations. In general, assimilation yields to a sense of belongingness, gives voice to both men and women engineers, and can improve recruitment and retention of engineers in the workforce.

Theme Four: Work and Family Relationships

The theme of work and family relationships crossed over the topics of issues and challenges, as well as successes and supports. For this reason, it became a theme of its

own. There were common responses among the unmarried women without children in terms of their career aspirations, coupled with the amount of time they could afford to commit to the long work hours and demands of their engineering profession due to their single marital status. By contrast, there were common responses among the four women engineers who were married with children as they voiced their challenges of being working mothers who strived to balance work and family responsibilities, and meeting the demands of both areas. The challenge of maintaining a balance between work and family became a consistent and primary factor in determining whether some of the women chose to stay or leave the engineering profession.

Leaving Engineering for Family Responsibilities

Erica, Sherry, and Debra enjoyed their engineering careers and before they were married with children, were able to meet the high demands of the engineering profession in terms of long work hours and extensive projects. But after starting their families and needing more time for child rearing, they decided it was in the best interest of their families to change careers from engineering to the field of higher education. They reported their decisions were based not only out of their interests in the education careers, but also due to acquiring family-friendly work schedules within the education professions that allowed more time to balance their responsibilities.

Erica remembered the complexity of weighing her options that led her to decide to leave engineering in the early 1990's in order to raise her family.

> …there was a great deal of uncertainty because… I felt that I was entering another phase of my life…I felt this need and urgency to want to accomplish more things…because… I have this human that I'm bringing into the world…I'm

looking for other opportunities within the company that would allow me to take on new experiences…and hopefully be rewarded—financially rewarded.

In addition to her need for more financial gain to support her child, Erica recognized her lifestyle needed to change in order to balance her new family responsibilities. Unfortunately, her engineering career was not accommodating her needs.

> We didn't have those flexible work arrangements that some companies have now where you can you know, once the child reaches a certain age, they actually have places where they have childcare facilities on site. Which I think is wonderful. …for me that [lack of childcare accommodations] actually proved to be a turning point in my life, to the extent that I chose to look for other employment opportunities that would allow me to get that more family friendly [work environment]. And would not require long hours at work which then of course I was away from my family (sic).

Erica's story demonstrated how marriage and family affect life choices and changes of priorities for career women. Sherry experienced related issues that resulted in her decision to leave engineering in the 1990's as well. In her case, childcare was a challenge, especially since she did not have nearby family support. "…my husband and I don't have outside family in the area…that was another reason why I ended up quitting and staying at home full-time, because we didn't have family that we could rely on to take care of our kids."

Before resigning from her engineering career, Sherry attempted to balance work and family as best as possible. She recalled how her supervisor was supportive of her

need for flexible hours for family reasons. But she sensed that some of her male colleagues were less empathetic of her needs.

> He [her supervisor] was very willing and understanding. Let me work part-time… So… I would work a half a day, and my husband would work half a day. He [her supervisor] was very flexible…It was the people that were around that were scheduled. They knew I would need to leave…at 3:30 and they would schedule a meeting at 3:30…Almost all of their wives were stay-at-home moms. So I really think their mentality was, 'We either want you here full-time to be like one of us, or why aren't you home full-time to be with your kids, like my wife?' So it was never explicitly said, but it was just the way.

Like Erica and Sherry, Debra recalled how initially she enjoyed working long hours and weekends with her engineering colleagues in the 1990's. While she was unmarried and had no children, she was afforded more time to spend on long projects, and advance in her engineering career. But due to family reasons, she also changed her career to higher education administration to allow more family time.

> As I got older, eventually I met my husband. And at that point I was already an engineering manager. So there are different demands and pressures from that job, but still able to have a reasonable work/life balance. And ultimately where I am now, I have a fairly young child…[So] part of my reason for leaving engineering was not so much that I didn't want to be an engineer, it was that I stepped out to be a mom.

Debra was pleased with her decision to change careers for personal as well as professional reasons. Regarding her current position in higher education administration,

she stated, “It works… They afford me the flexibility to take care of my family. They’re wonderful. It’s challenging work. I love it!”

Debra determined the meaning for her career changing experience reached beyond the necessity of family time, but discovered the possibilities of alternative careers that stemmed from her engineering background.

> As I look back, I think what it means is that there is a wider array of opportunity than I first envisioned with a particular type of degree. You know, ‘I’m an engineer. I have to do engineering.’ As opposed to ‘Well, I can be a manager. I can manage technical people, which is a greater door to open.’

In essence, Erica, Sherry, and Debra were well-established engineers who enjoyed being engineers in the 1990’s, but decided to leave the engineering profession in order to pursue careers in higher education primarily due to their family responsibilities. Their decisions to do so coincided with the research that stated how male engineers are better able to remain in the engineering profession because the traditional male gender-role expectations do not require as much of their time to be care-givers of their families (McIlwee & Robinson, 1992; Rosser, 2006). By contrast, wives and mothers make career decisions that enable them to maintain their female gender-role expectations as well as their desires to place their family responsibilities at the forefront of their priorities of work and family balance. Fortunately Natalie is employed in an engineering company that is better able to retain women engineers since they allow for family-friendly policies. Such policies enable women to both care for their families as well as maintain their ability to stay in the engineering workforce. The effect of having such accommodations is discussed in the next section.

Staying in Engineering Due to Family-Friendly Environment

Natalie has remained in her position as an engineer for twelve years, primarily because the company for which she is employed allows for flexible hours that accommodated her needs for balancing work and family responsibilities. She was very appreciative of the opportunity to take a leave during her pregnancy, and to return to a supportive and welcoming work environment. When she returned to work, she was permitted to work flexible hours as she described,

> I was out for... months. And then [to] come back and not feel [as though] people were like, 'Well where has *she* been?' You know, it didn't have that tense environment…It was just like, 'Okay, glad you're back. Let's get busy! We've been waiting for you to come back.' When I came back..I was working for four days [a week] and I just [recently] transitioned to getting back to [work] five days.

Even prior to having children Natalie was able to work a compressed work-week schedule of four ten-hour work days. The company offered this advantage to all its employees as general practice. In order to be given this opportunity, Natalie stressed the importance of having to be dependable and trustworthy, and to proving one's competency to her supervisor. She reiterated her appreciation for the company providing her flexible hours, which enabled her to maintain her career and life balance. Without this opportunity, Natalie would have had to choose to be a stay-at-home mom, which was not her preference. She discussed what it meant to her to be able to work and maintain her family, although it is challenging to do both.

> I realized that I wasn't that type of person [a stay-at-home mother]…I realized I need to be around people. And that makes me a better person, a better mother, a

better wife…I think realizing where you are in that definitely is important. And create… an environment where the corporation is receptive of that. I think you definitely have to prove yourself [as] a hard worker.

Without an option of flexible hours, Natalie declared that she would have left her engineering company in search of a more family-friendly environment. She further discussed how the balance of work and caring for family often required some of her female colleagues to set priority of family over career when offered promotions that would entail longer work hours and travel. Fortunately in her case, having support from her husband and in-laws enabled Natalie to travel when necessary. However, those without home support may choose to forego promotions with high demand. She also mentioned that her company provided travel dates in advance, which enabled her to plan her travel with her home supports. Natalie's story illustrated how companies that provide flexible work hours and planned travel dates are more accommodating to the retention of women engineers.

Natalie clearly stated that being married and having children impacts a woman engineer's career decisions in terms of whether she is afforded ample time and energy to maintain both priorities of work and family. In this same respect it is sometimes assumed that single women engineers are more available to their work responsibilities and able to accept promotions that require long work hours and travel from home. Although there is some truth to this assumption, it is imperative to note that single women engineers not only have interests and responsibilities away from the job, but also share concern about their futures and how they would manage their engineering career decisions if they should marry and have children. The following are stories shared by the unmarried

women engineers of this study regarding their perceptions and concerns about how the demands of their profession impact their outside work interests and responsibilities, and may impact their future family lives.

Unmarried Women Engineers' Perspectives on Work and Family

Unmarried women engineers in the study shared their perspectives on work and family balance. Each of the five unmarried women engineers of this study reported that they indeed work long hours, as often required in the engineering profession. However, they expressed concern about how their lives and priorities would change if and when they would marry and have children. For example, Jamie who has been an engineer for four years, informed me that her position regularly involved projects that may require her to be on call for days or even months at a time. When she thought about work and family balance, she replied, "I do not feel that if I had a family I would be in this position." She compared her perception of gender role expectations in terms of which gender generally makes concessions in engineering careers.

> This is where I feel like the true male/female roles come into play. Because…on any given day…you could have an issue…and be called into work. Well, if you're a guy who's married and has kids, it's easier—unless you're a single father, I'll say—you know, it's easier for you to just drop everything and go. Whereas most of the time if you're the mother, you're the caregiver and you're making sure that you cook and dress the kids…So I would say…it's harder for you [as a mother].

Terra, a current engineer for three years at the time of this study, had similar concerns as Jamie, who was a current engineer for four years at the time of this study,

regarding the anticipated challenge of balancing work and family. She compared her situation as an engineer to the more conventional female-chosen career of nursing.

> I think it will be difficult when I start to have kids because… engineering is kind of project-based…You start a project and you're expected to finish it. And…project duration can go anywhere from six months to three years. It's not…the way…a nurse[']s]…work flow is steady...We [engineers are] assigned to projects for a very long period of time. So I feel like that would be difficult to even leave for a little while, have…kids and then come back. You know the timing of the whole thing is going to be iffy.

The meaning Terra established to the notion of how to balance an engineering career with family was different from other participants of this study who either chose to leave or would consider leaving engineering for family responsibilities. Instead of choosing one over the other, balancing an engineering career and family for Terra meant that she would consider taking an entrepreneurial route to owning her own engineering company. By doing so, she believed she could therefore maintain both an engineering career and have time for family on her own terms. She reflected

> I thought about this before. So I think that probably one day, I'll…have my own company...Find some sort of niche market. Build it up and then not have to worry about any of those issues, because then I'm the owner. I can take off whenever I want. Work from home if I want.

Through her intentionality, Terra's perception of engineering is more challenging than nursing when considering how to balance work and family time. In order to stay in the engineering profession, Terra aspired to someday becoming a business owner. She

believed that having her own business in engineering would enable control of her work schedule, with the possibility of working from home, thereby would allow her time home with family. Entrepreneurial endeavors carry their own high demands, for which Terra contended she is one who can achieve.

In essence, the women engineers of this study viewed the juggling of work and family responsibilities for women engineers as challenging and critical to their career decision-making. Hakim's preference theory aptly correlates with the experiences and concerns of the married and single women of this study in terms of balancing work and family (Hakim, 2000). Hakim classified women into three categories: home-centered, adaptive, and work-centered, which define women's preferences and actions when challenged with work and family responsibilities. None of the women of this study would place into category one called home centered. Home centered women are those who choose not to work in order to care for their families. The four participants of this study who are married with children fit into the second category, called adaptive. The adaptive category pertains to women who prefer to both work and raise their families. Erica, Sherry, and Debra who changed careers from engineering to education professions in the 1990's, chose to do so primarily because they found the work hours of the engineering workforce to be too demanding, with long hours and travel responsibilities that conflicted with their needs for home life and child care. However, Natalie who has remained in her engineering profession in the 2000's has been able to do so thanks in part to her company which provides flexible hours that allow her to balance work and family, combined with her partnership with her husband who shares childcare responsibilities which enable her to travel for her job. Each of the five participants of this study who was unmarried and

had no children was employed as an engineer at the time of this study, and had been employed as engineers for less than ten years. Their work situations fit Hakim's category three, called work-centered. Work-centered women may prefer to focus on career advancement, and are better able to meet the high demands of long work hours and travel. Three of the five unmarried women of this study did stress however that their priorities would shift from work to family care if they should become married with children in their futures. In addition to their concerns about their futures, unmarried women also value a balance of work and the other interests in their current lives as single women, which is discussed in the next section.

While it may be true that those who are single with no children do not bear the same responsibilities of married working mothers, it does not change the fact that unmarried employees—specifically women engineers in this case—do have full lives. Their lives may be complete with other family-related responsibilities, such as caring for elderly parents, or children of other family members, as well as social obligations and interests that are of significance to them. As previously discussed, it is often a general workforce assumption that unmarried employees are more available to work extensive hours and meet demanding career responsibilities above and beyond the call of duty. Although they may be willing and able to do so, it should be emphasized that they also value active lives outside of their jobs. Such responsibilities and interests are what Marie discussed in regard to how she maintained a healthy balance between life and work, and the activities that kept her grounded. An exceptional trait that Marie discussed was her interest in never forgetting where she started and the support that was given to her. As a

result, she was very vigilant about ensuring that she gave back to others. Marie reflected how she enjoys spending time with family and paying forward by serving others.

> On Saturdays, I pick up my two nieces and a nephew and hang out with them. I make brownies with them. I still spend a lot of time with them. I do that to be reminded that I am more than an engineer…I know all the handouts that I got along the way. And I can't pay those people back, but I can certainly pay it forward. I do [charitable work with a social agency for children]…It keeps me humble…And I tell people, you know, I'm just like everyone else. The only thing that separates me from you is what I probably went to school for or the kind of career I have. But really we're [engineers are] human too.

In summary, women engineers, both married and unmarried, face the challenge of balancing the demanding responsibilities of the profession in terms of long work hours and travel. In order to maintain a healthy balance of all aspects of their lives, the engineering profession needs to accommodate their needs by enforcing family-friendly policies that allow for flexible work hours and time for their other interests and responsibilities. Under these conditions, women engineers are better able to make career choices between staying and leaving the engineering profession. Such accommodations by the engineering workforce may thereby contribute to the retention of women engineers. Retaining women engineers can provide more role models for young girls and women, as they serve as examples of what it means to be a woman engineer. The essence of being woman engineers was described by the participants of the study and is discussed in the final theme.

Theme Five: Essence of being a women engineer

The fifth and final theme that emerged answered the overarching research question of what is the essence or meaning of the experiences of being women engineers. As each answer was unique to the individual participants, there was an overwhelming response of pride in their profession and achievement of being an engineer.

Sherry began her response by denouncing the categorization of being a "woman engineer," and explained why.

> First of all, I really don't think of myself as a "woman engineer." I've instead usually thought of myself as an engineer that happens to be a woman…I also think what bothers me about your question is why it even needs to be asked. Do we ask men what it means to them to be a male engineer? This is where my usually-quiet feminist streak comes barreling out of me as these are those annoying issues about being a female in a career field where females just aren't as prevalent yet… I'd like to think, or at least hope, that I can ultimately make a difference in another younger female's life because of my background as a "woman engineer"---whether they're in elementary, middle or high school, a college student, just out of school, or been working in their chosen career for a while. Mainly by sharing all of my experiences that I've had on my journey so far, and perhaps they'll learn of things to do the same or to do differently---or at least things that I had to consider along the way as I made my choices about my family and/or career.

Sherry's point of the categorization was well taken as it describes an essence of feeling a sense of differentiation or exclusion from the profession strictly by gender.

Defining herself as a woman engineer meant to her an acknowledgment of being different from the other engineers, who happen to be male. Such categorization or labeling was seen from her feminist point of view as a contribution to the problem and not the solution of why too few women pursue engineering. In other words, women engineers are thought to be different or separate in some way from engineers who are men, simply by an implication of gender difference. Sherry's feminist viewpoint was clear and worth noting. However, the meaning of being a woman engineer changed from this prospective to another feminist-related view for Sherry when she thought of how being identified as a woman who is an engineer offers inspiration to young girls and women. Sherry realized and was hopeful that through her example, they may feel a sense of inclusion in the engineering profession. Sherry's response therefore carried dual meaning for her, neither response right or wrong, but both responses reflecting her truths based on her intentionality and worldview.

Like Sherry, Natalie and Marie had thoughts of how they may be role models to other females in effort to engage their interest in engineering. Natalie thought about her own children when she gave her response.

> Being a woman engineer means that I can bring hope to young women as they're deciding which field of study to pursue or as they're contemplating whether to stay in the discipline due to the challenging work load. Engineering is a space that I share with so few women, unfortunately. What does being a woman engineer mean to me? It means my girls will be exposed to the field of science much earlier in life and perhaps will choose to follow in their mother's (or father's) footsteps. That's one of the many legacies I desire to leave with my children.

Marie's response was similar, in acknowledging the significance of mentoring others and being an example to future women engineers.

> It means a great deal to me to be a female engineer. I love that aspiring female engineers look up to me and have asked me to be their mentors. And the lives I have been able to change…by encouraging students to stay in school and go on to their own personal successes…I have a lot of pride for my profession and I would not change it for the world.

Erica who changed her career to education in the 1990's looked back in appreciation of the hard work and perseverance she invested when she first became an engineer. She described her experience.

> Sense of accomplishment. It means it's a long journey and knowing that you succeeded. It's the ultimate experience of knowing that you have accomplished something that so many women have chosen not to pursue for one reason or another…You know that you're able to solve complex problems. You have critical thinking skills [and] use sound judgment. And I think it also allows you to have a higher level of appreciation for what engineers do and what all you have to go through to become one. Almost like a rite of passage. You feel like, 'I've arrived!' And now you can say that you're an engineer…It's a good feeling.

As engineering is known to be a very challenging profession, Erica shared her sense of pride in being one of the ranks. Debra's response was comparable to Erica's response. Debra, who has also changed career in the early 2000's from the field of engineering, described her essence of being a woman engineer with a great sense of pride and ownership of her profession.

> I define myself by my profession. And I have ever since I started working as an engineer. So if someone asks me, 'Tell me about yourself?' Generally I start off with what I do for a living… I'm an engineer. And even though I may now tell people I'm a [higher education administrator], I will often say I'm an engineer by training…What it means to me is…that engineers are respected…I have a level of intellect in that I can participate in conversation about *many* things. And that I'm not afraid to learn…What the training has given me is a good base for learning how to work.

Debra's statement is congruent to the social cognitive career theory derived from Bandura's (1989) social cognitive theory, which explains how self-efficacy influences career development, decision-making, and performance (Lent & Brown, 2008). In this instance, the essence of becoming an engineer for Debra meant that what she learned assisted in the development of her positive self-efficacy and ability to learn other things. In effect, her ability to become an engineer supported her confidence in her ability to transfer her engineering skills to a different career.

Terra, still an engineer at the time of the study, was also proud to be an engineer, but admitted that in the beginning of her career, she felt apprehensive about telling people that she was an engineer, because she encountered those who either did not know what engineers did, or were confused as to why she as a female decided to be an engineer.

> At first it was kind of embarrassing. It was like, 'Oh, I don't want to have a conversation about this.'… But then over the past few years, it stopped being about that, and started being something I'm really proud of (sic). And now…I

can't wait to tell people what I do. And I can't wait for their questions, so I can tell them…about it…I can take it now.

Pat, also a practicing engineer at the time of the study, seemed a bit modest or indifferent regarding her meaning of being a woman engineer.

Just kind of what I do…It's not *who* I am. But it's a *part* of who I am…I guess I just feel like everybody else. I have a job that I actually really like. I go to work every day.

Meghan, an engineer for three years, was also brief in response. She expressed her satisfaction with her career choice, as she simply described being a woman engineer as "Very rewarding."

Last but not least, Jamie explained that she decided to practice engineering after earning her degree, but over the years, has lost interest in continuing the profession. Therefore at the time of this research study, she was in the process of a career transition from engineering to another field. Although Jamie was planning to leave the engineering profession, she too was proud of having served as an engineer, and hoped that she had left a legacy for her engineering employers to learn about the needs of recruitment and retention of more women engineers. When asked what it meant to be a woman engineer, Jamie remarked,

It means to be a trailblazer. Hopefully…what I have done thus far will kind of…open their [her employers'] eyes that they need to get more women in there… because there *are* some very talented women who want to be engineers, who *want* this opportunity, and… hopefully I've exposed them [her employers] to other

things that otherwise they would not have been exposed to (sic). So hopefully I can open the door for somebody else to come up and…take my place.

In summary of theme five, the majority of the participants described the meaning of being a woman engineer as a point of great pride. They respected the profession of engineering, as it reciprocated respect to those who face the challenge and succeed in becoming engineers.

A major source of pride expressed in the meaning of being a woman engineer related to the participants' knowledge, their critical thinking skills, and their ability to learn. This meaning of women's ability to learn engineering is essential for educators to recognize, so as to overcome stereotypes that hold the misconception that women are not as interested or as skilled in science, technology, engineering or mathematics. Recognizing interested and capable minds of young girls from kindergarten to twelfth grade levels and through post-secondary education will enable teachers, and academic and career advisors to encourage female students to challenge themselves and consider STEM courses and careers in these fields.

The women engineers of the study were also proud of being role models to young girls and prospective women engineers. The notion of having female role models who wish to mentor is a viable resource that can be beneficial in encouraging more females to consider engineering (Burke and Mattis, 2007).

From a feminist perspective, it was mentioned that differentiating men from women engineers may mean that exclusion of women engineers is still an issue, just by nature of the question being posed, or the need for such research. Yet a second standpoint from the feminist perspective is to differentiate men from women engineers so as to

acknowledge the women who *are* engineers, in establishing visibility in terms of sharing pride of their accomplishments and contributions to the engineering profession. Bringing their existence to the forefront of the engineering profession may instill hope for recruiting young girls and prospective women engineers, and retaining rising women engineers in the workforce.

In summary, the themes of the analysis provided insight on what it means to be a woman engineer. Theme number one discussed how sociocultural influences of parents, family, teachers, advisors, and peers affect the career decisions of women who pursue engineering. Establishing a meaningful connection between their lives and engineering through career advice, classroom and internship experience, as well as social interactions fostered recruitment and retention of these women in engineering academia.

Theme number two discussed how women of this study learned engineering through context-based situated learning. From the classroom to the workplace, these women discussed how positive self-efficacy enabled them to learn engineering in the male dominated engineering environment. The findings supported the feminist theories (Gilligan, 1982; Fletcher, 2001; Hayes, 2002) of how women learn through their voices, and exercised mutual empowerment in team learning situations.

Theme number three discussed how gender, age, and race affect work relationships. Gender was an issue for some participants in terms of feeling isolated in the engineering male hegemonic environment. Younger engineers in the 2000's expressed no gender-related perceptions of isolation, but wondered whether their young age and level of experience was more of a concern for older, more experienced engineers. Some older engineers were perceived as very supportive mentors, while some

participants, as young engineers, wanted to feel certain that their skills were trusted. Race was not strongly discussed as a factor, just was combined with gender and age as factors attributed to one participants' feeling different or isolated as a minority in the engineering workplace.

Findings in theme number four revealed the importance of having family-friendly policies in the engineering work environment for retention of women engineers. Three women engineers who worked in the profession from the late 1980's to the early 2000's changed their career paths to education, primarily due to needing time for work and family responsibilities. One married participant who remained employed as an engineer at the time of the study was able to do so due to flexible work hours at her company which enabled her to manage both their work and child care priorities. Unmarried participants were able to maintain long work hours and travel demands of the engineering profession, but they questioned whether they would remain in engineering if and when they married and had children.

Finally, theme number five expressed the essence of being women engineers. The participants shared high gratification for their engineering education and career backgrounds. They also expressed interest in encouraging girls and women to pursue the field. Whether they left or remained in the engineering profession, being women engineers meant having pride in their professions. The woman engineers of this study continuously identified themselves as engineers throughout their professional and personal lives, and appreciated the contributions made by engineers overall, including their own professional contributions on their jobs. Chapter six concludes this study with

the discussion and suggestions for future research, as well as ideas to help further the status of women in engineering professions.

Chapter Six

Discussion

The United States workforce of the twenty-first century calls for more citizens to pursue careers in science, technology, engineering, and mathematics in order to maintain its competitive edge in the world market. In the field of engineering, there exists a predominantly male population, historically and present day. As women composed nearly fifty percent of the workforce in the year 2010, they represented only 13.5% of U.S. engineers (U.S. Dept. of Labor and Statistics, 2010). Other career fields once considered nonconventional for women, such as law, medicine, and business have shown an increase of women employees. The question then becomes why are there still so few women in the engineering profession?

As a higher education administrator in a College of Engineering, I am concerned with the recruitment and retention of engineering students, and have a particular interest in finding ways to increase the numbers of female college students who will plan to pursue engineering careers. For this reason, I chose a research topic that addressed the problem that there is little understanding of the essence, or meaning, of the social cultural factors that influence the reasons why fewer women than men enter and remain in the engineering profession. Through literature review, it appears that the disparity of women

engineers in the workforce result in fewer role models for young girls and women to emulate. My concern therefore expanded beyond the walls of the college campus and into the engineering workforce, in order to understand why there is such a shortage of women engineers. In this regard, I decided to conduct a qualitative study of women engineers. Using a transcendental phenomenological methodology, I conducted research that gave voice to women who are current or past engineers. Through phenomenology, the intentionality of the participants' responses was considered in order to analyze the essence of their experiences. Their comments regarding their perceived gender differences, challenges, successes, and rewards were based on their subjective truths. According to Pollio, Henley, and Thompson (1997), our interpretation of situations is based on the way in which we see ourselves, and our inner world perceptions affect the way we perceive our outer world. I believe that understanding the meaning of the experiences of the participants of this study may contribute to understanding why there are so few women engineers.

In this regard, the purpose of my study was to understand the meaning that women engineers make of the social cultural factors that influenced their reasons for entering and remaining in the engineering profession. This study furthered the prior research found regarding college women who were majoring in engineering (Gill, 2000 and Choudhuri, 2004), by studying college-graduated women who are or were employed as engineers. I hoped the information found would inform educators as well as employers of ways in which they may attract and retain more women to engineering college and careers.

The research questions I developed in order to gauge an understanding of the meanings women engineers make of their social contexts that influenced their experiences were as follows:

1. Regarding issues and barriers:
    a. What issues and barriers did/do women engineers in this study encounter in the engineering workforce?
    b. How do/did these issues and barriers shape their career decisions?
    c. How do/did these issues and barriers shape how women learn to be engineers?
2. Regarding successes and supports:
    a. What successes and supports did/do women engineers in this study encounter in the engineering workforce?
    b. How do/did these successes and supports shape their career decisions?
    c. How do/did these successes and supports shape how women learn to be engineers?
3. What is the overarching essence or meaning of the experiences of being women engineers?

The framework for this study was postmodern feminist theory (Creswell, 2007), with the social cognitive career theory (Lent & Brown, 2008) as a secondary framework. From a purposive sample of nine participants, I gathered data from individual interviews of each participant in order to hear their stories about their issues and challenges, as well as successes and supports in their engineering careers. Each participant was interviewed privately. I recorded and later transcribed each interview. I also took notes during the

interviews in order to document and highlight information that was shared. In addition to the transcripts and notes, I kept a journal of my own experiences as a researcher in order to keep my progress organized and remember specific experiences. Throughout the process of transcription, I contacted participants for their review as a part of member checking until I received their approval of each of their final transcripts. All data sources combined (transcripts, notes, and my journal) were then used for data analysis in order to derive meanings from the participants' stories of their experiences as women engineers. Through horizontalization, five primary themes emerged and were coded. The five primary themes were 1) gender roles and social cultural influences regarding women's career decisions and opportunities; 2) context-based situated learning; 3) male/female work relationships; 4) work and family relationships; and 5) essence of being a woman engineer. Sub-themes were found and categorized within each of the five primary themes. The sub-themes provided more depth of information regarding the women's experiences.

Summary of Themes

The theme entitled *Gender Roles and Social Cultural Influences Regarding Women's Career Decisions and Opportunities* exemplified the various social cultural influences of women engineers' career decisions. Such influences derived from parents, family members, teachers, professors, peers, and academic advisors, as well as participation in sports and/or STEM pre-college programs. The mothers and teachers of the participants of this study were very supportive of the participants' engineering career choices. Although they did not specify engineering per se, the mothers of the women engineers of this study encouraged their daughters to pursue their dreams, which in these cases were dreams of becoming engineers. Debra's mother encouraged her to do

whatever she wanted to do, which she said was like being "given permission" to succeed. Similarly, Terra's mother told her to challenge herself, which influenced Terra's choice to become an engineer. And it must have felt very liberating for Natalie, whose parents encouraged her to seek out more information about her interest in engineering. These three participants ranged from ages in their twenties to forties, which implied that some mothers have been and still are encouraging of their daughters to step out of the norm to follow their dreams of pursuing engineering professional careers.

The literature review for this study indicated that many women engineers are positively influenced by male family members, especially fathers who were engineers (McIlwee & Robinson, 1992). A father, grandfather, and a brother, who were all engineers, as indicated by three participants respectively, provided such influence. However, some fathers of participants were cautious of their daughters' decisions to enter the male-dominated field of engineering, as they represented the more traditional ideology of female gender career expectations.

Teachers, college professors, and advisors seemed to have been supportive, according to the participants. Although some professors during their college careers were very challenging, no participants reported lack of support from these educators.

Those who participated in extracurricular activities such as sports and STEM programs believed they received positive influence on their engineering career decisions, whereas those who participated in competitive sports reported their experience prepared them for the competitive engineering workforce. However, those who had not participated in sports did not find sports important to their competency in engineering. Participants who had experience in STEM pre-college summer programs found relevance

to the academic and career preparation, as well as the motivation they gained to become engineers.

In summary, the women engineers of this study reported that they received social cultural support from various areas in their lives regarding their goals to become engineers. No one in the study reported having no support at all. This information implied that women engineers who receive support of their goals of becoming engineers find meaning in having extrinsic motivation.

The second theme, *Context-based Situated Learning*, pertained to the importance of understanding the meaning of how women learn to be engineers. Issues and barriers, successes and challenges were discussed in terms of how women learn to be engineers.

From the feminist framework of this study, Hayes noted that women learn through social interaction. Hayes also noted that males learn through reporting more so than social interaction (2002). The findings of my research showed that women engineers of this study learned through both social interaction as well as reporting. Specifically, Debra and Sherry reported how they were called on often to report answers in class. Debra did not view her classroom experience as being isolated as a female in a predominantly male classroom, but rather as an opportunity to prove her knowledge and improve her self-confidence as well as gain the confidence of her male peers and professor. In fact, from her work concerning how women learn, Hayes (2002) contended that women benefit from high inquiry classroom teaching, whereas this teaching method enables women to learn through their voices and social engagement. Women engineers of this study therefore discussed how they learned from both social interaction (through teamwork), as well as reporting (in classrooms).

A question I pose in this discussion is what is the intention of a professor who calls on the female more than the male engineering students in the classroom? Are they attempting to isolate the female student, strengthen her confidence, or highlight her competency? Researchers, McIlwee and Robinson (1992) contended that female engineering students tend to excel higher than the males in the classroom, in which the professors appreciate. Whatever the professors' intention, which is likely to vary among professors and situations, students like Debra and Sherry were able to withstand the pressure and excel as a result. But what happens to some of the female engineering students who may feel singled-out by their professors? Do they lose their confidence and therefore change their majors from engineering? These questions were not answered in this research study, but perhaps future research studies focusing on these questions would contribute to understanding the meaning women make of such experiences, and whether it contributes to the retention or attrition of female engineering college students. It is important to note that the aforementioned classroom experiences reported were from participants, Debra and Sherry, who graduated engineering in the late 1980's. The women engineer participants who graduated in the 1990's and 2000's did not report similar examples. This could be interpreted as a hopeful implication that classroom experiences have become more equitable for female engineering students in recent years.

Results of the participants' stories showed that they learned engineering in college as well as the workplace through teamwork. As teamwork is commonplace in both the engineering classrooms and work environments, it is paramount that teammates share their talents and skills. The women engineers in the study gave several examples of teamwork situations from which they learned. A sub-theme that emerged involved their

feeling of validation when they felt inclusiveness with their male colleagues. When the women's voices were heard, and their talents acknowledged, they felt empowered. Conversely, they felt isolated when they were not acknowledged as part of the team.

Just as importantly as being heard, the women engineers of this study valued the voices of others—fellow teammates, engineers, technicians, and customers. Marie and Natalie aptly discussed how mutual empowerment of employees, and feedback from customers enabled the participants to learn to be better engineers. Similarly, Debra added the concept of diversity of professions that provided the team a multifaceted perspective to an experimental approach. Ultimately, the appreciation of input from others called for setting their engineering egos aside, and seeking the knowledge of members inside, and sometimes outside of their immediate work environment, in order to optimize assimilation and talent of diverse teamwork.

In summary, the analysis of this study indicated that women engineers need to feel assimilated from the classroom to the workplace, with their voices heard, and contributions recognized in situated learning contexts. They also reciprocated and valued mutual empowerment in team situations. Gilligan's (1982) feminist theory was supported by this research in finding how women's learning styles benefited from social interaction and relationship building. As Fletcher (2001) purported, these relational practices are generally identified as female-gender role specific. However, in my view as a researcher, this perspective poses a challenge to conventional gender role characteristics, whereas certain situated learning contexts—such as in engineering classrooms and workplaces—rely on, or even require relational practices. Although a male dominated profession, engineering is such a profession where teamwork is prominent, and the reliance on the

expertise of others is critical to successful design and implementation. Therefore, male engineers must possess qualifications of team participation and value relational practices in work situations. Further, if gender roles of women are identified with concepts such as relational practice and mutual empowerment, then it would stand to reason that women indeed are much needed in the engineering workforce. This finding therefore implied that feminine gender-role characteristics of relational practices should therefore be valued assets to engineering recruiters in such a way as to motivate and increase more women to pursue engineering professions and by bringing their talents to the field.

The theme entitled *Gender, Age, and Race at Work* was in reference to the way these factors affect male/female work relationships. Rosser (2006) suggested that the feeling of isolation was a major concern of women engineers in the male hegemonic engineering work environment. Isolation was attributed to the disparity of female role models and the challenge of feeling excluded from those in power, namely male engineers. In addition, the issue of having to prove themselves to their male colleagues as competent engineers was a common response by several of the participants of the study. In this regard, Debra, Jamie, and Pat stated, "I know what I know," meaning that their high self-efficacy enabled them to maintain confidence in their engineering competency when challenged by their male colleagues. Furthermore, Debra added that she felt liberated when she came to realize it was not her responsibility to convince anyone that women are good engineers. Instead, her focus on her work and the task at hand transcended any doubt of her engineering competency, which in effect proved that women *are* good engineers.

Self-efficacy was a prevailing sub-theme among the women engineers of this

study during the discussion of the male/female work relationships. In this instance, the secondary theoretical framework, social cognitive career theory (Lent & Brown, 2008) applied, providing perspective to the study in terms of their feelings of competency in learning and being engineers. Specifically, having high self-efficacy enabled them to persevere through academic and workplace challenges, and even achieve advanced engineering career opportunities.

As some women engineers of this study sought assimilation, they experienced how older male engineering colleagues served as links to professional networks to bring them into the circle of power. The sub-theme of gender and age was discussed by some of the younger women engineers. While the young women engineers of the study appreciated the support and guidance of the older male engineers, they sometimes perceived ambiguity in communication with them, as to whether their engineering competencies were trusted by the older males. Studying the intentionality of the older male engineer would assist in understanding the meaning they made of the learning situations. However, this current study of women engineers instead focused on the subjective truth of the women participants, who at times seemed unsure of whether the older male engineers' intentions were positive. Participants who discussed this paradox were women engineers currently in the engineering workforce, which means this is a current issue of concern. The notion of not understanding intentions of the older male engineers implied that better communication between the male and female engineers could benefit the work climate. Improving communication could also foster effective mentoring in the engineering workplace. Effective mentoring of women engineers may foster their retention in the engineering profession.

Other relationships discussed by the participants were that of the relationships between themselves and their supervisors. The findings of this study showed that supportive supervisors, male or female, made a significant impact on the participants' perceptions of validation as contributing engineers in their workplaces. Stories of supportive supervisors were shared by participants who were engineers in the 1990's as well as those currently employed as engineers. Therefore, this study was not able to imply that supervisors have become more supportive of women engineers over the years. It instead implied that past and present supervisors range in personalities and leadership styles, whereas some are more supportive of their subordinates than others.

Nevertheless, some of the women engineers of this study expressed that the optimum way they learned to co-exist with their colleagues in the engineering workplace were by being their authentic selves. Frehill's (2001) research found that some women find it challenging and consider ways in which to conform to the male hegemonic engineering environment. Through analysis of this research, the participants who emphasized the importance of being authentic presented this valid characteristic as a means to getting along with others, feeling assimilation, and establishing visibility in the male hegemonic environment while maintaining their female gender identity. It was also duly noted that some of the women engineers did not feel isolated from male engineers, and furthermore they were able to use their gender as agency in cases where diversity of talent and staffing was sought. For example, using gender as agency occurred for one participant who was called for consulting to provide a female-gendered perspective.

In summary, implications from the *Gender, Age, Race, and Work* theme re-emphasized the notion that individuals and situations, and the interpretation of situations

determine the meaning that women engineers assign to their engineering experiences. Some of the participants found colleagues and supervisors to be more supportive than others, and various levels of feeling isolated and assimilated in their male/female work relationships. The feminist postmodern perspective (Creswell, 2007) framing this study allowed for subjective truth. The stories of the women engineers' truths supported the stance of Creswell (2007), who purported that our gender roles are critical to our perceptions of self. Self-perception affects the way we interpret behaviors and relationships in the workplace.

Of the five themes that emerged from the women's stories, the theme entitled *Work and Family Relationships* was the only specific theme reported to have direct influence on whether participants chose to stay or leave the engineering workforce. A recent theory called preference theory (Hakim, 2006) explains and predicts women's choices between work and family values. Preference theory describes the difference between the career choices of men and women in terms of their work and family priorities. Preference theory applied to the career decisions made by the participants of this study, particularly where married women, who are typically the primary care-givers in the family, are more prone than men to place their needs to balance work and family responsibilities above their career aspirations.

The engineering field entails long enduring projects and contracts that may continue for years. Engineers' responsibilities are affected by the nature of the projects, and thereby may require long hours and sometimes traveling until completion of projects. As women in today's society still carry the gender role of primary caregivers of family, women engineers often face the dilemma of balancing work and family care. Regarding

the four participants in this study who are married with children, three of them who worked as engineers in the 1990 decade left their engineering professions due to the need for time to care for their families. However, the participant who is married with children and currently works as an engineer in the 2000's has been able to remain in her profession due to the flexible work hours afforded by the engineering company for which she is employed. The unmarried participants who are currently employed as engineers are able to meet the demanding hours and travel requirements for now, but expressed concern as to whether they would remain as engineers should they marry and have children, due to the need to balance work and family.

The results of this study implied that engineering companies that provide family-friendly policies are more likely to retain women engineers. This finding is very important to the engineering profession, as the stories of the participants shared what it meant to face the challenge of balancing their priorities of family and career. In their cases, family priorities took precedence when forced to choose one or the other. Flexible hours enabled one participant who is currently working as an engineer to balance her priorities, and therefore not have to leave her profession.

It was difficult to determine whether age or time made a difference among the experiences of the nine participants of this study. Some women who left the engineering workforce in the 1990's did so due to work and family responsibilities, whereas one participant currently in the engineering workforce was able to remain because her company afforded her flextime. However, this study cannot be generalized to say that currently all companies in the 2000 era offer flexible time for working engineering mothers. Nor can it be stated that no engineering companies in the 1990's offered flexible

time. But rather, the findings of this study showed that three of them left engineering in the 1990's but one was able to remain in the 2000's due to flexible time in the workplace.

Although this study cannot be generalized, there may be indications that conditions in the engineering workforce are improving since the 1990's, in terms of implementing family-friendly policies. Yet, considering how the current unmarried engineers of this study voiced their concerns as to whether they would be able to remain as engineers if they were to marry and have children implied that more improvement in family-friendly accommodations is needed in industry. Perhaps the findings of this study may serve to inform engineering companies of the positive effects of providing such accommodations for women (and men) who must balance their work and family relationships.

The final theme addressed *The Essence of Being a Woman Engineer*. Throughout the issues and barriers, successes and supports of becoming and working as engineers, the participants of this study shared their feelings of high self-efficacy and pride of being engineers. According to the women engineers of this study, the essence of being a woman engineer meant they were intelligent and accomplished. They felt empowered to utilize their talents and technical skills to make positive changes in the world. Their perceptions of high self-efficacy aligned with the social cognitive career theoretical frame that described its influence on career decisions and development. The women were interested in participating in this study in order to enlighten others about their experiences with hope of encouraging other women to pursue this field, and to inform educators and employers of areas that may contribute to increasing the number of women engineers. Some of the participants commented that ideally they would like to be referred to as

"engineers," not "women engineers." But they realized that the disparity of women in engineering calls for attention to the matter, by identifying women as engineers, expressing their interests and concerns, as well as their accomplishments. They hope to reach a time in the future where engineering is not viewed as an unconventional career option for them. As a result, more women and men may become acculturated to accept engineering as a conventional field for everyone. Until then, women engineers' voices must be heard, to acknowledge their existence and value their contributions to society.

The issue described in this study's findings regarding Marie being a new engineer who joined her company and her colleagues thinking she was a new administrative secretary is indicative of the problem of the disparity of women engineers. It should be a given that a new engineer in the workplace may be a woman. Instead, social traditions in the United States place women in conventional career fields, such as secretarial. Such conventional, gender-based career expectations not only keep women out of certain fields, but imply they are unwelcome in these fields. Feeling unconventional can be uncomfortable for some women. That is why initially Terra felt embarrassed to tell people she was an engineer. She was tired of people asking her what an engineer does and then following up with the question of why she (as a woman) chose to be one. Terra later grew to embrace her engineering career decision to the extent of now spending her time performing outreach activities with young girls, encouraging them to follow her footsteps to pursue STEM careers. Similarly, Jamie considers herself a trail-blazer by being a woman engineer. Terra and Jamie's stories exemplified that in the 21st century, the number of women engineers are still so few, that women in 2012 are still considering

themselves trailblazers, although the literature review cites women engineers in the United States as far back as the early 20th century.

The question remains, why is it then that are there still so few women in the engineering workforce? And why is it that women who have worked so hard to become engineers, have proven their worth as engineers, enjoy the profession, and are proud of being engineers, still considering leaving the engineering workforce due to family reasons? The engineering workforce needs to make change in order to improve acculturation of women in engineering, as well as accommodate women's family-care needs. It is obvious that some of the companies have made accommodations over the years. Some organizations, such as where Natalie is employed, have made such adjustments, and as a result have enabled their women engineers to maintain their professions as well as care for their families. This is the action that apparently needs to be more widespread in order to retain talented women engineers in the workforce.

Some feminists (Hayes, 2001; Rosser, 2006) caution researchers about identifying differences between male and female engineers. However, such distinctions become necessary when issues such as childcare take precedence over staying in a particular profession. It is important however, to note that childcare issues are no longer considered only a woman's responsibility, as more fathers are sharing in this responsibility.

In summary of theme, *The Essence of Being a Woman Engineer*, regardless of whether they remained or left engineering, the participants' responses showed consistency in three major areas. First, family and child rearing were important areas of concern that factored into decisions of whether they chose or will choose to remain in engineering. Secondly, self-efficacy, confidence, and perseverance were common sub-

themes that arose which enabled women to become engineers and assimilate in a male dominated work environment. Third, there was an expression of an overwhelming sense of pride in being engineers. The women of this study wanted to encourage more girls and women to pursue engineering. No one in the study wanted to deter other women from the profession. As a researcher, I believe this is a positive and encouraging outcome of this study that could positively impact the engineering workforce. The engineering workforce needs to embrace the knowledge and attitude of women engineers such as the participants of this study in order to promote a more positive and welcoming environment for more women in the profession.

The Key Elements Found in this Study

Based on results that pertained to the research questions of this study, the following key elements were found.

1. With regard to internal validity, this study has proven that social cultural factors do influence women engineers' career decisions. Results of this study showed that mothers and some fathers of participants supported the participants' pursuit of college and successful careers, which indirectly supported their choices of engineering professions. Some participants reported their fathers as cautious of their choices to pursue engineering, due to their belief that engineering was more suitable for men. Other participants received support from male family members who were engineers, such as a grandfather and a brother. Basically, parents and family members varied in levels of support, but in general supported the participants' engineering career decisions. In addition, teachers, advisors, and peers are very influential in encouraging girls and women to become engineers.

These findings are in agreement with the research of McIlwee and Robinson (1992).

2. Women engineers need their voices heard, and their talents and contributions valued by their colleagues and supervisors in the engineering workforce in order to feel welcomed, equal and assimilated. Such feeling of inclusion is necessary to retain women engineers in engineering.
3. Flexible work hours and family-friendly policies at workplaces are necessary to retain working mothers in the engineering industry.
4. Women engineers are proud of their profession. They want to serve as role models and mentors to encourage more girls and women to pursue engineering. Male engineers may also serve as mentors to encourage more females to pursue engineering, particularly where there may be a shortage of female engineer mentors. Having both male and female mentors can foster positive communication between genders, and thereby transform the engineering work environment.
5. Positive social interaction and relational practices are valuable attributes to the engineering environment in regard to learning engineering, and the necessary teamwork in engineering design and projects. These are characteristics that both men and women engineers can bring to the engineering workforce.

Limitations

With regard to external validity, the phenomenological qualitative research of the voices and subjective truths of nine women engineers was not generalizable to all women engineers, but may be relatable to the experiences of many women engineers. Since it

was not generalizable, there were issues that were unanswered in this study. For example, experiences of the women engineers, such as certain gender role issues or family-friendly accommodations in the workplace traversed the participants' ranges of years of employment from the 1980's, 1990's, and 2000's. Therefore, this study could not determine whether family-friendly accommodations for engineering companies have improved over the years. In addition to these issues, participants of the study indicated they were sometimes uncertain as to whether their gender or young age, or combination of both affected their experiences in the engineering workforce. I was not able to discern this finding due to the limitations of this study.

My research presented another limitation in that it is unknown through this study how the male gender, as compared to the female gender group dynamic in engineering identifies with the need for relational practices in the engineering workforce. Specifically, if it is assumed that male engineers rely on each other's expertise to complete a successful design or project, i.e. exercise relational practices, then the feminist identity characteristic of relational practice in this context is thereby challenged. It would instead be suggested that relational practice is both a male and female characteristic in certain work environments, such as engineering. This notion supports the reason that some feminists (Fletcher, 2001; Hayes, 2001; Rosser, 2006) caution the overbearing of certain gender identifiers, in that some identifiers may either positively relate to both genders, or negatively infer stereotypes of women (i.e. they are less competitive and reliant on relationships) as well as on men (i.e. they are more competitive than team players).

Future Research

As mentioned in the limitations of this study, it was not discernible whether there were significant differences for women engineers in the engineering workforce within the years in the 1980's, 1990's, and 2000's. To better understand if conditions have changed or improved, I recommend a comparative quantitative study of engineering women of 1980's, 1990's, and 2000's in order to measure whether there is a significant difference in experiences, in terms of their sense of assimilation in the engineering workforce, and their reasons for staying or leaving.

A comparative study of women engineers within specific engineering fields, such as civil, chemical, electrical, environmental, and mechanical engineering, could possibly determine whether there are different experiences within these specific fields that affect the retention of women engineers.

Another qualitative study of women engineers could compare cultures from different countries in Europe and Asia to American culture, to possibly provide insight on differences and similarities of women engineers' academic preparation and social effects on their career decisions.

Regarding the issue of gender versus age barriers in the engineering workplace, I recommend future research involving a comparative quantitative study using a sample of male and female engineers to explore the relationship between gender and age in order to measure the effects of these factors on the experience of being engineers. This study could possibly better determine how gender or age, or combination of both effect retention of young male and female engineers.

I also recommend a qualitative study of both male and female mentors and mentees, in order to examine cross-gender mentoring relationships and the effects of communication in the engineering work environment.

Related to this topic is the issue of the young women engineers in this study who mentioned being taken under wing by older male engineers. The fact that they felt ambiguity in interpreting the communication between some older male engineers creates wonder about the experiences of young male engineers and how their experiences with older male engineers compared to the young women engineers. For example, how did the young male engineers perceive networking with older male engineers in terms of assimilation? Did the young male engineers also feel as though they had to prove their competencies to older male engineers in order to enter the circle of power in workplace? In this regard, I recommend a phenomenological qualitative study of young recently graduated male and female engineers to see how their experiences compare in the workforce. Results of studies of young male and female engineers may provide recommendations to the engineering workforce, such as 1) communication workshops to build relationships between older and younger engineers, and 2) mentoring programs to facilitate professional networking for younger engineers, with emphasis on gender-related issues of effective communication in the workplace.

An additional recommendation for future research is a study based solely on women engineers who have left the engineering profession, in order to provide more details regarding the various reasons why women engineers change careers. This information could be valuable to the engineering workforce in ways to improve retention.

The question remains of why there are still so few women in the engineering workforce when other occupations once considered nonconventional for women, such as medicine, law, and business have seemed to overcome the challenge of increasing more women in the workforces. Future research that may shed some light on the situation would be qualitative studies that compare women engineers to women professionals in medicine, law, and business industries. Questions regarding why they chose their career fields, how they were treated in the workplace as compared to their male counterparts, and why the women have chosen to stay (or leave) these fields would be helpful to understand what may be similar or different in the experiences of women in those aforementioned nonconventional fields to those of women engineers.

A related research project would be to study the actual workplaces of various nonconventional fields. Specifically, a research project involving a few engineering firms, business firms, law firms, and medical institutions may provide useful comparisons from the employer perspectives. Issues of diversity, male and female gender interactions and comparisons, family-friendly policies are areas to explore in search of differences that may matter, and recommendations that could be applied to engineering employers. The notion of such research is based on the experience of participant, Natalie, whose ability to stay in the engineering workplace is partially credited to the engineering company where she worked that provides her the flexible hours she needed in order to maintain both priorities.

Implications

My goal in writing this dissertation was to help educators recruit engineering students, and also educate engineering employers regarding what is needed to retain

women engineers in the workforce. The stories reported in my research will provide companies suggestions for improvement of the work environment for women, such as recognition of their talents, acknowledging their voices, and improving family-friendly policies.

In essence, when women are challenged in balancing work and family responsibilities, they are often prone to leaving or changing their careers for the sake of their families. This fact implicated that engineering companies secure a better chance of retaining women engineers when they allow for family-friendly policies that enable women to both care for their families while maintaining their professional engineering careers.

Recommendations

Based on the findings of the phenomenon of women engineers in this study are the following recommendations to prospective women engineers, engineering academicians, and engineering employers.

In reference to how women learn to be engineers, the women in this study commented regarding how they learned through their college classroom engagement and reporting. Therefore I recommend that the high inquiry classroom teaching method is incorporated or enhanced in engineering education. High inquiry teaching methods involve social engagement of students, and their application of subject matter in order to construct knowledge. According to the research of Cavallo, Rozman, and Potter (2004), this teaching method enables women to learn by constructing meaning about topics. I contend that the implementation of the high inquiry teaching method in engineering academia may prove beneficial in the classroom provided that professors exercise equity

in the treatment of both male and female students' participation and reporting. By doing so, stereotyping of gender role behaviors may be alleviated through allowing both genders to learn from diverse methods. Training students to learn and respond in diverse ways would also contribute to their ability to convey their knowledge in their future careers to colleagues, clients, and consumers in the engineering workforce.

Regarding women's preparation for the engineering workforce, I recommend more female engineering college students participate in the cooperative education program, which is designed to provide paid, career-related work experience to college students. Cooperative Education programs are widely offered throughout engineering colleges in the United States. I recommend that all engineering college students, male and female, participate in cooperative education in order to complement their classroom experiences with real-world experiences. Other recommended ways of preparation would include shadowing an engineer to see first-hand the engineering day-to-day work dynamics between colleagues. Colleges could also provide career workshops regarding work environment behaviors and expectations, so that both women and men can learn strategies for positive communication on the job. Career expectations and interpersonal communication skills could also be incorporated into engineering education, to compliment the technical and academic preparation. I also recommend mentoring programs in college and the engineering workforce for the enhancement of professional development of women and minority engineers.

Like the recommendations of McIlwee and Robinson (1992) and Mattis (2007), I recommend that women engineers seek women engineer mentors through organizations such as the Society of Women Engineers (SWE) and Women in Engineering ProActive

Network, Incorporated (WEPAN). In addition, I recommend engineering companies to develop and/or improve mentoring programs, so that women may obtain mentors, both male and female, to help improve communication styles between male and female engineers.

Engineering companies need to focus not only on the recruitment of women engineers, but on the improvement of retention of women engineers. As referenced by Burke and Mattis (2007), information regarding achievements of women engineers contributes to parity of women engineers. For this reason, I recommend that companies acknowledge and market the successful career stories of their women engineer employees, in order to attract additional women engineers. Engineering companies also need to share their stories, knowledge, and successes with other companies about how they attract and retain women engineers. By doing so, stories of the existence of successful women engineers in the workforce may attract more women to the field, which would help the engineering industry overall.

I recommend that both engineering employers and educators recognize the symbiotic effect of efforts to recruit and retain more women engineers as follows: Supporting women engineers in industry retains women engineers in industry. Retaining women engineers in industry may attract and foster recruitment of more women engineers in industry. More women engineers in industry may become mentors and role models to girls and women to pursue engineering. Therefore more women engineers in industry may foster recruitment and retention of more girls in K-12 STEM academic subjects. More girls in STEM foster recruitment and retention of college-ready young women in pursuit of engineering degrees which may foster more women with

engineering college degrees entering and remaining in the engineering industry, as industry may become known for supporting women engineers.

Conclusion

The purpose of this study was to understand the meaning that women engineers make of the social cultural factors that influence their reasons for entering and remaining in the engineering profession. This study was intended to meet the need to further research from college women majoring in engineering to women engineers in industry. By doing so, it is hoped that both engineering academia and employers will be able to better understand ways to recruit and retain more women engineers in the workforce.

The results of the study showed that issues and barriers, as well as challenges and successes traversed all of the five themes regarding social cultural influences of women engineers. In essence, the voices of the women engineers of this study emphasized that these experiences combined helped to determine their decisions of becoming engineers. Their technical skills, problem-solving abilities, and high self-efficacy paved their way to their engineering professions. As they faced gender-related issues and barriers in the male hegemonic engineering work force, they gained strength to persevere, and through maintaining their authenticity strived to gain the confidence of their colleagues and superiors. The challenges and successes of engineering careers provided them personal and professional rewards. All of their experiences, including perceptions ranging from isolation to assimilation, contributed to their context-based learning situations in college as well as the workplace, which combined helped them learn to become engineers, and assist in transforming the culture of the male dominant engineering workforce.

Work and family relationships were the issues of concern among the participants which caused some to leave the engineering profession where family-friendly policies did not afford them ample opportunity to balance both priorities. It was shown through this study that a company that offered family-friendly accommodation, such as flexible hours retained women engineers. In this regard, companies are recommended to consider or improve upon family-friendly policies, as an aid to retention of women engineers. This is a very important finding, as more women engineers, including engineers of color, are needed in the United States workforce in order to add diversity and increase the country's number of engineers. Moreover, engineering is a professionally rewarding career that would afford women more social capital.

In reference to social cultural gender roles, there are characteristics, behaviors, interests, talents, and activities that society deems as male or female gendered. I contend that acknowledging the fact that these characteristics exist in both genders and are utilized based on situational contexts may serve to transcend societal stereotypes and conventional gender roles. With regard to the engineering profession, integrating people in the workplace, free of restrictive stereotypes can therefore make way for all citizens, male and female, to offer their contributions to their communities, their workplaces, and the lives of others.

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Appendix A

Survey Questions for A Phenomenological Study of Women Engineers

1. Tell me about yourself.
2. What is/was your field of engineering? Why did make this career choice?
3. How did your parents, family, teachers, academic advisors, and friends feel about your career choice? What did their feelings and opinions mean to you?
4. How did your own feelings of confidence and competence play a role in your career decision?
5. Were you ever involved in competitive sports? If so, do/did you find an association between your sports and work behavior and/or experience? How so?
6. Describe your work culture in terms of relationships with your male and female colleagues and supervisors. What do/did these relationships mean to you?
7. Describe an engineering teamwork learning situation that occurred on your job.
8. What did this experience mean to you?
9. Describe any issues and barriers you have experienced as a woman engineer.
10. What did these experiences mean to you?
11. Describe any successes and supports you have experienced as a woman engineer.
12. What did these experiences mean to you?
13. Describe your balance of work and family. What do these experiences mean to you?
14. Describe your preconceptions of engineering prior to entering the workforce and how and why they may have changed over the years.
15. What social cultural factors played a role in your perceptions and experiences?

16. Explain why you have chosen to stay or leave the engineering profession.

17. Would you like to add any more information to this interview?