Impact of Social Supports on Persistent Women Engineers

Perspectives from the United States and India

by

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ABSTRACT

Lower representation of women in the engineering and computer science workforce is a global problem. In the United States, women in engineering drop out at a rate higher than their male counterparts. The male/female ratio in the engineering workforce has remained stagnant despite growing percentages of graduates. Women dropout due to familial responsibilities and they leave to take positions in other industries. In India, women are also employed at a lower rate than men. Many studies address the reasons why women leave, but few studies address why they stay. Those that do, address the personal and organizational characteristics that enable women to persist. Little research was found regarding the social supports that further women's ability to persist in the male-dominated field of engineering. This study surveyed 173 men and women engineers in the United States and India as well as collected qualitative data. The research focused on the social supports of family, friends, a special person, supervisors, coworkers, and professional networking, to determine how they support engineering persistence in the four demographics. The participants were scored on their level of persistence and the impact of social supports was evaluated against it. All supports were significant, although not for all demographics. Social supports of family, friends and a special person were more important to the sample of engineers from India, a collectivist culture. The importance of the supervisor relationship to women in the United States was reaffirmed. Professional networking, informal or formal, was the only support significantly related to persistence across all demographics. In the qualitative data there was a strong theme; coworkers are their friends and they support them in their engineering life. As companies re-think their organizational environment and attempt to

change engineering culture and long-standing attitudes, women can engage in creating strong social supports and assist in building quality professional networking opportunities. A strong web of support strengthens a woman engineer's ability to persist during difficult times and provides them opportunities for personal and career growth. It can also be a vehicle for furthering diversity and inclusion in their organizations.

DEDICATION

A special dedication to my Dad,

Major John Wayne Kehres

It was your love for education, your love for your daughters and your unfailing support that created my desire to pursue my Master's degree (it just took me forty years).

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A special “Thank you” and my eternal gratitude to my husband who supported me and took care of things when I couldn’t (the wedding, the family trips, the funeral, the hospital visits).

To my children (Richard, Joie, Jackie, T, Samantha, Pieter and Preston) and my grandchildren (John Wayne, Asha, Richie, and Ava) for the joy you bring into my heart.

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CHAPTER 1

PROBLEM STATEMENT

What are the environmental and cultural factors which lead women to leave engineering after they have challenged the stereotypes, completed a grueling education and then landed a traditionally well-paying job? Research exists that examines the reasons women leave, but less is known about what factors influence female engineers to stay in engineering. What skills, attitudes and support systems do women need to not only survive, but be successful and even allow them to be an agent for change in the male-dominated, masculine environment of engineering that exists in the United States? Are the factors that impact engineering persistence common for both genders? Do other countries have similar issues and success factors? What can we learn from similar technologically advanced societies?

The lack of women in Science, Technology, Engineering and Mathematics (STEM) related fields is often discussed as a "leaky pipeline" metaphor. The National Science Foundation (NSF) introduced the pipeline model back in the 1970's to measure and predict workforce needs. The model is based off a "linear sequence of steps necessary to become a scientist or engineer" (Metcalf, 2010, p. 2). The loss of women at any of the steps was considered a 'leak'. Females were less likely to be encouraged to build skills and interest in math and science as a child or adolescent, less likely to go to college, less likely to choose STEM as a college major and less persistent at graduating in a STEM field. Once women successfully completed their STEM education, they were less likely to enter into their trained profession and less likely to stay as compared to their male counterparts (Metcalf, 2010). Much research has been done and many programs exist to attract women and improve the environment in STEM education resulting in more women graduating in STEM fields. There are more women entering the pipeline. As causes for the female exodus from the engineering workforce are identified, it shines a light on the issues and raises them to the consciousness of government and business. When the causes deal with the engineering culture and environment, they can be difficult and slow to change. In the meantime, what can women do to increase their likelihood of persisting in their chosen field?

Focus on Engineering and Computer Science

Women such as Ada Lovelace, Grace Hopper and the female computer programmers of the first computer were early pioneers in the computer industry (Sydell, 2014). Despite early involvement in the field, women have failed to have the same success in computer science as compared to the medical and law professions. The graph in Figure 1 shows the comparison between the percentages of women in other formerly male dominated college majors and computer science. In the United States (US) the percentage of women studying computer science was on the rise, but in the mid-1980's the male/female ratio began to decline and has failed to rise to 1980's level of enrollment (Henn, 2014). For the basis of this research, Computer Science graduates, also referred to as software engineers, are linked with engineering disciplines. The engineering profession, regardless of degree type, frequently operates under tight deadlines, unexpected problems, and changing customer demands. It is a profession that experiences constant change as advances in technology redefine the fundamental tools, processes and even job descriptions.

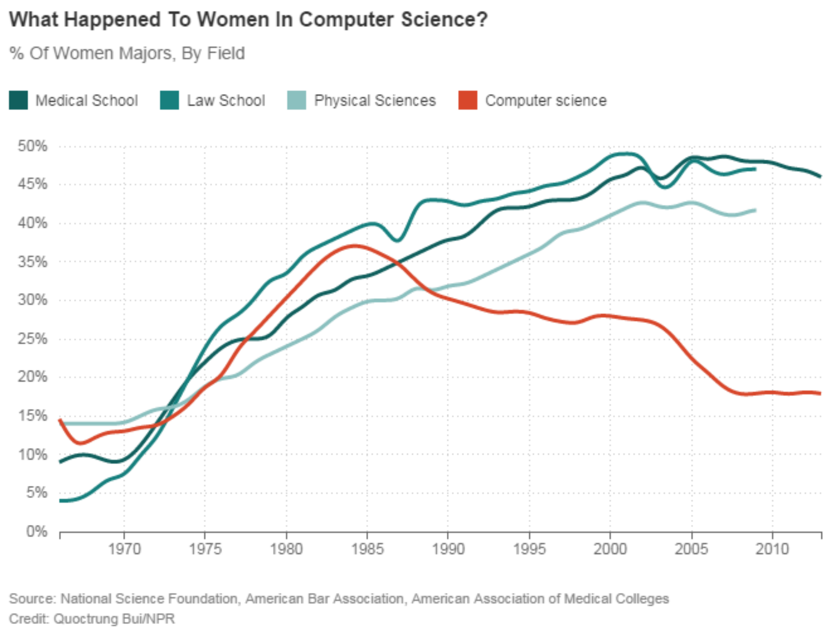

Figure 1. Percent of women majors in the United States, by field (Henn, 2014).

When we look at all science and engineering bachelor degrees awarded in the United States, it appears women have closed the gap receiving 50 percent of the degrees (National Science Foundation, 2012). In the fields of engineering and computer science women are underrepresented, with approximately 19 percent of Bachelor's degrees awarded to women. Although there are more women entering and graduating in these fields, there are also more men, and the male/female ratios have dropped. Between 2002 and 2012 the percentage of female computer science graduates dropped by 10 percent and female engineering graduates dropped 3 percent (NSF, 2013). The 2011 American Community Survey (ACS) conducted by the U.S. Census Bureau identified that among science and engineering graduates, men are working in their trained occupations at twice the rate of women (Landivar, 2013, p. 23). There is a larger gender imbalance in the workforce, implying the lower number of graduates is only partially responsible for the low representation of women in engineering. Compounding the lower percentage of women graduating in engineering and computer science with fewer women working in their chosen field, the United States experiences a lack of gender diversity in the high-tech industry. In the United States, 82 percent of STEM jobs are in engineering and computer occupations (Landivar, 2013, pp. 4-6). 76 percent of STEM jobs held by Science and Engineering graduates are male (Landivar, 2013, p. 22). Although the number of women working in these fields has increased since 2004, the ratio of men to women has remained virtually unchanged (NSF Table 9-2, 2013).

Importance of Gender Diversity

Technology touches all parts of our lives from the razors we use in the morning, to the water we drink, the phones we use, the cars we drive and the computers we use to do our jobs. Innovation and growth is about who can develop and patent new technology that meets a need in the global market, who can bring new perspectives and create innovative and creative solutions to complex problems. It is necessary to have gender diversity for "women's voices are essential to the problem-solving and innovation that is at the heart of engineering" (Collis, 2013). Research shows that the intelligence of a team increases when there is a woman on the team (Anita Borg Institute) and that "gender balanced teams consistently outperformed other teams" (London School of Business, 2007). Gender diversity enables teams to solve problems in diverse ways. Half of the world's population are women and they need to be part of the research and innovation required to solve issues, since they provide a different perspective. It is generally accepted that the problems of today can be better solved by the innovation from cultural and gender diverse teams of tomorrow.

For corporations there is a financial benefit to gender diversity. "Gender-diverse companies" are 15 percent "more likely to have financial returns above their national industry medians" and 35 percent for "ethnically diverse companies" (Hunt, Layton, & Prince, 2015). Businesses are concerned about building and retaining engineering skillsets so they can compete in the global market. For companies to be successful, it requires having the right talent which includes both gender and ethnic diversity. Although this study focuses on gender disparities, diversity and inclusion company initiatives are about bringing together and valuing diverse perspectives, experiences, life styles and culture (Donnelly, 2015).

Technology influences both developed and developing nations. Those nations that address gender diversity have the opportunity to improve the fiscal situation of their female citizens. Women have higher poverty rates than men (United Nations, 2015, p. 192), therefore educating them and providing them STEM employment opportunities has the potential to contribute to poverty reduction. For example, in the U.S., science and engineering women graduates working in a STEM field earn $16,300 more per year than those not working in STEM (Landivar, 2013, p. 23). Knowledge industries such as technology are highly sought after because of their ability to raise the Gross Domestic Product (GDP) of a nation. Ensuring the availability of qualified technical talent is a challenge and it is generally accepted there is a shortage of technological talent in the United States. Finding and retaining women in engineering and computer science fields is an opportunity to benefit from untapped talent and improve the human condition simultaneously.

A Global Problem

Social theorists view globalization as "fundamental changes in the spatial and temporal contours of social existence" (Scheuerman, 2010). Although globalization has been driven by the world's open economies, technology has been a vehicle for shrinking our world and changing our social existence. With the internet, social media and many multi-national corporations (MNC), socialization is not limited by the locality we live and work. In technology industries, many engineers work on virtual teams, whether within a MNC or partnering with corporations around the globe. Globalization and technology have made the world smaller by making societies more tightly coupled than in the past, causing an increase in interdependence and a co-mingling of culture and values. Most of what affects the United States will likely affect other nations. Although issues don't affect all cultures and nations the same, there is cross pollination of both problems and solutions.

Lower representation of women in the engineering and computer science workforce is not just a phenomenon in the United States, it exists globally. In 2012, the organization, Women in Global Science & Technology (WISAT), assessed Brazil, India, Indonesia, the Republic of Korea, South Africa, the United States and the European Union. The data for all the countries align closely with the data from the United States Census. At the college level there is underrepresentation of women in engineering, physics and computer science, although the trend is increasing percentages for all countries (WISAT, 2012, p. 64). An education does not always translate to entering and staying in the engineering labor force. The WISAT report also identified a drop in female participation as women transitioned from education to the science and engineering workforce "by about 30 points, indicating a substantial loss of females and the investment made in their education" (WISAT, 2012, p. 65).

Although this problem is nearly universal in the developed world, there are exceptions in the developing world. The United Nations Educational, Scientific and Cultural Organization (UNESCO) statistics identify the developing country Bolivia as having 63 percent of their researchers as female. The average number of women researchers in Latin America and the Caribbean region is 44 percent compared to 32 percent in North America and Western Europe (UNESCO, 2012). For many developing countries, the percentage of women in scientific and technical research is higher than many developed countries. In recent years educational and economic changes for women have allowed their numbers in STEM to grow in unexpected locations. In Jordan, for example, their computer science programs were 49 percent female in 2011. In many countries, the status of an engineer is second only to the medical profession. In developing countries, girls who do well in school are encouraged to pursue more financially rewarding occupations. Muslim countries are pushing to become knowledge-based economies, and are offering science and technology curriculum to women. Therefore, the societal acceptance of engineering as an acceptable field for women has facilitated gender parity at the college level (Matthews, 2013). In India, women are graduating at a higher rate, but the challenge is finding a job and once there, getting them to stay after they have children (IEEE WIE, 2011). Due to the global nature of the issue and the growth of multinational corporations, there is an opportunity to work together and possibly learn from other cultures. Globalization creates a social interconnectedness which crosses the traditional boundaries of culture and geography and opens up the possibility to learn from others who are outside our traditional sphere.

Perspectives from the United States and India

Although geographically India and the U.S are on opposite sides of the world, there is significant trade between them. India is the top outsourcing destination in the world (Tholons, 2014). Large MNCs have facilities throughout India or corporations partner with Indian companies. The number of Indian students who come to the United States for education purposes is surpassed only by Chinese students and 80 percent of Indian students studying in the U.S. pursue STEM fields of study. According to the 2014 census, Indians make up 5.2% of immigrants in the U.S, second only to Mexican immigrants (Zong & Batalova, 2016). Many technically-trained people immigrate from India, adding to the Indian population in high technology within the United States. It is not unusual to have global teams in MNCs that meet often, travel back and forth between the United States and India, and develop a close camaraderie. The intermingling can bring cultural respect and an environment that facilitates learning and adaptation.

In India, there are also challenges for women in engineering, but the environment is changing. In 2014, close to 25 percent of students studying engineering were women and the trend is on the rise (Choudhury, 2016, p. 99). In some technical fields, Indian women are graduating at a higher rate than their U.S. counterparts, for example, in 2003 55 percent of computer science degrees were awarded to women, compared to 25 percent in the U.S. in 2004. India is witnessing the growth of all-female private engineering colleges, which contributes to the rise in the number of women in engineering (Gupta, 2015, pp. 663-664). The high number of women graduating in engineering may not necessarily be to procure jobs. In higher levels of Indian society, educating women and giving them the tools to technology, supports improved marriageability. Arranged marriage practices tend to seek for spouses who have similar characteristics including class, economic status and education. Arrangements tend to place educated women with higher educated men. There may be no intention to actually work in engineering (Patel & Parmentier, 2005, p. 35).

When women graduate, they may encounter barriers to employment. Studies found there was higher unemployment by women engineer graduates, sometimes taking over a year to get the first job. 16.8 percent of Indian women reported they were not invited to campus interviews, in addition they had difficulty in getting jobs through campus recruitment (Singh S. , 2014). It was found that Indian executives carry gender bias, with 59 percent of male executives and 42% of female executives concerned about employing women. They reason, women engineers won't remain working once they marry and begin families (Patel & Parmentier, 2005, p. 39). Although market demand supports women's inclusion in technology fields, once women get the job, they are often pushed into gender appropriate roles as defined by Indian society. Women may be accepted as first line managers, but middle and high level management positions are predominately men. In addition to poor representation in leadership, they are often excluded from the higher end of development (Buddhapriya, 2013, p. 607). Technology in India is considered woman-friendly, therefore the male bias and the "horizontal and vertical gender segregation of the labour market" is perceived as related to the patrifocal nature of Indian society not with the culture or climate of the engineering industry (Gupta, 2015, pp. 668-669).

In the United States, we see more women receiving engineering degrees, but it is not translating to more women in engineering occupations. Women aspire to work in the field, but aspects of the culture, the environment or their personal lives is moving some women to leave the field. In the United States, the number of women employed in the engineering profession has remained steady around 10 to 11 percent since 1996 (Buse K. R., 2011, p. 4) . Once women graduate, 30 percent don't take jobs in their trained occupation. 56 percent of women with STEM expertise will leave the industry dropping out within the first 5 years. Within 18 years after graduation, only one-third of the women will remain and about half the men (Frehill, 2008, p. 15). Using the data from the National Longitudinal Survey of Youth 1979, Glass, Sassler, Levitte and Michelmore (2013) compared retention of women in STEM to a variety of professional and managerial women. Their findings were that women in STEM are eight times more likely to leave their chosen profession (pp. 739-740). The rate they leave the labor force is on par with other professional women (approximately 2-3%), therefore, the majority are leaving for different professions (Fouad, Singh, Fitzpatrick, & Liu, 2012) (Glass, Sassler, Levitte, & Michelmore, 2013). The data leads one to believe the retention of women in engineering is less about the work demands, the lack of education opportunities, the maturity or even the work demands, but about unique difficulties women face in engineering.

Defining the Focus for this Research

Since India is the top offshoring destination for high-technology and there is intermingling within MNCs, this study focused on women in the United States and India, who have persisted in engineering fields. It also incorporates perspectives from male engineers to seek for clues and help understand differences. The purpose is to investigate what enables women to persist and learn from other cultures and genders. The literature research was mainly focused on women in the United States with highlights from India and was guided by the following research questions (RQ):

RQ 1: What environmental and cultural factors influence women's persistence in the engineering workforce?

RQ 2: What personal characteristics influence women's persistence in the engineering workforce?

RQ 3: What social support systems influence women's persistence in the engineering workforce?

Environmental and cultural factors include the corporate organization, the development opportunities in engineering, societal norms, the corporate culture or climate and the social culture engineers must navigate. Corporate culture and climate define organizations. Culture has five components – values, beliefs, myths, traditions and norms. Although companies may capture some of their values in mottos, codes of conduct, etc., the remaining components are hard to measure and may be difficult to explain. The consequences of corporate culture is the organizational climate which is easier to measure. The factors that determine organizational climate are leadership, organizational structure, historical forces, standards of accountability, standards of behavior, communication, rewards, trust, commitment, organizational connectiveness, external environment, vision and strategy (The Kennedy Group, Ltd.). Personal characteristics are individual factors that a person has the ability to develop. Social support systems are helpful human relationships and interactions with others.

The literature review is based off the research questions. The findings for the environmental (RQ1) and personal (RQ2) factors are presented in the literature review. The empirical focus of this research is the social supports that impact women's persistence in the engineering workforce (RQ3). The research delves into the social supports that engineers can develop to support career commitment, satisfaction and persistence. The research was designed to identify the impact of social supports on persistence in engineering for women and men engineers in both the United States and India. The intent was to examine the four demographics to identify the similarities and differences and provide an understanding of what social supports have the greatest impact to persistence. Although organizational supports could be implemented to enhance social supports, the focus is on how engineers can build a "web of support" to enhance their career commitment and satisfaction. Institutional and systemic factors in the engineering environment, culture and organization are out of scope.

CHAPTER 2

LITERATURE REVIEW

Increasing the number of women in STEM and specifically in engineering is a hot topic of research and is also part of national and corporate initiatives. The data and the research is heavily focused on the United States, therefore, for this study, assume that all research is for that demographic unless stated otherwise. The STEM literature covers the topic starting with building girls' interest in math and science, the issues in graduating women in STEM majors and attracting and keeping women as STEM educators and in the workforce. Researchers are aware of the lack of gender diversity specifically in engineering and have explored the causes and contributing factors, including how a women's personal choices and the organizations they work for impact their participation. The literature specifically devoted to the retention of women in the engineering workforce is growing and covers, why women leave, why women stay and what changes can be made to improve retention. Corporations are addressing organizational changes required to support an environment of diversity and inclusion, but that research is outside the scope of this study. This review is focused on the end goal of retaining women in the engineering workforce and specifically on those factors that can be cultivated by the individual and are required for women's success. An overview of the engineering environment and culture that women navigate will be covered. The theories related to career persistence of women engineers will be reviewed and analyzed to determine the variables women can influence directly, specifically the personal factors and social supports that impact retention of women in engineering.

Much of the research regarding how to increase women in the STEM pipeline has been in the realm of education – how to increase women in STEM education as students and as educators (Dawson, 2014) (Blickenstaff, 2005). There has been considerable focus on why women drop out of STEM majors and includes recommendations for how to increase the number of women completing degrees in STEM fields. Recent studies claim that the gap in the dropout rate in STEM majors has been closed and more focus is required on increasing the number of young women entering STEM fields. Current research shows that at the university level, male-dominated fields such as engineering are retaining the women at the same rate as the men (Miller & Wai, 2015). The university environment may be more inclusive and there may be interventions that support a lower dropout rate in STEM majors thereby shoring up the STEM pipeline leaks in college. In June 2016 Dartmouth College's Thayer School of Engineering was the first university to reach gender parity, when they awarded 54 percent of their undergraduate engineering degrees to women (Thomas, 2016). There is progress in retaining women at the college level, so the next step is making the leap into the STEM workforce.

Although increasing the number of women educators and graduates increases the number of women in the 'pipeline', it does not, by itself, solve the problem of gender diversity in the engineering workforce. Engineering is a challenging field and has retention issues regardless of gender. In 2004, Preston "reported that all engineers leave the field at a rate four times that of doctors, three and a half times that of lawyers and judges, and 15-30% more than nurses or college teachers" (Preston, 2004) Studies show that the issue of retention for women is more severe. In 2007, the Society of Women Engineers (SWE) found that one-in-four women in engineering leave after age 30, compared to one-in-ten male engineers (Frehill, 2008). A comparison of women in STEM to women in other professions found that 50 percent of women in STEM leave after twelve years in the industry compared to 20 percent of other professional women. The workplace demands are not drastically different between professions and is no different than what men engineers experience, but the poor retention of women engineers suggests there exists "climate issues or lack of 'fit' between worker and job" (Glass, Sassler, Levitte, & Michelmore, 2013, pp. 743-734). When the climate within an organization does not support inclusiveness or does not align with an employee's values or beliefs, a "lack of fit" may exist creating an undesirable environment. Before identifying what women can do to persist in engineering, it is necessary to understand the environment, climate and culture they navigate.

Environmental and Cultural Factors that Influence Persistence in Engineering

Understanding why women leave engineering provides indirect indicators of what influences women's persistence in engineering. In the early to mid-1900s, lower representation of women was attributed to sex discrimination in hiring. The current data suggests that in the U.S., overt discrimination is a past problem; it is technically illegal and support structures are in place to combat its practice. Focusing on the current problems is required to understand the engineering environment that women maneuver, including the bias in the industry (Ceci & Williams, 2011). The barriers women confront in engineering may not be blatant and the women themselves may be unaware of the challenges they face. Barriers can come from society, organizations and individuals, even from themselves. Women in engineering may experience barriers to achievement, unconscious bias, second generation gender bias and intentional as well as unintentional discrimination, all while balancing more family responsibilities. Unconscious bias occurs when our brain makes quick judgements which are based on our socialization and past experiences. It affects both men and women alike and we are often unaware when it occurs. Second generation gender bias is an implicit bias that is a subtle, invisible bias due to “cultural assumptions and organizational structures, practices, and patterns of interaction that inadvertently benefit men while putting women at a disadvantage” and it is also part of the societal imprint on women (Ibarra, Ely, & Kolb, 2013). For example, assertive behavior in a man may be seen as a good leadership quality, but as aggressive in a woman and not rewarded.

The Project on Women Engineers’ Retention (POWER) cited reasons for leaving engineering as seen in Figure 2. The work was identified 56 percent of the time, which included references to excessive travel, low salaries, no advancement, too many hours, poor working conditions and the engineering organizational culture. In addition, anecdotal discussions with women engineers point to reasons for leaving such as being pushed into management, lack of opportunities for promotion in technical paths, a male-dominated engineering culture and feeling their ideas are not valued. Work-family conflict was referenced 17 percent of the time and loss of interest in the work was cited 17 percent of the time. Issues with bosses and coworkers were cited 10 percent of the time (Fouad, Singh, Fitzpatrick, & Liu, 2012, p. 27). Wasilewski’s doctoral research (2015) and the research by Servon and Visser (2011) reaffirmed the findings of the POWER study citing issues with engineering culture, including bias and discrimination, and difficulties with colleagues. Both studies cited that women’s retention was also impacted by feelings of isolation. For men, isolation was not an issue and their persistence was negatively affected because the field required “too much interaction” (Wasilewski, 2015, p. 97). Due to globalization, jobs in engineering have developed extreme demands such as extensive travel, 100-hour workweeks, constant customer or colleague demands, working across multiple time zones and global responsibilities. Although the extreme nature of the job affects both men and women, it affects retention and advancement of women disproportionately. The demands put undue stress on dual-career families and impact family and childcare responsibilities typically belonging to women (Servon & Visser, 2011, pp. 278-279).

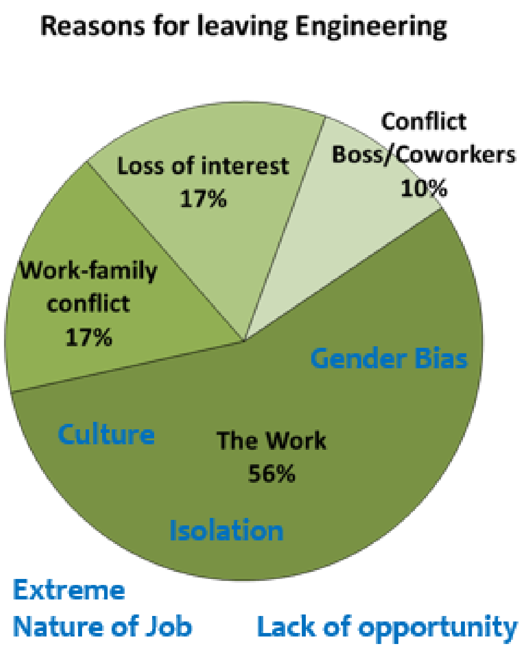

Figure 2. Reasons for leaving engineering.

Women deal with barriers their male counterparts don’t experience and they may develop survival strategies that have a negative impact on their career. Many men are unaware of the issues their female colleagues experience (Buse & Bilimoria, 2014). Although men experience the same work environment demands, women may cope with feelings of isolation, limited role models, mentors or sponsors. Often, they do it with less pay and less opportunity in their career progression (Ceci & Williams, 2011) (Servon & Visser, 2011) (Bornsen, 2012) (Buse & Bilimoria, 2014). These factors can contribute to feeling their efforts are not appreciated or that they are not supported. Competition is another factor, where some women admit that they themselves don't trust or support other women. They may assume they are competition or cannot be trusted or lack the "ability and power" to support them (Servon & Visser, 2011). Women may unconsciously promote barriers for other women or even for themselves. For example, forming cliques which excludes others and inhibits networking or volunteering to perform secretarial activities which marginalizes the perception of their technical abilities. Engineering can be an environment perceived as having limited informal or formal organizational supports; therefore women develop coping or survival strategies often in response to the barriers they encounter in the workplace. Some strategies have positive outcomes; some have a mixed outcome or possibly even do more harm to their career than good. For women who stay in engineering, two notable survival strategies found in the literature are adaptation and opting out of a career growth path.

The ability to adapt and change in response to stressful circumstances is a valuable skill in engineering. Due to the perceived barriers that women face in engineering, they learn to adapt or a least appear to conform to the male-dominated environment they work in. They must learn to navigate in a corporate culture which is a masculine social construct, where masculine traits tend to be rewarded and hostile and predatory behavior can leave women feeling marginalized and isolated. This behavior may take the form of sexual harassment, being viewed as less capable, bias in evaluations and unwanted attention due to their feminine appearance (Servon & Visser, 2011). To cope, women may determine feminine traits are inappropriate in engineering. They may dress less feminine, change the way they communicate and may adopt male styles of behaviors. In a sense, this response contributes to advancing of the male-dominated culture and further marginalizes women. It can also contribute to the competition women feel with each other (Bornsen, 2012). Women adapting to the male-dominated culture and training programs to help women assimilate into the environment, assume women are the problem. The adoption of masculine traits, therefore, is not necessarily a viable solution since it only focuses on changing women.

For some women, the cost to grow in their career may mean personal and family sacrifices they aren't willing or are unable to commit to. Women's choices are "constrained by biology" due to giving birth and the societal imprint they have experienced since they were children. Their choices may be due to gendered expectations impacted by work-family balance options available to them (Ceci & Williams, 2011, pp. 3156-3157). Women in India and the U.S. spend more unpaid hours than men on household responsibilities and care-related activities. U.S. women spend twice the number of hours than men and Indian women spend 10 times more effort than men (WISAT, 2012). To stay in engineering, they may find a "pocket of sanity" where they feel comfortable, where they opt out of a career growth path. They may stay for long periods of time in a position or even shift to lower level positions at the detriment of their salaries and advancement (Servon & Visser, 2011, p. 280). While women are making these choices, men may be earning more and making advancements in their careers. Women, or any engineer for that matter, who stay in the comfortable job for long periods of time or downshift in responsibility, run the risk of being written off by management which feeds into a lack of advancement opportunities.

Organizational changes aimed at changing the work culture and environment is necessary to have real progress in growing the number of women in the engineering workforce. Work culture and environmental factors that have a positive impact on persistence in engineering include normal workloads, clear work direction, supportive co-workers and supervisors, mentoring and company development opportunities (Fouad, Singh, Fitzpatrick, & Liu, 2012, pp. 58-60). The Project on Women Engineers' Retention (POWER) made the distinction that career satisfaction did not impact decisions to leave engineering, but job satisfaction did. It found women who stay committed to engineering are "less likely to consider leaving engineering when the company invested in their training and development, provided them with opportunities for advancement and valued their contributions to the organization. Finally, family friendly work cultures and availability of work-life benefits played an instrumental role in discouraging women from thinking about quitting their companies." (Fouad, Singh, Fitzpatrick, & Liu, 2012, pp. 52-55). For example, Google decreased post-partum attrition by 50 percent when they extended maternity leave to five months and "changed it from partial pay to full pay" (Madrigal, 2012). Infosys in India provides paid maternity leave, one year child care sabbaticals, part-time and flexible hours and a "Stay Connected" program to help women return to employment (Khosla, 2014). If employees are allowed to have a longer career ladder giving them the ability to pause during family demands without fear of becoming obsolete or "written off", companies are able to create an environment where women can be productive and thereby increase retention (Servon & Visser, 2011, p. 279). However, changes to culture, climate and organizations can be slow to change and are not universal across all companies. Understanding the factors that allow women to persist in engineering in spite of negative conditions, can provide insight into the skills and behaviors that can help them endure and even thrive.

Personal Factors that Influence Persistence in Engineering

The research regarding retention of female engineers has adapted and extended existing theories – Social Cognitive Career Theory (SCCT) and Intentional Change Theory (ICT) – as well as the creation of career persistence models using the grounded theory method. The studies explore the career persistence of women in engineering and point to women who are highly confident in their abilities including technical, juggling their work-life balance and maneuvering within organizational politics. Persistent women engineers have positive attitudes and expectations regarding their role in engineering and they identify as an engineer. Persistent women engineers are less likely to be married and most likely have fewer children, due to cultural conditioning to juggle work and non-work roles (Buse, Bilimoria, & Perelli, 2013). The personal factors found to positively impact persistence (common among the various researchers and variables within theories) are self-efficacy, identity and the related "ideal self", hope, optimism, adaptability and work engagement. Of these individual factors, self-efficacy, identity and the "ideal self" are core constructs of existing theories.

Self-efficacy. Confidence is closely related to self-efficacy in that it refers to the strength of your belief in something, but is not necessarily tied to an outcome of success. Self-efficacy (also known as social cognitive theory or social learning theory) is the belief in your ability to succeed, where higher levels of self-efficacy determine "how much effort will be expended, and how long it will be sustained in the face of obstacles and aversive experiences" (Bandura, 1977). It is an individual factor that is the central component of Social Cognitive Career Theory (SCCT). Lent, et al. (2003) identifies the impact of perceived organizational supports and barriers on self-efficacy and the relationship it has on outcome expectations, interests, goals and thereby persistence. Multiple researchers extended the SCCT model to explain women engineer's career persistence or turnover intentions by incorporating career attitudes such as career satisfaction and commitment. The studies found that self-efficacy positively impacts work engagement and career persistence as defined by career attitudes (Fouad, Singh, Fitzpatrick, & Liu, 2012) (Buse K. , 2012) (Bornsen, 2012) (Singh, et al., 2013) (Buse, Bilimoria, & Perelli, 2013) (Dawson, 2014) (Buse & Bilimoria, 2014). Furthermore, the applicability of SCCT has been tested in South Asian contexts, which found the theory is applicable outside the Western context. Self-efficacy was determined to be a predictor of persistence for both men and women (Saifuddin, Dyke, & Rasouli, 2013). Although it does not guarantee persistence in engineering, cultivating self-efficacy is a tool that can help women solve engineering problems and confront the barriers they experience in engineering. The POWER study which investigated both those who persisted in engineering and those who left, found that self-efficacy was present in both groups. One can assume it is not a key determinant of persistence, but rather the lack of self-efficacy hinders persistence (Fouad, Singh, Fitzpatrick, & Liu, 2012).

The barriers women face in engineering can impact the ability to sustain and enhance their self-efficacy. To strengthen and build self-efficacy, Bandura (1977) identified four approaches – performance accomplishments, vicarious experience or modeling (seeing others achievements), social or verbal persuasion and psychological states such as moods, emotions and stress (p. 198). Women can learn how to develop self-efficacy by looking for and taking advantage of opportunities where they can obtain necessary feedback. Women engineers may be at a disadvantage due to a lack of mentors and female role models. Having a good relationship with co-workers and supervisors is important for celebrating accomplishments and receiving the feedback required for self-efficacy growth regardless of gender.

Identity, Ideal Self and Personal Vision. Identity is how an individual perceives themselves and in the case of this study, is comprised of the perceptions they have as it relates to being an engineer. Studies found that identifying as an engineer has a positive influence on persistence for both women and men in engineering (Wasilewski, 2015) (Buse K. R., 2011) (Buse, Bilimoria, & Perelli, 2013) (Buse & Bilimoria, 2014). Using the SCCT theory, Buse, Bilimoria and Perelli (2013) concluded that identity is one of the individual factors that influence persistence. Wasilewski's doctoral research (2015) noted that identity can be framed from the social perspective using social identity theory (SIT), self-categorization theory (SCT) and cognitive dissonance theory. According to SIT and SCT, individuals define who they are as part of group membership. Cognitive dissonance theory implies people will seek for consistency when their behaviors are not in alignment with how they perceive themselves. If their identities are inconsistent, there is stress, and depending on the magnitude may provide the motivation to make a change, including that of leaving engineering (Wasilewski, 2015). As a social construct, identity could be impacted by the barriers that women experience such as feelings of isolation, exclusion from informal networks and lack of support.

Identity has been found to impact the ideal self as researched by Buse et al (2011; 2014; 2012), which in turn impacts engagement and career persistence in women engineers. The ideal self is our personal vision of who we want to be and is driven by our dreams, hopes and identity. They are constructs in the intentional change theory (ICT) which is a complex system with multiple levels. The intentional change occurs through a series of five discoveries, the first being that of the personal vision of our ideal self (Boyatzis, 2006). Using ICT as a framework, Buse (2012) proposed a career persistence model that established five discoveries which are “the ideal self, the real self, career persistence, learning and adapting, and resonant relationship” (p. 119). When the ideal self and real self are misaligned, it creates a ‘tipping point’ where women may decide to opt out of engineering. Although engineers may expect to continue in their field, pressures such as “birth of a child, the death of a parent, a new manager, a company-wide reorganization, or the effects of a hostile work environment” may illicit the ‘tipping point’ (Buse K. , 2012, pp. 120-121). Those who persist see engineering as part of their core identity and have a personal vision that serves as a motivation to persist in the face of barriers (Buse K. R., 2011, pp. 119-120). The interrelationship of identity, the real self and the ideal self and their impact on career persistence for both genders provides an understanding of how engineers can develop a personal vision to insulate themselves from life changes that could threaten their commitment to engineering.

Initial development of an engineer identity most likely occurs during college. If women find it difficult to fit in at that level, and have a difficult time identifying as an engineer, they most likely will struggle during the transition to the workforce or not make the transition into the workforce. Those who start their career identifying as an engineer may experience “less adaptation and conformity” demands, which decreases the stress on adjustment to a new career. As women progress in their career, they may find themselves at crossroads where experiences and interests may change the course of their career and their identification, for example, parenthood. When individuals are confronted with the changes in their life, they experience a time of evaluation where they respond to feedback, both external and internal. If the new identity does not align with that of being an engineer or the two identities are incongruous, an adjustment may be required, which may include leaving the job, and for women often leaving the industry (Wasilewski, 2015). Developing a personal vision which includes being an engineer is a proactive approach to preparing an individual for future crossroads. The personal vision is often a positive vision 10 to 15 years in the future and can be a guide for future behavior (Buse K. , 2012, p. 123). For what we dream, we seek; what we seek determines what we do; and what we do prepares us for who we can become.

Social Support Factors that Influence Persistence in Engineering

Some of the reasons why women leave engineering – the culture, work-family conflicts and issues with bosses and coworkers – can be impacted by social supports. Women experience the pull of family, often to a larger extent than men, either through dependents or other care-taking responsibilities or if in a relationship, through the pressures of balancing two-careers. Within engineering, women are a minority and they may not get the social support they need from their colleagues. They may have difficulty finding coworkers who are willing to help them or listen to them when experiencing difficult challenges at home or work. Due to the extreme nature of their job and the barriers they encounter in engineering, social supports from family, friends or the community may have a greater impact for women engineers. There are few studies that include in their research the social supports that enable women to stay in engineering. The literature regarding social supports fall into two categories – those that tie social support to the persistence of women in engineering and theories that are nearly universal.

Jepson (2010) identified three interacting variables that impact career success in engineering – corporate culture or climate, personal factors and social supports. Although the research identified a more substantial influence from personal factors and corporate culture, a positive relationship between social supports and career success does exist. Bornsen's doctoral dissertation (2012) used a grounded theory approach to design a model of persistence which focused on what attracts women to the field of engineering. She posited that the core category was a strong "web of support", which increased the likelihood of women remaining in the engineering field. The web in her research included support in categories of "attraction to the field, education, environment, adaptability, motivation, and strategies" (p. 64). Support is gathered from different areas and aspects of a women's life and if areas are missing, the web is weakened and threatens their success (p. 94). A strong "web of support" can create a safety net when plagued by difficult times in an engineer's work or life.

Social support theory defines social support as our relationships with others that help in some way, whether it be emotional (cared and loved), instrumental (aid in tasks) or structural (ties in a network). Social support research shows it is always beneficial, but is an important factor when in stressful situations. Generally there is a significant relationship between social supports and turnover intentions, where higher levels of social support are associated with lower levels of turnover (Lucas, et al., 2009, p. 56).

The nature of engineering is stressful due to constant change and high demands and social support may contribute to dealing with that stress. A related theory is the need to belong or belongingness theory. It is stated as “a need to form and maintain at least a minimum quantity of interpersonal relationships, is innately prepared (and hence nearly universal) among human beings” and is considered a powerful and influential human need (Baumeister & Leary, 1995, p. 499). A difference in how relationships are expressed can be found among men and women and so the means for achieving belongingness may be different. The hypothesis is that women focus on “close, intimate relationships” and men are oriented towards “larger networks of shallower relationships” (Baumeister, 2012, p. 136). In laboratory studies, those who are socially excluded (lack of belongingness) are found to exhibit behavior that is not conducive to high performing teams, such as reduced helpfulness, cooperation and impaired intellectual performance (Baumeister, 2012, p. 137). Therefore, the assumption is that inclusive environments make better teams and have a positive impact on turnover intentions.

Work Supports: Supervisor, Leader, Coworker. The barriers women face are tightly related to the corporate culture in engineering which is gendered and impacts the work relationships women have. Buse (2012) included the ‘relational culture’ as one of the contributing factors to career commitment for women engineers. The leader – member exchange or the relationship between one’s supervisor or boss has been found to be beneficial in creating engagement and thereby persistence in women engineers (Buse & Bilimoria, 2014). In general, the relationship with one’s direct supervisor/leader is a driver to employee engagement regardless of gender. Recent research by Fouad et al. (2016) determined that organizational factors such as workplace social support “are powerful drivers of employees' satisfaction and commitment with their careers" (p. 90). Leaders who engage with their women engineers, or with any employee for that matter, can positively impact their retention by providing support to help them develop their skills such as self-efficacy. In addition, they can help them find relationships that will support their success such as mentors and sponsors, which are not always readably available for women. Support and understanding by supervisors and coworkers regarding work-life challenges create positive environments that welcome and provide a sense of belonging.

Network Supports: Informal and Formal. Due to the gendered history of engineering, women often do not have access to the informal networks that are sources of opportunity for men. For example, the "men's room" conversation, the golf tournaments, the after work "happy hour" may be informal networks women are not invited to or able to participate in due to family responsibilities. Research on networking opportunities, whether formal or informal, was not found in the career persistence model literature for women engineers. One study explored networking and its impact on engineering career success and satisfaction; networking was not found to be a contributing factor (Jepson, 2010, p. 120). In India, firms such as Infosys founded inclusivity and family networks to address the unique needs of women. The programs appear to be working, but the literature lacks the evidence connecting these programs with improvements to retention of their women engineers (Buddhapriya, 2013) (Khosla, 2014). With more focus on the retention of women and with the growth of professional engineering organizations such as the Society of Women Engineers (SWE), women are availing themselves of the networking support these organizations can provide.

The value of female focused networking in the engineering community has grown in recent years. Professional networking organizations targeting women engineers have expanded their membership; the Society of Women Engineers (SWE) has approximately 35,000 members worldwide. In 2010 there were approximately 5000 attendees to their yearly United States conference with the numbers increasing to approximately 8000 in 2015 (SWE Organization, 2016). SWE held their first conference in India in April 2016 with 359 women in attendance (Bierman, 2016). The United States Grace Hopper Celebration of Women in Computing had about 6000 attendees in 2014 and they expect to have almost 15,000 in 2016 (Grace Hopper Celebration, 2016). They started holding conferences in India in 2010 and in 2015 they had over 2000 attendees, an increase of 41% from 2014 (Our Time to Lead, 2015). With so many women engineers graduating and working in India, there is room to grow networking organizations to provide the opportunities lacking for women. Corporations such as Honeywell and Northrop Grumman have established women councils to support leadership development and networking amongst their women. Women are availing themselves of networking opportunities and companies are tapping into women groups to support diversity and inclusion initiatives.

Family Supports: Special Person, Family, Friends. The family and work demands of women in engineering are not that dissimilar between women in other professions, but the reactions of women engineers is more severe. The longitudinal research by Glass, et.al (2013) found marriage for women in engineering negatively affects retention, but marrying a spouse who is also in a STEM field “nullifies the negative effects of being married”. Having a second child increased the odds of leaving the labor force for both women engineers and professional women – a 395-percent increase for engineering women as compared to a 147-percent increase for professional women (p. 741). Certainly work-life balance is a factor in retention of women engineers, but is it due to the nature of the job or lack of supports? This study did not investigate work-life balance issues. There was limited existing research on the impact that social support from family and friends has on persistence. Jepson's (2010) dissertation found social support accounted for only 3 percent of the variance on career success and satisfaction, but about 80 percent of the respondents felt friends or a special person were important to their success (p. 124).

Social Support Research in India. Research in the United States identified the organizational climate in engineering companies as one of the root causes of female lack of persistence (SWE Culture Study, 2016) (Fouad, Singh, Fitzpatrick, & Liu, 2012). In India, women may not experience the 'chilly climate' that exists in the United States (Escueta, Saxena, & Aggarwal, 2013), but the organizational climate hinders their advancement and impacts women retention (Donnelly, 2015) (Ravindran & Baral , 2014) (Poster, 2013). Indian men receive more support than Indian women, more supervisor and co-worker support, but also more support from extended family (Ramadoss & Rajadhyaksha, 2012). The differences in the extended family support may be due to the patrifocal nature of Indian society, where women leave their families to live with the husband's family and may experience more conflict than the men. No comparable research was found regarding the impact of marriage and children on women engineers in India.

Considerations for Societal Differences

The construction of social support is different between societal cultures and even between subcultures. Culture is learned and understanding the values of national cultures can provide a deeper understanding of social support sources. In his original research, Hofstede (2001) identified four core cultural patterns or value dimensions characterizing the dominant culture. His study ranked countries on the continuum for each dimension after surveying more than one hundred thousand IBM employees in 50 countries. Since this research investigated social supports from both the U.S. and India perspective, it's necessary to understand the distinctive differences in cultural patterns to assist in evaluating the data. The rankings for India and the United States for each of the dimensions are in Table 1 and the descriptions of the dimensions are:

1. Power distance is "how societies manage the fact that people are unequal." India has a higher power distance than the United States, meaning inequalities are expected and they tend to be dependent on more powerful people. In the U.S., subordinates most likely consider themselves as equal to their superiors (Samovar, Porter, McDaniel, & Roy, 2013, pp. 181-183).
2. Collectivism versus individualism is considered "one of the basic pattern variables that determine human action." The United States has a strong individualistic culture, where the individual is first and there are weak ties to the group. India is a collectivist culture where the individual has strong ties to the group. In general, Indians are closely tied to their community, defining who they are by the group or the community they belong. They tend to be focused on their

relationships and rely on their associations with those they trust and value (Samovar, Porter, McDaniel, & Roy, 2013, pp. 177-180).

3. Femininity versus masculinity is “the degree to which masculine or feminine traits are valued and revealed.” A masculine culture is one were emotional gender roles are distinct, men focus on “career success” and women on the “quality of life”. A feminine culture is where the roles overlap and both men and women can both be nurturing and focus on the “quality of life” (Samovar, Porter, McDaniel, & Roy, 2013, pp. 183-184). The distance in ranking between the U.S. and India is substantially less than the other dimensions, therefore substantial differences between the cultures are not expected.
4. Uncertainty avoidance is a dimension where both the U.S. and India are ranked as low uncertainty avoidance cultures. That means they “more easily accept the uncertainty inherent in life, tend to be tolerant of the unusual, and are not as threatened by different ideas and people.” (Samovar, Porter, McDaniel, & Roy, 2013, pp. 180-181)

Table 1

Hofstede Value Dimension Ranking Comparison between India and the United States (Hofstede, 2001)

Hofstede Value Dimension	*Ranking*	
	United States	*India*
Power distance	38	10/11
Collectivism versus individualism	1	21
Femininity versus masculinity	15	20/21
Uncertainty avoidance	43	45

Problems in the Literature

The existing research identified personal characteristics and organizational supports having the biggest impact on career success, satisfaction and commitment with the positive influence of social supports contributing to a lesser degree. The search of the literature found limited research on the impact of relationships, the impact of professional networking and limited comparisons between gender and cultures with regards to women's persistence in engineering. The value of the leader-member exchange was explored as part of organizational support literature, but there are minimal references to informal relationships with co-workers. The value of a spouse who understands or works in STEM is included in the literature, with little research on the support from friends and family. The value of professional networking was explored by Jepson (2010) in her doctoral dissertation, but the national and global environment has changed and new data could provide new information. There are few studies that compare what impacts male and female engineer's persistence and no literature was found that made comparisons between cultures with regards to engineering career persistence. Considering the socio-cultural nature of the barriers that women face in engineering environments, identifying the influence of the social supports women create in their work and non-work lives may be of value. During times of stress or 'turning points' in their career, the informal relationships women build may be sources of strength to weather the storm.

Hypotheses on Social Supports Impact on Persistence in Engineering

Although cultures may be distinctly different, there is common ground; the desire to be loved and cared for and the need to belong is shared across cultures. The basic assumption is that as human beings, regardless of culture, everyone needs social support from those who are important to them. Each demographic group – women in the United States, men in the United States, women in India and men in India – may lean on different supports, but the need for them has no gender or cultural boundaries. Bornsen's (2012) "web of support" correlated the importance to the persistence of women in engineering. The social supports to be examined are family, friends and community, workplace – including supervisors/bosses and coworkers – and professional organizations. The generic hypotheses for all demographics are:

Hypothesis 1 Perceived social support from family, friends or significant others positively impacts career persistence in the engineering profession.

Hypothesis 2 Perceived social support from supervisors and coworkers positively impacts career persistence in the engineering profession.

Hypothesis 3 Networking through professional organizations positively impacts career persistence in the engineering profession.

Significance of the Study

Increasing the number of women studying and graduating in engineering and technology is important, but to what end if women are not being retained in the workforce? High attrition comes at a cost to companies. The cost is more than just the hiring and training of new resources, there is a loss in organization learning, a loss of domain knowledge and possible losses in customer satisfaction (Mulla, Kelkar, Agarwal, Singh, & Sen, 2013). The cost of attrition and the loss of diversity impact a company's ability to compete. Understanding the issues women face and possible solutions can help companies identify organizational supports required to retain women. It's not just business, countries lose out on the benefits of a gender diverse workforce and a decreased ability to compete in the global economy. Their understanding of the issues women face can help them draft policies and community supports that can help women persist in engineering.

No research was found that focused on social supports effect on persistence in engineering nor were there studies with cultural comparisons. The significance of this study is insight into the social supports that influence career persistence, commitment and satisfaction. Investigating social supports for men and women in both the United States and in India opens up the opportunity to learn from each other. While changes to the culture and climate in engineering are in progress, engineers can develop skills and build supports that help them persevere during difficult times and contribute to their ability to be an agent for change.

CHAPTER 3

METHODOLOGY

The purpose of this study was to identify social supports that enhance the persistence of women in engineering. To be clear, this study did not examine if the reverse is true; the absence of these supports does not necessarily indicate women will leave engineering. The intent was to identify social supports that women can develop that will support them during the difficult junctures in their career and increase their likelihood of persisting in engineering. Engineers from India and from the U.S. often work together on global teams and an understanding of gendered and cultural differences and similarities contributes to a richer understanding of the issues. A mixed methods research approach was selected since the problem is a real-life issue with multiple perspectives. The research used a correlational design with triangulation to validate the quantitative data. Quantitative research assessed which social supports are statistically significant in their impact on persistence in engineering. Qualitative research provided a better understanding of the factors identified in the quantitative research. The qualitative data provided evidence to support the conclusion and provided anecdotal observations of how persistent engineers use social supports.

The quantifiable data from existing constructs provided support for using a survey to capture the impact of social supports, so a quantitative research method was selected. The intent was to expand knowledge by testing similar or new hypotheses in areas that have limited to no existing knowledge. This research tapped into a different audience than previous research, including male engineers and engineers from India. The extension to India was selected for multiple reasons, the main one being the opportunity to learn from a distinctly different culture, where the main differences are the power distance and individualistic versus collectivist dimensions. India was selected, because there is a large pool of English-speaking engineers, it is the number one outsourcing location by multi-national corporations, a large number of Indians study engineering and migrate to the U.S. and researcher access. Although the focus is on female engineers, understanding what supports work for and are available to male engineers may provide additional insight.

There were three phases to the research:

1. Survey Development: The building of a survey instrument targeted for the United States and India populations
2. Survey Collection and Analysis: The quantitative data collection and analysis of the survey data
3. Qualitative Data Collection and Analysis: The qualitative data collection and analysis as it relates to the findings from the quantitative analysis

Survey Development

The chosen data collection method was an online survey since it allowed for collecting information from diverse locales. The questions came from pre-existing constructs in the literature. The survey design followed the recommendations provided by Fowler in his book "Survey Research Methods" (1993, p. 94). Before initiating contact with the study participants, the Institutional Review Board (IRB) granted approval to proceed (APPENDIX A). The following activities were conducted to ensure the quality of the data collection:

- Conducted a focus group with targeted respondents to clarify the abstract concepts and variables included in the survey.
- Adjusted the initial set of questions based on input from the focus group. Built the initial online survey using the online survey tool "Survey Monkey" – tool link is https://www.surveymonkey.com/.
- Conducted 'individual laboratory interviews' concerning the online survey.
- Used the feedback from interviews to refine the questions and the data collection human interface.

The initial questions for the survey came from the literature and where possible the questions were patterned after existing research. Likert scales were used to tally the degree of importance for both subjective and objective data to support quantitative analysis. To ensure questions were clear to the audience, two methods were used to refine the questions.

1. A focus group composed of four engineers, one from each of the demographics, was conducted on concepts and variables to provide a richer understanding of the issues. The focus group protocol can be found in APPENDIX B. The intent was to identify unambiguous vocabulary and explanations and ensure all concepts were culturally sensitive. No issues were found.
2. A pilot online survey (APPENDIX C) was conducted using work colleagues from both genders. Two engineers from each gender and from the United States and India were asked to take the survey and identify any issues or clarifications required. A total of eight engineers were involved. They provided feedback on how questions could be worded to facilitate better understanding and more

precise responses. The survey was modified, due to minor issues found during the pilot survey.

Survey Collection and Analysis

The next step was to conduct the online survey with a larger audience. Using a snowball survey distribution method, e-mails containing the survey link were sent to engineers in the United States and India. Participants were requested through work colleagues, friends, a corporate women's engineering network, the Society of Women Engineers (SWE) and by word of mouth through e-mails and social media (Facebook and LinkedIn). The intent was to find respondents who obtained a degree in engineering and had five or more years of experience in an engineering field. Men were asked to participate with the purpose of providing a control group and an opportunity to learn what is similar or different as compared to women. Reaching outside the United States provided a greater understanding of attitudes and behaviors that enhance persistence in engineering.

Due to the higher percentage of men in the engineering workforce and the higher number of women who drop out of engineering, the expected challenge was finding women to participate in the survey. By capping the experience level at five years in engineering, an additional loss of the pool of respondents was expected. Based off of statistical research and the central limit theorem, a closer to normal distribution of the population was expected with a sample size of 30 or more respondents (Field, 2013, pp. 170-171). Therefore, the goal was to gather a minimum of 30 respondents for each group – women working in the United States, men working in the United States, women working in India and men working in India – a total population of 120 engineers. The actual challenge was finding women engineers in India. Due to the contact with women networking organizations, the women in the United States demographic was the easiest to fulfill.

The data collection took nine weeks due to personal and corporate circumstances. To obtain a higher response rate, a '3-step procedure' recommended by Creswell was used (Creswell, 1994, p. 122). Step one is an initial mailing, step two is a second mailing and step three is a reminder to complete the survey. The contact with the pool of respondents was conducted as follows:

1. Step one:
    a. An initial request with a mass mailing to collected e-mail addresses of friends and colleagues.
    b. A survey link was sent to women networking groups.
    c. A survey link was posted on women in engineering social media and LinkedIn.
2. Step two:
    a. A mass mailing two weeks later including a "Thank you" for those who completed the survey and a reminder to others. It also requested them to forward to engineers they knew.
    b. Due to the limited response from India, personal contact was made to Indian male and female colleagues asking for help in recruiting engineers in India.
    c. Another shorter reminder e-mail was sent five weeks after the initial mailing to known contacts as well as through social media and distribution channels.
3. Step three:

a. Mass e-mails were sent seven weeks after the initial mailing thanking those who participated and letting possible respondents know the survey would be closing in a week.
b. A more personal or focused contact was used asking for support in the India demographics.
c. Due to the difficulty in collecting the Indian women demographics, members of the corporate women networking group reached out to their colleagues in India soliciting support for the survey.

The data collection took longer than expected, so once the goal of the number of respondents was reached, the survey was closed. The collected data was analyzed looking for those variables with an impact on persistence. The hypotheses were used to analyze and contrast the results for the four demographic groups.

Survey Measures and Constructs

Existing studies were used to identify which supports to measure in the quantitative survey. The measures were taken from demographic data or from existing measures from previous research. Four measures, previously validated both in the United States and in India, were utilized. The constructs included in the survey are shown in Table 2. Responses were given on 4, 5 or 7 point Likert scales, where the higher score indicated a higher presence of the item being measured. The complete survey is in APPENDIX C.

Table 2

Survey Constructs

Construct	*Measures*	*Source*
Career Commitment (CC)	12-items using a 5-point Likert scale	(Carson & Bedeian, 1994)
Career Satisfaction (CS)	5-items using a 5-point Likert scale	(Greenhaus, Parasuraman, & Wormley, 1990)
Perceived Persistence (PPE)	Number of years as an engineer Ever chosen to leave engineering Career Commitment (CC) Career Satisfaction (CS)	Basic demographic questions
Perceived Work Supports (PWS)	12 items using a 4-point Likert scale (empty if no such person)	(Caplan, Cobb, French Jr, Harrison, & Pinneau Jr, 1975)
Perceived Social Support (PSS)	12 items using a 7-point Likert scale	(Zimet, Dahlem, Zimet, & Farley, 1988)
Networking (NW)	4 items using a 7-point Likert scale (empty if not applicable) Note: This measure was not validated in India.	(Jepson, 2010)
Demographic Data	Degree discipline Highest Degree received Industry sector employed Age Sex Country employed Country raised/educated Marital/relationship status Partner's education/career in engineering Dependent responsibilities Number of children	Basic demographic questions

Career Commitment (CC). The construct career commitment has been used to differentiate between dedication to the career as opposed to dedication to a specific job or organization. Blau defines career commitment as "one's attitude towards one's profession" (1985, p. 280) and created a 5-item measure (1999). The measure has been used in research studies conducted within engineering and Information Technology (IT) both in the United States and India (Buse K. , 2012) (Srikanth & Israel, 2012). Carson and Bedeian (1994) raised "construct contamination" concerns regarding Blau's measure. They highlighted an issue with possible overlap of career commitment and career withdrawal as well as validity and reliability concerns. They, in turn, created a 12-item Career Commitment measure which has been used in recent studies in the United States and India (Fouad, Singh, Cappaert, Chang, & Wan, 2016) (Rangnekar, 2015). The measures were aligned with our study "by replacing the generic words of "my line of work/career/field" with "engineering"" (Fouad, Singh, Cappaert, Chang, & Wan, 2016, p. 86). Fouad, et.al. found that career commitment was significantly related to women's retention, where there was a higher career commitment for women in the United States who are persistent in engineering (2016).

Carson & Bedeian's (1994) measure is composed of three subscales – Career Identity, Career Planning and Career Resilience – where the reliabilities ranged from 0.79 to 0.85 (pp. 251-252). The subscales Career Identity and Career Resilience provide additional value. Career/professional identity has been positively linked to career engagement, commitment and retention (Buse K. , 2012) (Buse & Bilimoria, 2014) (Wasilewski, 2015). Both personal and career resilience have been found to support retention and career success of women engineers (Kidd & Green, 2006) (Jepson, 2010).

A 5-point Likert scale (1=strongly disagree; 5 = strongly agree) provided a level of agreement for statements such as "Engineering is an important part of who I am" and "I have created a plan for my development in engineering." High scores show higher levels of career commitment.

Career Satisfaction (CS). For women in engineering, positive job satisfaction does not necessarily translate to commitment to engineering. (Glass, Sassler, Levitte, & Michelmore, 2013). Job satisfaction is related to the position currently held and research shows women who are dissatisfied with their job are more likely to leave engineering. Career satisfaction has been shown to be an indicator of career persistence. This will be measured using a five-item scale created by Greenhaus, Parasuraman and Wormley, which had reliabilities of 0.88 (1990, p. 73). The measure was found to be significantly related to women's retention, where there is a higher career satisfaction for women in the United States who are persistent in engineering (Fouad, Singh, Cappaert, Chang, & Wan, 2016). It was also used in India to measure the effect of self-efficacy and support on career satisfaction (Johri, 2015). A 5-point Likert scale (1=strongly disagree; 5 = strongly agree) provides a level of agreement for statements such as "I am satisfied with the progress I have made toward meeting my overall career goals." High scores show higher levels of career satisfaction.

Perceived Persistence (PPE). Persistence of women in engineering can effectively be measured by those who left and those who stayed. Tapping into the demographic of those who left is difficult, therefore the dependent variable Perceived Persistence (PPE) was created. Fouad et.al (2016) extended the Social Cognitive Career Theory (SCCT) identifying career commitment and career satisfaction as strongly correlated to an engineer's decision to stay or leave their profession. A precedence has been set where Career Commitment (CC) and Career Satisfaction (CS) were used to represent the concept of career persistence, sometimes in combination with demographic data such as position, years employed as an engineer and if they've ever left the industry (Jepson, 2010) (Buse & Bilimoria, 2014). For this study the Perceived Persistence (PPE) was a weighted average composed of four values – Career Commitment (CC), Career Satisfaction (CS), the demographic data for length of time in engineering and if they ever left engineering. The longer someone stays in an engineering field can be considered as having higher levels of persistence, whereas having ever left engineering may show lower levels of persistence. The higher the PPE value, the higher the persistence rating.

Perceived Work Support (PWS). Work social supports provide stress relief when dealing with family and work issues. A widely used and well established measure on perceived workplace social supports was created by Caplan, Cobb, French, Harrison and Pinneau, which had good reliability (Cronbach's alpha 0.70 or above) (1975). The scales have been used in the United States to explore the impact social support has on persistence in engineering (Fouad, Singh, Cappaert, Chang, & Wan, 2016) and has been used in India to research the moderating impact on work-family-conflict (Ramadoss & Rajadhyaksha, 2012). The scale was modified by replacing references to 'wife' with 'spouse'. It is composed of three subscales – supervisor/boss, coworkers and family (spouse, friends and relatives) – where each group has four items. On a 4-point Likert scale (1=Not at all, 2=A Little, 3=Somewhat, 4=Very Much, 0=Don't have any such person), the respondents rated levels of work social support they received over the majority of their engineering career. Questions such as "How much does each of these people go out of their way to do things to make your work life easier for you?" with separate entries for "Your immediate supervisor (boss, leader) …", "Other people at work …" and "Your spouse, friends and relatives …"

Perceived Social Supports (PSS). Due to the chilly and sometimes sexist climate in engineering, women must be equipped to deal with the outright as well as subtle forms of sexism. Perceived social support is a coping mechanism that is "associated with better psychological outcomes" for women who experience prejudice and/or unconscious bias (Chu, 2011). The Multidimensional Scale of Perceived Social Support (MSPSS) is a 12-item scale by Zimet, Dahle, Zimet and Farley, where the original study's reliabilities ranged from .85 to .91 (1988, p. 36). It has been used to assess social support impact on career success of women engineers in the United States (Jepson, 2010) and was also used in India to assess the social support impact on those who suffer serious health related issues (Peter, Kamath, Andrews, & Hegde, 2014). MSPSS is composed of three subscales – family, friends and significant other – where each group has four items. On a 7-point Likert scale (1 = very strongly disagree; 7 = very strongly agree), respondents rated the social support they have received over the majority of their career on statements such as "There is a special person who is around when I am in need" and "I can talk about my problems with my family". High scores show higher levels of perceived social support.

Networking (NW). There is limited research on how professional organizations contribute to career satisfaction and commitment in engineering. A demographic question on the opportunity to be involved in networking organizations was asked. The questions from Jepson's (2010) research were used by modifying "career success" with "career commitment". Using a 7-point Likert scale (1 = very strongly disagree; 7 = very strongly agree), respondents rated the networking opportunities they received over the majority of their career on statements such as "I am satisfied with the AMOUNT of networking opportunities given to me." Respondents were given the choice to select "Not Applicable".

Demographic Data. In addition to the questions mentioned in the measures, demographic data was collected to help categorize the results. The items include degree/field of engineering, graduation year, highest degree received, industry sector employed, age, sex, the country they live in and work in, country raised and educated, dependent responsibilities and the number of children. Engineering is unique in that persistent women engineers often have significant others who work or are educated in engineering fields. In addition to collecting relationship status, information was collected on the significant others educational background.

Qualitative Data Collection

The quantitative data revolved around three types of social supports – work, personal and networking. The qualitative data collected looked for narratives related to the three support types and was collected in three ways – open questions on the survey, focus groups and personal interviews. The focus group/interview protocol can be found in APPENDIX B and the same researcher acted as the interviewer. The thoughts and opinions collected were used to illustrate research findings and provide a deeper understanding of the social supports and their importance to persistence in engineering. The intent was to collect stories of why the variables are important and how those variables were developed and enhanced. Each focus group and interview was recorded and then converted to electronic text.

Survey Open Questions. The survey included open ended questions allowing respondents to share their thoughts. The open questions were:

1. Thinking back over your career, what, if any, social support factors particularly affected your engineering career the most and why (Jepson, 2010, p. 144).
2. Thinking back over your career, what, if any, networking opportunities particularly affected your engineering career the most and why.
3. In what ways, if any, did your marital status affect your engineering career? Please describe. (Jepson, 2010, p. 146)
4. In what ways, if any, did having dependents affect your career? Please describe. (Jepson, 2010, p. 147)
5. In what ways, if any, did your gender affect your engineering career? Please describe. (Jepson, 2010, p. 145)

Focus Groups and Personal Interviews. Two focus groups were conducted, one before the survey and one after the survey. The questions for the pre-survey focus group revolved around concepts and searched for common definitions between cultures, where each group demographic was represented by one engineer. The U.S. post-survey focus group was conducted with the purpose of collecting anecdotal and descriptive data. Due to technical and coordination issues, focus groups with India were not possible. Personal interviews were conducted with India over Skype. Due to holidays, festivals, work demands and the eleven and a half hour time difference, it was difficult to coordinate interview times.

Qualitative Data Analysis

Qualitative data analysis followed traditional coding practice as presented by Neuman in his book on "Social Research Methods" (2006, pp. 460-464). The analysis required review and coding of the qualitative data three times. The three levels of coding are:

1. Open coding is the first pass looking for themes, where initial codes are attached to the data. This pass used codes that were related to the data collected in the survey and revolved around work supports, personal supports, networking and an array of miscellaneous themes such as bias, country culture and personal attitudes.
2. Axial coding, the second pass, where the initial coding was examined in an effort to organize and identify the "axis of key concepts" (Neuman, 2006, p. 462).
3. Selective coding looks for contrasts and comparisons that support the coding categories. Stories or narratives that communicated knowledge, attitudes or behaviors were identified.

CHAPTER 4

RESULTS

The results for this study contains the following four parts 1) the demographic information collected from the survey, 2) a description of the tests run against the quantitative data for each of the hypotheses, 3) results from the qualitative data and 4) comparisons of the demographic groups. The assumption is that all demographic groups need social supports, which aligns with the need to belong theory; therefore, the hypotheses were generic regardless of gender or culture. A survey was sent to four demographic engineering groups – women working in the United States, men working in the United States, women working in India and men working in India. For each hypothesis, additional investigation was done for the demographic groups to further evaluate demographic differences. The significance threshold was set at .05.

Survey Response Rate and Focus Group/Interview Participation

There were 173 respondents to the survey. Due to the high dropout rate in engineering the first five years, engineers who worked in engineering fewer than 5 years were excluded. There were 16 respondents with fewer than 5 years; therefore the survey redirected them to the end and no data was collected. There were an additional 20 respondents who did not complete the survey, leaving 137 responses to be evaluated. The total population solicited is unknown since the request for responses was solicited using a web link. The link was sent with a request to forward onto other engineers. It was sent to work colleagues, friends, female professional networking organizations (Society of Women Engineers (SWE) and a corporate women engineering network) and social media (Facebook and LinkedIn).

A large portion of the women in the U.S. were recruited from female professional networking organizations. The snowball distribution method linked the sample with "Mommy Engineer" social media, therefore the data was skewed to women engineers with children and women who are involved with professional networking. The other demographics were heavily recruited through a multi-national corporation (MNC) and through former work colleagues through e-mail and on LinkedIn. Although the U.S. women demographic may be skewed towards a sample closely tied to networking and family, the other demographics are not, and act as control groups.

The respondents were divided by where they lived and worked, where approximately 10% of the respondents were raised in India but migrated to the United States. Since the U.S. is a melting pot of cultures and ethnicities, it was not considered an issue; the intent is to capture how engineers living in the U.S. navigate the culture. Throughout the research, the group demographic of the sample was used as a categorical predictor often referred to as "Demo-Living". The demographic makeup was 30 or more respondents for each of the four demographics as shown in Table 3. Women compose 50.4% of the respondents, with 28.5% from the United States and 21.9% from India. Of the respondents, 54% of the engineers are living in the United States.

Table 3

Demographic Makeup of Survey Respondents

DEMOGRAPHIC	*Number*	*Percent*
Men - India	33	24.1%
Women - India	30	21.9%
Men - United States	35	25.5%
Women - United States	39	28.5%
Grand Total	137	

The tool QDA Miner Lite v1.4.6 from Provalis Research was used to code the qualitative data. The qualitative responses are referenced as follows:

- The survey open-ended questions included comments from on average 56% of the 137 survey respondents. Women in the U.S. responded 73% of the time, with men in the U.S at 51%, women in India at 45% and men in India at 41%. References to survey sources are "Case #1" through "Case #173", where they are sorted in the order the survey data was entered.
- The pre-survey focus group included 4 participants, one from each demographic. They are referred to as "Focus-USF", "Focus-USM", "Focus-INF" and "Focus-INM".
- The post-survey focus group included 5 U.S. based participants – 3 women and 2 men. They are referred to as "Focus-F1", "Focus-F2", "Focus-F3", "Focus-M1" and "Focus-M2", where 'F' represents female and 'M' represents male.
- Two personal interviews were conducted with India over Skype, one male and one female. They are referred to as "Interview-M" and "Interview-F".

Survey Data Preparation

To prepare the data for use with Minitab® the data was cleaned as follows:

- The Career Commitment (CC) scale had 8 of the 12 items worded negatively. Since the scale would be used such that the higher score implied greater persistence, the negative items were reverse-coded, such that the 'strongly disagree' (1) was converted to a 'strongly agree' (5).
- The coding for the descriptive "ever choose to leave engineering" was changed so the higher number is representative of greater persistence. 'No' (2) was reverse-coded with 'Yes, I left but I have returned' (3).
- All zero and not applicable (N/A) data items were converted to empty cells so the statistical software would not count the entry.

Descriptive Statistics

To get a better understanding of the respondents to the survey, substantial descriptive information was collected. Table 13 in Appendix D lists the descriptive data collected, providing the total demographic percentage for each of the descriptive options. The options were also broken into the four demographics to help understand the differences between the United States and India and between genders. The descriptive categories were divided into education, employment and relationships.

Education. The respondents are well-educated with a higher percentage of the Indian men with advanced degrees (63.6%) and the women in the U.S. with only 35.9%; U.S. men and Indian women both approximately 43%. The three main fields of study are Aerospace, Computer-related and Electrical with U.S. women having the largest variety where 43.9% studied "Other" engineering fields. The wider variation in education fields for the U.S. women was due to tapping into the women's networking organizations. Of those working in the U.S., 12.5% of the women and 18.4% of the men studied outside the U.S., with 10.4% having studied in India. For those living in India, almost all studied in India.

Employment. The majority of the respondents (94.9%) are working in the corporate world and 81% are in the Aerospace industry. The U.S. women had a greater variation in their career position with 30.8% in management or higher positions compared to 14.3% for the U.S. men. Additionally 5.2% of the U.S. women were no longer in engineering by choice. Half the Indian women were in management or higher positions compared to 39.4% for the Indian men.

There were 17 of the 137 respondents that left engineering and/or came back, 13 provided input on why they left or returned. Just over 1 in 4 of the women working in the U.S. (11) left engineering and/or came back to engineering, compared to 10% of the Indian women (3). Of the 10 women who provided a narrative of why they left, reasons were due to layoffs, pursuit of education, and half left for family reasons. The men (3) left for positions in other industries, but two returned to engineering due to the technical challenge it provides.

Figure 3 compares the number of years in engineering across the demographics, indicating the older age of the U.S. engineering respondents as compared to India. For India respondents and women in the U.S., the median for the number of years in engineering is 11 to 15 years, whereas in the U.S. the median for men is 21 to 25 years. The age of the respondents is closely correlated to the number of years in engineering where 8.9% are less than 29 years old and over half of the respondents (51.9%) are between the ages of 30-39. The U.S. respondents have the oldest engineers with 22.2% older than 49 years, where the largest portion are U.S. men.

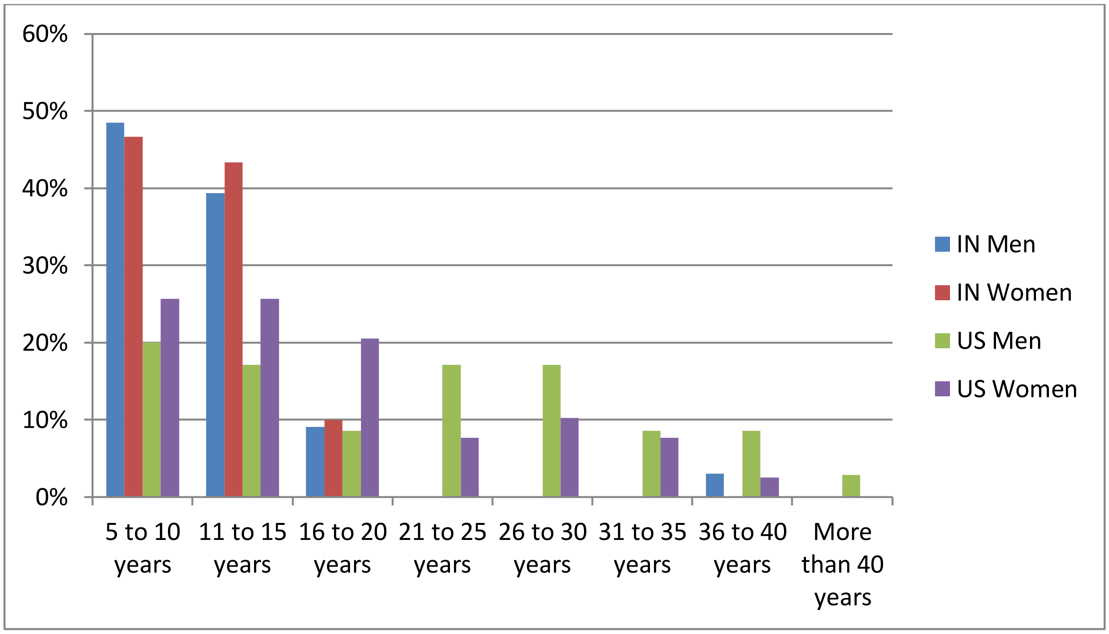

Figure 3. Comparison of the number of years in engineering for all demographics.

Relationships. The remaining descriptive categories deal with relationships and the work-family responsibilities of engineers. The networking descriptive captures the professional networking opportunities available to engineers. Figure 4 compares the availability of networking opportunities ("YES - FREQUENTLY Available During My Career" and "YES - OCCASIONALLY Available During My Career") across the four demographics. The U.S. women had the greatest access to professional networking opportunities (94.9%). Indian women had the least access at 56.6%. U.S. men overall had greater access to networking opportunities than Indian men.

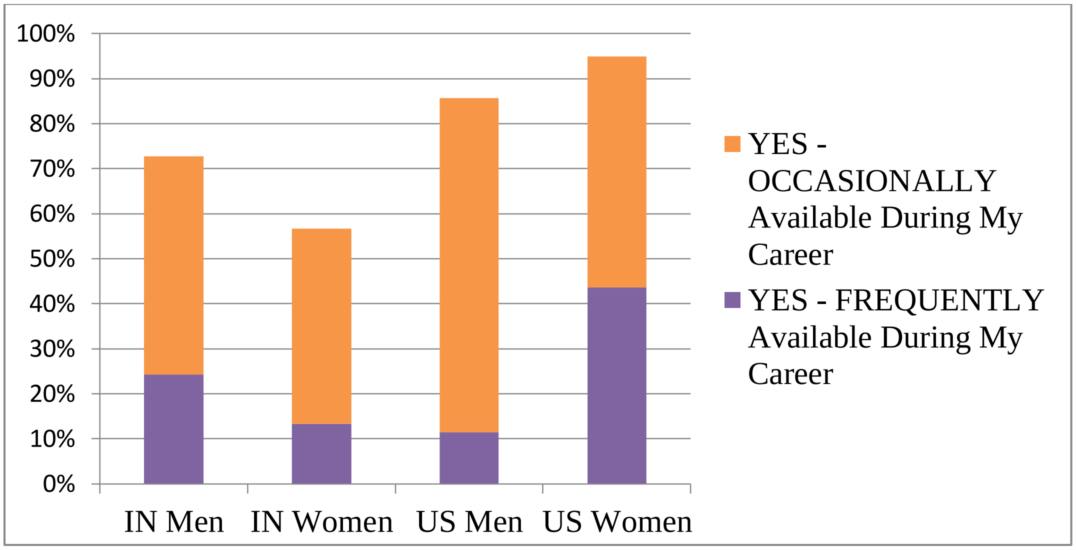

Figure 4. Comparison of the availability of networking opportunities for all demographics.

The majority of the engineers were married or in a relationship (86.9%). For female engineers in a relationship, their partner was usually educated in engineering; information was not collected on whether their partners were employed in engineering. Figure 5 compares the four demographics against the percentage of those with partners that had an engineering degree. Most Indian women (96%) have partners with an engineering background, 76% of the U.S. women and 67% of the Indian men.

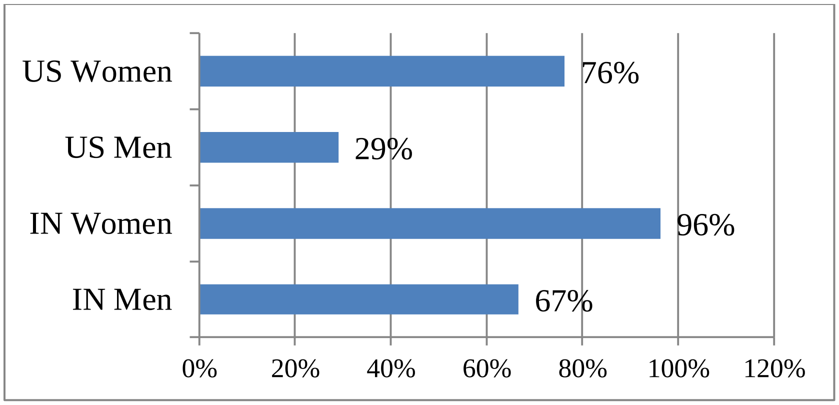

Figure 5. Comparison by demographics of the percent of spouses with an engineering education.

The majority of the engineers were married with children (73.3%). The "married with children" demographic was the lowest for U.S. men (60%). About half of all respondents had childcare responsibilities. The research literature identifies barriers to marriage and children, citing lower averages than what was collected in this sample. For U.S. women engineers, the marriage and children percentages (over 71% had responsibility for children) were higher. The survey tapped into the "Mommy Engineer" social network, so the data may have been skewed toward women engineers with families. In this sample, 30% of U.S women have 3 or more children, but it should be noted that the number of dependent children included stepchildren. The U.S. has a higher divorce rate than India, therefore they have blended families. The higher average of dependent children compared to India was expected. Almost half of the Indian engineers have the responsibility of caring for their parents and/or their siblings, over 30 points higher than the U.S. engineers. U.S. men are least likely to have dependent responsibilities, with 17.9% having no dependent responsibilities over 10 points higher than the other demographics.

When asked how their marital status affected their career, 62% of the survey respondents provided feedback. About 50% of the U.S. women made positive references to the support from their spouse as compared to 24% for U.S. men, 28% from Indian men and 7% from Indian women. Engineers found motivation in their job because of their spouse or family responsibilities. U.S engineers referenced career motivation three times more often than Indian engineers when discussing spouse and children, but they also were twice as likely to have children. U.S. women often cited pay and benefits as their motivation, Case #17 reflects a repeated sentiment, "They (children) are the reason I work in this profession since it has been a stable source of income to raise them." The U.S. men cited the desire to set an example and how the family grounded them to what was important, Case #70 explained "To be an example to my children to work hard, I need to maintain my performance, even when my morale is low." The Indian engineers also spoke of financial benefits, but they also referenced how marriage and children made a positive impact on them, such as an Indian woman (Case #153) wrote, "Post marriage and kid my engineering career seen newer heights. I felt I became more efficient, confident and could convert many challenges into good."

Perceived Persistence Indicator (PPE)

The Perceived Persistence (PPE) measure was used as a dependent variable and was calculated by scoring four measures with a 100-point scale and using a weighted average. For each measure, a score from 0 to 100 was created by averaging the items within the measure (if there is more than one), multiplying by 100 and dividing by the number of selections or the scale used for the measure. The weighted scores were then added together to create the PPE. The means and standard deviations of the scores for each component of the PPE are in Table 4.

The four measures within the PPE score were as follows:

1. The "number of years in engineering" descriptor was weighted with 10%. There were 10 possible selections, where "more than 40 years" had a value of 10. This descriptor favors those engineers who are older and stayed in their career.
2. The "choice to leave engineering" descriptor was weighted with 10%. There were 3 possible selections, where "No" had a value of 3. This descriptor often penalizes those who leave their career due to circumstances such as raising a family or taking care of elderly parents.
3. Career Commitment (CC) was weighted at 40% and was a construct that consisted of 12 questions using a 5-likert scale. The scale had internal consistency, as determined by Cronbach's alpha of 0.7723.
4. Career Satisfaction (CS) was weighted at 40% and was a construct that consisted of 5 questions using a 5-likert scale. The scale had a high level of internal consistency, as determined by Cronbach's alpha of .8907.

The higher the PPE value, the higher the persistence rating. All four indicators impact or measure career persistence. The lower weighting was given to items 1 and 2 due to their relationship to circumstances rather than attitudes that may impact persistence. To form a better understanding of the PPE value as it relates to women, additional tests were run to evaluate the variance – between all demographics, between both women groups and between men and women in the U.S.

Table 4

Means and Standard Deviations for the Components of the Perceived Persistence (PPE) Measure

Perceived Persistence (PPE) Measure Components		
Independent Variable	*Mean*	*SD*
Number of years in engineering score		
All (n = 173)	42.77	18.34
India Men (n = 33)	37.58	11.46
India Women (n = 30)	36.33	6.69
US Men (n = 35)	56.86	20.83
US Women (n = 39)	48.46	17.1
Choice to leave engineering score		
All (n = 173)	93.64	18.1
India Men (n = 33)	97.98	11.61
India Women (n = 30)	95.56	14.47
US Men (n = 35)	98.1	7.85
US Women (n = 39)	84.62	26.32
Career Commitment (CC) score		
All (n = 137)	71	12.4
India Men (n = 33)	70.91	12.89
India Women (n = 30)	71.11	12.36
US Men (n = 35)	73.81	12.51
US Women (n = 39)	68.46	11.82
Career Satisfaction (CS) score		
All (n = 137)	68.55	18.83
India Men (n = 33)	64.12	18.1
India Women (n = 30)	64.53	19.81
US Men (n = 35)	72.69	15.29
US Women (n = 39)	71.69	20.71
Perceived Persistence (PPE) score		
All (n = 137)	69.72	10.88
India Men (n = 33)	67.57	10.48
India Women (n = 30)	67.45	11.18
US Men (n = 35)	74.09	8.36
US Women (n = 39)	69.37	12.13

Note: Maximum possible score = 100.

Difference in PPE Mean Between All Demographics. The interval plot in Figure 6 compares the variance of the Perceived Persistence (PPE) score between the demographic groups. The symbol/dot represents the group means and the bars represent a 95% confidence interval for the mean. A t-test was run to determine the significance of the difference. Men working in the U.S. have a marginally higher PPE (M = 74.09) than women working in the U.S. (M = 69.37, $t(1) = -1.97$, $p = .053$). The U.S. population (men M = 74.09, women M = 69.37) has a significantly higher PPE than Indians (men M = 67.57, women M = 67.45, $t(1) = -2.23$, $p = .028$), although this may be due to the significant age differences between the U.S. and India respondents. To control for age, the PPE was re-calculated to exclude the number of years employed in engineering and the t-test was rerun, with null results ($t(1) = -1.47$, $p = .145$). Since research shows that women continue to drop out after long periods in the industry, the years employed in engineering was left in the calculation of the PPE score. In the final analysis, if age is not accounted for, persistence is not significantly different across the demographic groups.

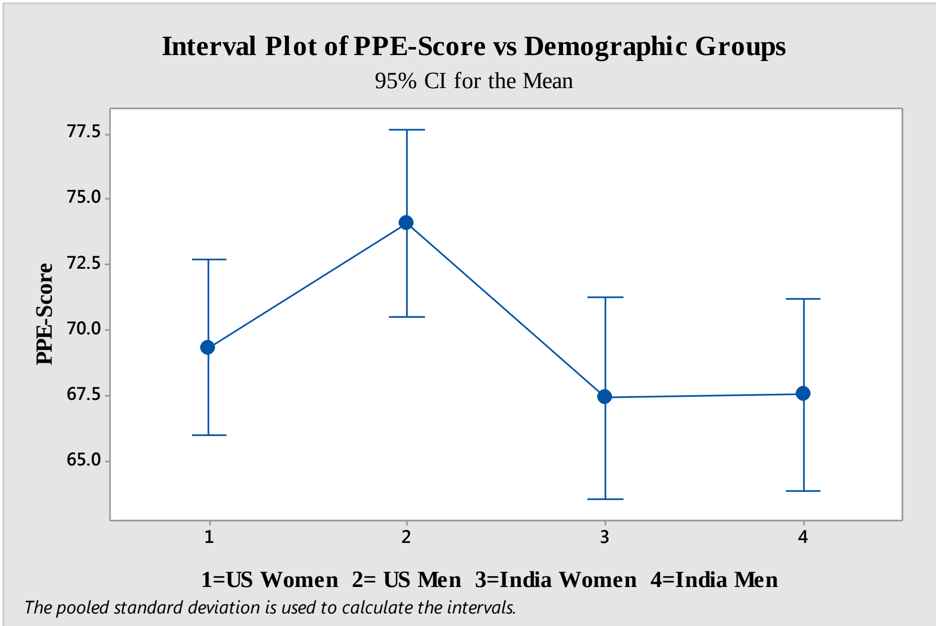

Figure 6. Interval plot of Perceived Persistence (PPE) scores for all demographics (Minitab®).

Difference in PPE Mean Between Women in India and the United States. The difference in PPE score between women in India and the U.S. is not significant. To understand the variation in scores (India M = 67.45, U.S. M = 69.37), a t-test was run to determine significance of the PPE components. The difference in the "number of years in engineering" was significant ($t(1) = 4.05$, $p < .001$). The difference in the "choice to leave engineering" was significant ($t(1) = -2.2$, $p = .032$). The difference in career commitment and career satisfaction was not significant.

Difference in PPE Mean Between Men and Women in the United States. Since the overall PPE score of men and women in the U.S. has a marginally significant difference ($p = .053$), a t-test was run for all components of the PPE score (Table 5). The component, "choice to leave engineering", had the most significant difference ($p = 0.004$). The marginally significant components were the "number of years in engineering" (*p* = .064) and the CC score (*p* = .064). Since the CC score is composed of 3 subscales, they were further evaluated to determine if there was significance. The subscale Career Resilience was found to be significantly higher for men (*p* = .024).

Table 5

T-Value and P-Value for Perceived Persistence (PPE) Components for Men and Women in the United States (Minitab®)

Perceived Persistence Components	*Men vs Women in the U.S.*	
	T-Value	*P-Value*
Perceived Persistence Score	-1.97	0.053**
Number of years in engineering	-1.88	0.064**
Choice to leave engineering	-3.05	0.004*
Career Commitment (CC) Score	-1.88	0.064**
CC-Identity	-1.00	0.321
CC-Planning	-0.32	0.750
CC-Resilience	-2.31	0.024*
Career Satisfaction (CS) Score	-0.24	0.814

*Significance is $p < .05$, **Significance is $p < .10$

Difference in Career Resilience Scores. Since the PPE scores for women and engineers in India are closer in value, t-tests were run comparing the Career Resilience scores between India and U.S. men. It was found that U.S men have significantly higher Career Resilience scores than the other demographics – with U.S. women (*p* = .024), Indian women (*p* = .034) and Indian men (*p* = .025). A multiple regression was run for the PPE score and the 3 questions for Career Resilience (p < .001, R-sq = 14.68%).

Career Resilience is significantly related to higher scores of perceived persistence, where the two questions with impact are:

1. Given the problems I encounter in engineering, I sometimes wonder if the personal burden is worth it.
2. The discomforts associated with engineering sometimes seem too great.

Measurement Model Analysis

Using Minitab® to do an initial analysis, a fit regression model was used for all the social variables. For the analysis, the dependent or response variable (Y) was the Perceived Persistence (PPE) score and the independent variables or predictors (X) were:

- 12 questions for Perceived Work Supports (PWS)
- 12 questions for Perceived Social Supports (PSS)
- 5 questions for professional networking (NW)
- The group demographics (women in the U.S., men in the U.S., women in India, men in India) as a categorical predictor

The regression model identified three significant predictors of PPE (Table 6) – "Special person when in need" (PSS1, $p < .001$), "Supervisor relied on when things get tough" (PWS7-S, $p = .032$), and "Professional networking opportunities" (NW1, $p = .016$). The Variance Inflation Factors (VIFs) average out to about 2, indicating the predictors (X) are moderately correlated. Each of the hypotheses were supported. Of significance is the combined R-square value for the three types of support – work, personal, and network, R-Sq = 36.93%, adjusted R-Sq = 31.20%, and the predicted R-Sq = 24.11%. The R-squared (R-Sq) value is the coefficient of determination, meaning it is "the proportion of variation in the fitted models that is explained by the components"

(Minitab Inc., 2015). Therefore, when considering all supports, with the demographic categorical predictor, the model will predict persistence almost a quarter of the time. For social research that is significant. Of note is that when the regression is run without the demographic predictor, R-Sq = 27.02%, adjusted R-Sq = 24.50% and the predicted R-Sq = 21.10%, meaning the group demographics plays a role in how social supports impact persistence.

Table 6

Results of Regression Analysis using a Forward Selection for all Social Measures Including Group Demographics as a Categorical Predictor where P-value < 0.2 (n = 120) (Minitab®)

Independent Variable	*Coefficient*	*SE Coefficient*	*T-Value*	*P-Value*	*VIF*
Supervisor easy to talk to (PWS4-S)	2.65	1.39	1.91	0.059	2.54
Supervisor relied on when things get tough (PWS7-S)	2.61	1.20	2.17	0.032*	2.47
Supervisor willing to listen (PWS10-S)	-1.59	1.07	-1.49	0.140	1.95
Special person when in need (PSS1)	2.73	0.63	4.32	0.000*	1.36
Count on friends when things go wrong (PSS7)	-1.08	0.83	-1.30	0.197	2.72
Talk about problems with friends (PSS12)	1.43	0.78	1.84	0.069	2.26
Professional networking opportunities (NW1)	-3.26	1.33	-2.46	0.016*	1.26

*$p < .05$

NOTE: R-Sq = 36.93%, R-Sq (adj) = 31.20%, R-Sq (Pred) = 24.11%

For each hypothesis, additional tests were performed to identify how the predictors impact persistence. Comparisons were made between the demographic groups to understand the differences between gender and culture.

Results of Perceived Social Supports (PSS)

The Perceived Social Support (PSS) construct consisted of 12 questions, four each for family, friend and special person, and had a high level of internal consistency (α = .9305). The "special person" subscale ("There is a special person who is around when I am in need") and the "friends" subscale ("I can talk about my problems with my friends") were found to be significant predictors of Perceived Persistence (PPE). Hypothesis 1 (Perceived social support from family, friends or significant others positively impacts career persistence in the engineering profession) is supported.

The 4 measures for each of the 3 subscales – family, friend and special person – were averaged together. A regression analysis using forward selection was run for all demographics for the PPE score (Y) versus the 3 subscales of the PSS construct (X). The significant predictors of PPE were the "special person" ($t(1) = 2.41$, $p = .017$) and "friends" ($t(1) = 2.20$, $p = .030$). A multiple regression was run with PPE (Y) using the 3 subscale averages (X) and the demographic grouping as a categorical variable. The sample size was n = 137 with 6 data points with large residuals and 5 with unusual X values. If the values are removed the sample size becomes too small to measure the relationship of the variables, so they were left in. The relationship between the PPE (Y) variable and the "special person" and "friends" (X) variables is significant ($p < .001$, R-square = 25.35%). The "special person" is a larger contributor to the variation as seen in the graph in Figure 7. The group demographics is a substantial contributor to the variation. The family subscale does not contribute to the variation.

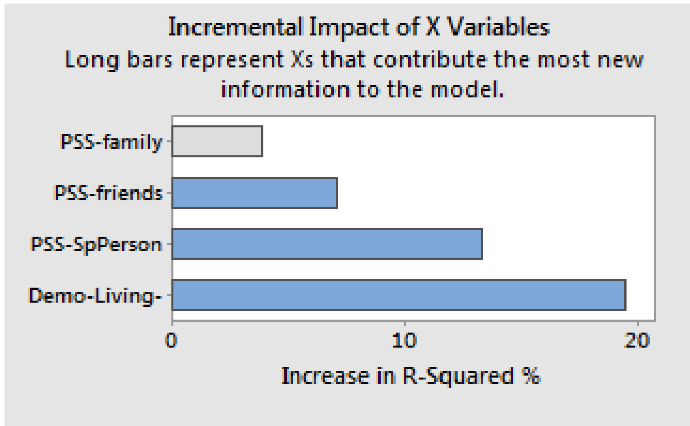

Figure 7. Impact of PSS (X) variables (family, friends or a special person) on PPE (Y) with the demographics as a categorical variable (Minitab®).

To evaluate the differences between the demographics, a Pearson Correlation was used to correlate each of the PSS subscale predictors with the PPE score, where Table 7 contains the coefficient *r*-values and *p*-values. The "special person" subscale was significantly correlated for Indian women (r = .723, p = .001). For U.S. men there was no correlation and for U.S women there was a small strength of association. The friend subscale was significantly correlated for the Indian men (r = .376, p = .031) and marginally related for both men and women in the United States, but there was a medium strength of association. The family subscale was not found to be a significant contributor to PPE, but was significantly correlated for women in India (r = .438, p = .015) and marginally correlated for the Indian men. There was a medium strength of association for both groups. For each demographic there were strong correlations between family and the "special person". Friends were correlated with family and the "special person", except in the case of U.S. men.

Table 7

R-values and P-values from Pearson Correlation between PSS Subscales and PPE for All Demographics (Minitab®)

Demographic Group	*Pearson Correlation between PSS Subscales and PPE Coefficient, r-values and p-values*					
	Family		*Friends*		*Special Person*	
	r	*p*	*r*	*p*	*r*	*p*
U.S. Women	0.190	0.247	0.313	0.052**	0.264	0.104
U.S. Men	0.242	0.162	0.331	0.052**	0.001	0.995
India Women	0.438	0.015*	0.195	0.301	0.723	0.001*
India Men	0.322	0.068**	0.376	0.031*	0.180	0.315

*Significance is $p < .05$; **Significance is $p < .10$

Strength of association: small ($r = .1$ to .3), medium ($r = .3$ to .5), large ($r = .5$ to 1.0)

The graph in Figure 8 visually explains the impact of a “special person” on the PPE of each of the 4 demographics. For men (in both the United States and India) there is a slightly negative, but non-significant impact on PPE scores, where the higher support from a “special person” lowers the PPE score. For U.S. women the impact of the “special person” on PPE is also non-significant, but the impact to the PPE score is slightly better than the men. For Indian women the impact is significant; there is a positive correlation between a higher score for the “special person” subscale and increasing the PPE score.

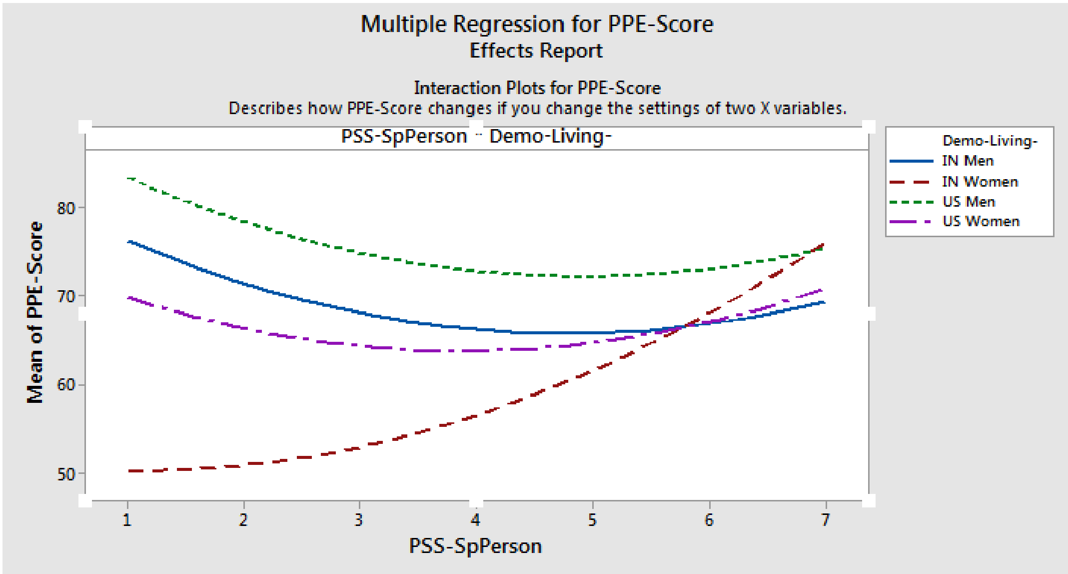

Figure 8. Effect of a "Special Person" (X) on the PPE score (Y) by demographic group (Minitab®).

Results of Perceived Work Supports (PWS)

The Perceived Work Supports (PWS) construct consisted of 12 questions, four each for supervisor/leader, co-workers and family, and was internally consistent (α = .8089). A multiple regression was run for each of the subscales using all demographic group data. The supervisor/leader subscale ("How easy is it to talk with your supervisor?") was found to be a significant predictor of Perceived Persistence ($p < .001$, R-sq = 15.47%). The coworker subscale ("Coworkers can be relied on when things get tough at work?") was also significant ($p = .004$, R-sq = 11.09%). Hypothesis 2 (Perceived social support from supervisors and coworkers positively impacts career persistence in the engineering profession) is supported.

The 4 measures for each of the 3 subscales – supervisor/leader, co-workers and family – were averaged together. A multiple regression was run with PPE (Y) using the 3 subscale averages (X) and the demographic grouping as a categorical variable. The sample size was n = 137 with 7 data points with large residuals. If the values are removed the sample size becomes too small to measure the relationship of the variables, so they were left in. The relationship between the PPE (Y) variable and the supervisor/leader (X) variable is significant ($p < .001$, R-square = 15.29%). The group demographics is a substantial contributor to the variation. The coworker and family subscales were not found to contribute to the variation.

To evaluate the differences between the demographics, a Pearson Correlation was used to correlate each of the PWS subscale predictors with the PPE score, where Table 8 contains the coefficient *r*-values and *p*-values. The supervisor/leader subscale was significantly correlated for Indian men ($r = .383$, $p = .033$) and U.S. women ($r = .340$, $p = .034$). For U.S. men there was no correlation and for Indian women there was a medium strength of association. The coworker subscale was significantly correlated for the Indian men ($r = .480$, $p = .005$). It was not significant for any of the other demographic groups. There was no correlation of the family subscale to the PPE score.

Table 8

R-Values and P-Values for Pearson Correlation between PWS Subscales and PPE (Minitab®)

Demographic Group	*Pearson Correlation between PWS Subscales and PPE Coefficient, r-values and p-values*					
	Supervisor/Leader		*Coworkers*		*Family*	
	r	*p*	*r*	*p*	*r*	*p*
U.S. Women	0.340	0.034*	0.203	0.214	0.113	0.494
U.S. Men	0.107	0.540	0.129	0.461	0.083	0.635
India Women	0.355	0.054**	0.188	0.319	0.245	0.192
India Men	0.373	0.033*	0.480	0.005*	0.095	0.599

*Significance is $p < .05$; **Significance is $p < .10$

Strength of association: small ($r = .1$ to .3), medium ($r = .3$ to .5), large ($r = .5$ to 1.0)

Results of Networking Opportunities (NW)

The Networking (NW) construct consisted of 5 questions. One question captured whether engineers had the opportunity to be involved in professional networking and 4 questions were a 7-point Likert scale and was internally consistent ($\alpha = .7272$). The question for NW1 "Over the course of your career, have you been given the opportunity to be involved in professional networking opportunities?" was found to be a significant predictor of Perceived Persistence (PPE). Hypothesis 3 (Networking through professional organizations positively impacts career persistence in the engineering profession.) is supported.

A multiple regression was run with PPE as the response (Y) variable and the 4 scale questions as the predictor (X) variables. The NW1 variable was used as a categorical variable where the response options were:

- 1 = YES – FREQUENTLY Available During My Career
- 2 = YES = OCCASIONALLY Available During My Career
- 3 = NO – Not available During My Career

The sample was N = 125, since some of the respondents did not answer all the questions. Two variables were found to affect PPE, NW4 (I am satisfied with the AMOUNT of professional networking opportunities given to me) and NW1. The graph in Figure 9 visually explains the impact of networking on PPE as well as the interaction of being satisfied with the amount of networking opportunities (NW4) and the networking opportunities availability (NW1). For those who had no networking opportunities in their career, the satisfaction with the amount of networking had the least significance on persistence scores. Those engineers who had frequent networking opportunities and were more satisfied with the amount of opportunities had higher persistence scores. The relationship between PPE and the two predictors (NW1 and NW4) is statistically significant (p = .009, R-sq = 13.34%).

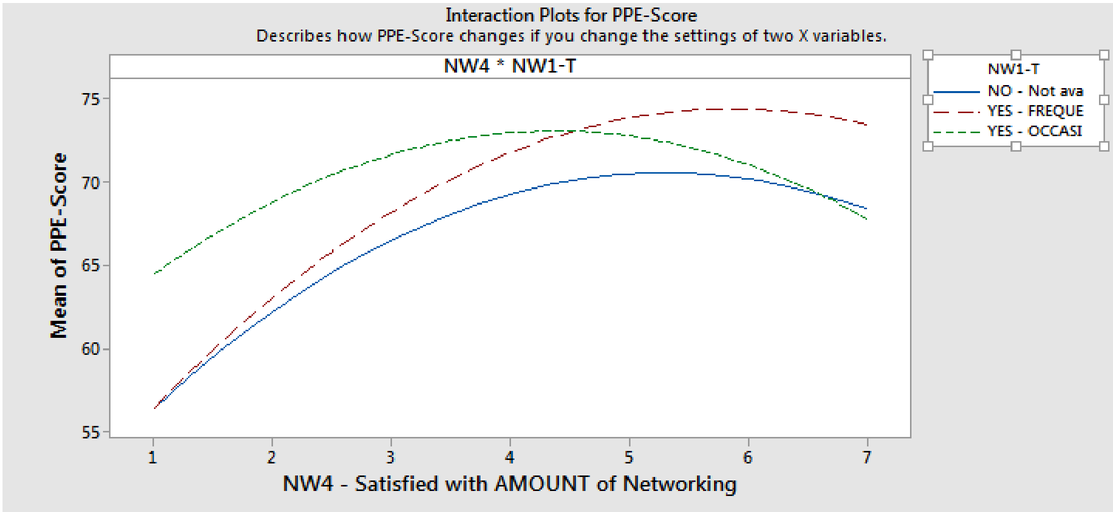

Figure 9. Graph of the effects of NW1 and NW4 on PPE (Minitab®).

The NW1 independent variable could be used as a continuous variable as well as a categorical variable. Therefore, the regression was rerun with the categorical variable being the group demographics and NW1 was included as a continuous variable. NW1 and NW4 were again found to be significant (p = .002, R-sq = 16.01%)

The means and standard deviations of the scores for PPE compared to the networking opportunities (NW1) are in Table 9. It includes the data for all NW1 options for each demographic – Indian men, Indian women, U.S. men and U.S. women. More Indian women did not have networking available in their career. The mean for all demographics shows a trend where the PPE score increases when the amount of networking opportunities increases. In addition, the standard deviation is larger for those who do not have networking opportunities available.

Table 9

Mean and Standard Deviation for Networking Opportunities (NW1) Grouped by Demographics and NW1 Options

Networking Opportunities (NW1) Mean and Standard Deviation											
	All		***YES – FREQUENTLY Available During My Career***			***YES – OCCASIONALLY Available During My Career***			***NO – Not available During My Career***		
Categorical Groups	***Means***	***SD***	***Means***	***SD***	***N***	***Means***	***SD***	***N***	***Means***	***SD***	***N***
ALL Demographics (N=137)	69.72	10.88	73.00	9.80	33	71.10	9.84	75	62.41	11.64	29
U.S. Women (N=39)	**69.37**	**12.13**	71.68	10.77	17	**68.78**	**12.02**	20	55.60	22.70	2
U.S. Men (N=35)	**74.09**	**8.36**	78.93	8.65	4	**74.50**	**7.81**	26	68.12	9.38	5
India Women (N=30)	67.45	11.18	72.08	9.23	4	71.75	8.24	13	61.71	12.25	13
India Men (N=33)	**67.57**	**10.48**	73.31	8.99	8	**67.96**	**10.04**	16	61.76	10.40	9

To evaluate the differences between the demographics, a Pearson Correlation was used to correlate each of the NW predictors with the PPE, where Table 10 contains the *P*-values. For U.S. women the significance was in NW4 (satisfied with the amount of professional networking) and NW5 (satisfied with the quality of professional networking). For the remaining groups, NW1 was the significant predictor.

Table 10

P-values from Pearson Correlation between NW and PPE for all Demographics (Minitab®)

P-values from Pearson Correlation between NW and PPE					
Demographic	*NW1*	*NW2*	*NW3*	*NW4*	*NW5*
All	0.000*	0.509	0.659	0.001*	0.001*
U.S. Women	0.132	0.318	0.314	0.022*	0.018*
U.S. Men	0.048*	0.060	0.075	0.843	0.822
India Women	0.025*	0.719	0.843	0.142	0.366
India Men	0.020*	0.830	0.797	0.303	0.204

*Significance is $p < .05$

The survey included open-ended questions regarding networking where of the 127 that answered the networking questions, 39% (50) provided additional information. Table 11 has a breakdown of the themes contained in the responses, where formal networking references accounted for 50% and informal networking accounted for 28%. Only 16% of the responses came from the Indian engineers. Of note, was that 7 U.S. men (out of 17 responses) opted out of formal networking even though they had the opportunity. The 2 U.S. women who opted out did so because of family responsibilities. There was one U.S. female engineer (Case #69) who lived in a small community in central Nebraska and did not have networking available.

Table 11

Qualitative Data for Networking – Themes, Counts, Percentages (50 Responses)

Demographic	*Formal Networking*	*Informal Networking*	*Lack of Networking*	*Opt Out Networking*	*Demographic Percentage*
IN Men	1	3		1	10%
IN Women	3				6%
US Men	5	5		7	34%
US Women	16	6	1	2	50%
Percentage of Total Responses	50%	28%	2%	20%	100%

Overview of Results

An overview of how the significant predictors affected the demographic groups is in Table 12. Using a 95% confidence level, the effect was:

- Positive, meaning the level of persistence increased when the predictor increased.
- Null, meaning there was not a significant correlation between persistence and the predictor.
- Some predictors were significant at a 90% confidence level and were noted by an asterisk (*).
- Some of the subscale predictors did not show as contributing new information when analyzing all demographics together. When investigating the subscales by demographic, some were found to be significant and are noted by a double asterisk (**).

Table 12

Overview of Social Predictors of Persistence – Significance and Impact on Variation of Persistence for by Demographics

Predictor of Persistence	*Multiple Regression with Categorical Demographics*		*Pearson Correlation*			
	P Value	*R-Squared*	*U.S. Women*	*India Women*	*U.S. Men*	*India Men*
Social Support – all subscales	< .001	25.35%				
Special person	< .001	23.14%	Null	Positive	Null	Null
Friends	< .001	14.04%	Positive*	Null	Positive*	Positive
Family**	< .001	14.13%	Null	Positive	Null	Positive*
Work Social Support – all subscales	< .001	15.29%				
Supervisor	< .001	15.47%	Positive	Positive*	Null	Positive
Co-workers**	.002	11.96%	Null	Null	Null	Positive
Professional Networking – all subscales	.002	16.01%				
Networking opportunities			Null	Positive	Positive	Positive
Satisfied with amount**			Positive	Null	Null	Null

Positive Significance is $p < .05$
*Significance is $p < .10$

**Does not contribute new information in the all subscale regression.

CHAPTER 5

DISCUSSION

This study focused on the social supports engineers create for themselves and how they impact their persistence in engineering. The factors considered were the social supports from family, friends and significant others, the work social supports provided by supervisors, leaders and co-workers and the support provided by professional networking opportunities. The research included both men and women from the United States and India with the intent of understanding the differences, if any.

Social supports matter. They contribute significantly to persistence in engineering and account for about a third of the variance in this sample. The type of social support that makes a difference varies between culture and gender (see Table 12). Professional networking was the only support that was significant across all demographics. This research contributes to Bornsen's doctoral dissertation (2012) which used a grounded theory approach to "describe the success factors found in practicing women engineers", where the core category is support, a "web of support" (p. iii). Support gathered from different areas and aspects of a women's life create a safety net when plagued by difficult times in their work or life. If the web is weak or becomes weakened, it does not guarantee exodus from the field, but it may weaken career commitment, career satisfaction and thereby persistence in engineering. This discussion will develop an understanding of the perceived persistence indicator (PPE), delve into professional networking and finally cover personal and work supports.

Understanding Perceived Persistence

The study was predicated on the perceived persistence measure, a method for gauging an engineer's persistence to their field. The men in the U.S. had the highest score overall, as well as in each of the sub-categories that make up the indicator. They are older and they haven't needed to nor have they chosen to leave engineering to take care of family or parents. Their commitment to engineering and their career satisfaction is the highest average score; all indicators of working in an environment where they can thrive. It also indicates they are survivors and demonstrate career resiliency. Their identity is strongly tied to engineering and a focus group participant (Focus-M2) stated "it never occurred to me to ever change professions, because I enjoy what I do." One engineer (Focus-M1) who was contemplating leaving his job stated, "I still want to be doing something analytical, it is my personality type, whether I'm doing engineering or whether I'm solving problems." For many men, engineering is part of who they are and they enjoy the technical challenge.

For this sample of women in the U.S., the choice to leave engineering was significantly different from the other demographics, usually they left to raise a family or pursue additional education, and later returned to engineering. The percentages may be higher because the sample tapped into the "Mommy Engineer" network, but there are cultural differences in the organizational opportunities surrounding family that should be noted. The Indian women referred to the challenges of maternity leave on their career, but did not leave their positions for an extended period of time like the women in the U.S. In discussing maternity leave with Interview-F, it was explained that her company provided four months of paid maternity leave and then allows an unpaid extended leave up to a year. In addition to the extended time with her child, her parents and in-laws stayed with her and supported her for about three years. Not all women in India are fortunate enough to have such great support. She also mentioned that if Indian women quit their job, the majority do not come back and will have a difficult time finding work. Possibly the climate in India does not support returning to work after leaving the workforce and those women who choose to leave cannot come back.

The men and women in India had basically equivalent persistence scores, which implies their environment supports both genders. Since half the Indian women surveyed were in management or higher positions, the women engineers of the study may have a different perspective coming from management. The persistence score was shown to be significantly smaller than the U.S. men, due to the younger age of the Indian engineers and a lower career satisfaction Mean (7 points lower than the U.S. men). When age was removed as a factor, the difference was no longer significant. Since the intent of the study was to address persistence in the field, age was an indicator that could not be removed and was difficult to control for with the data gathered. So age was left in the calculation of the persistence indicator

In comparing U.S. men with the other demographics, it was found they score significantly higher on the career commitment subscale career resilience – persisting in the face of adversity. U.S. women, Indian women and men have lower career resilience scores, implying they question if the personal burden and the discomforts associated with engineering are worth it. An example of struggling with the personal burden came from a U.S. woman with adult children (Focus-F3), who felt engineering interfered with her quality of life and doesn't recommend it to younger engineers. She stated, "I have considered leaving engineering a few times. … You're not able to have children and a career and do good at both, something's going to suffer."

The findings in Jepson's doctoral dissertation (2010) was "that the personal characteristics of having a positive attitude and resilience were the biggest factors in overall career success and satisfaction." Resilient attitudes have been linked to adaptability, self-efficacy, work engagement and the ability to fight job-related stress (Buse K. R., 2011) (Campbell, 2011, p. 292). These are personal characteristics referenced in career persistence models and in the organizational behavior and career development literature. One U.S. woman (Focus-F2) talked about her former struggle with wanting to leave engineering and provides insight to the impact of adaptability on persistence. She ended up staying and in her words, "I didn't leave because I didn't want to start over. I couldn't figure out what else I wanted to do, so I kind of buckled down and said 'in the gigantic world of engineering there has to be some corner that was going to be better than what I was currently doing.' I need to find it." A good example of a positive attitude, self-efficacy and using social supports to tackle issues is explained by an Indian woman (Interview-F):

> I had a lot of motivation within myself. I take things very positively and look for opportunity to improve. I never blame others for anything. When challenging situations come, I try to resolve myself. Otherwise I don't mind approaching people and seeking help. I have certain friends and mentors in office. I talk to them and try to find out what the suggestions are, what opinion I can get. Sometimes when it is really required, I discuss with my husband also and then take their opinions. Finally I decide what to do with those inputs.

Professional Networking Opportunities

Professional networking opportunities had a significant positive relationship across all demographic groups. In Jepson's doctoral dissertation, networking was not found to be a contributor to career success and satisfaction for women engineering leaders in the United States (2010, p. 120). For this sample, persistence increased as an engineer's availability to networking opportunities and their satisfaction with the amount of opportunities increased. Since the U.S. women engineer respondents were recruited from professional women engineering networks, they had more frequent networking opportunities and their persistence was tied to the amount and quality of the networking (reference Figure 9). The other demographic groups had less networking opportunities than the U.S. women, but their persistence also increased as their opportunities increased.

Study participants were asked about their satisfaction or dissatisfaction with professional networking opportunities. There were three themes to the discussion:

1. Opting out of networking or not having the opportunity.
2. Informal networking which revolved around their personal relationships with their colleagues.
3. Formal networking with professional organizations was beneficial to their persistence in engineering.

Opting Out or Lack of Networking. U.S. men (40% who responded) mentioned there were networking opportunities available to them, but they did not avail themselves of them, often citing cost or the lack of support from their employer. Women raised issues of no access to women professional organizations. Over 40% of the Indian women did not have any networking opportunities, whereas most of the U.S. women did although one mentioned none were available in her smaller community. Some of the U.S. women mentioned it is difficult to participate due to travel, work schedules and family responsibilities.

Informal Networking. U.S. men spoke more often of the personal relationships with colleagues as being meaningful network opportunities, whether through their connection on LinkedIn or their contacts with former co-workers. One U.S. male respondent (Case #82) adeptly described the underlying theme, "I have typically not been interested in formal networking opportunities during my career and have preferred not to pursue them. Instead I have put greater value in maintaining strong personal relationships with colleagues." This type of networking is informal and ideally grows stronger as an engineer ages. It can be a vehicle for finding advocates, mentors or that next job. In a male-dominated industry, it is easier for men to pursue this networking option. For U.S. women, the informal networking fights feelings of isolation that can happen in a male-dominated field. As one U.S. women (Case #162) put it, "networking happens naturally in well-functioning groups. I do not seek networking for the sake of getting ahead, but due to the feeling of belonging and encouragement that is provided when you surround yourself with caring and like-minded people." Women also referenced social groups, happy hour and other "outside the workday" activities, which allowed them to acquaint themselves with people outside their team. A U.S. woman (Case #145) talked of former company internal social groups encouraged by the employer, which allowed their early career to be fun, but were more difficult to participate in when raising a young family.

The Indian engineers generally did not reference informal networking in the survey questions. Culturally they approach work relationships differently than their U.S. counterparts, for example, in Indian culture, relationship building is how you get the job done. When comparing India with the United States using the Cultural Orientation Index (COI), the Indian culture focuses on building relationships as opposed to the U.S. where the focus is task completion. They are a cooperative, collectivist culture in that they work together to build agreement and define themselves as a group (COI Comparision, 2016). A male engineer from India (Interview-M) explained how professional networking, both informal and formal, supported him when he transitioned to a new industry. Through electronic forums and his personal interaction "with a few of the college lecturers and professors to get clarity, if (I'm) not understanding issues" supported his growth. He referred to his work colleagues that supported him as "valuable assets".

Formal Networking. Professional networking and organizations are considered beneficial. An Indian man (Case #85) referenced the importance of "maintaining a healthy network, it is essential and challenging too", which can refer to both the informal as well as formal networks. The women in India expressed regret in not having more professional networking opportunities. For example, Case #14 noted how it could have helped her, "I would have known what I lack and what to improve, so that I can fill the skill gaps. It would also make me feel more secure from career perspective." Although many of the U.S. men who responded, opted out of formal networking, those who participate find personal value. Case #94 reflected, "Looking back, networking has provided me with the opportunity to grow as an engineer by presenting me with opportunities for intellectual growth as well as personal development."

The women in the U.S. were the most vocal and referenced the positive impact on their career. They commented on support from their employer to participate in women's groups, professional organizations and company mentorship programs. The U.S. women active in professional organizations found it key to their persistence in engineering. Case #62 expressed "I would have quit many times over if I didn't talk to my SWE colleagues on a regular basis" and Case #63, "SWE has really helped me to stay in engineering." For U.S. women, being active in professional women's organization was seen as a benefit to them. They benefited through help in finding jobs, establishing connections outside their office peers and finding mentors and role models. They also helped them learn, such as how to build relationships or "about the engineering culture for women in other industry sectors" (Case #147). These organizations were influential in weathering the difficult times by helping them understand how to reach out when facing a problem and they provided a path to "people to vent to" (Case #147). A woman in her forties (Case #112) expressed the value of her network,

> At several key crossing points in my career, I have had the fortune to have a person (different ones over the career) that have stepped up to really help me progress. This was help technically as well as networking. Looking back it was always at a time where I was transitioning to a new role, starting a new job, or just at a point where I was questioning my career path. I was fortunate to have people really step up and help me, but I think that was also due to my ability to create a good network around me as well.

Personal and Work Social Support

The significance of personal and work social supports is different across the four demographic groups implying differences due to culture and gender. The United States is an individualistic society, where the focus is on the individual and India is collectivist, therefore their focus is on the group and their relationships. In Indian culture, their satisfaction with their relationships is closely tied to their feeling of well-being (Galinha, Garcia-Martin, Oishi, Wirtz, & Esteves, 2016). Another value dimension that may come into play is the power distance, where Indians are more dependent on those in power, accepting and expecting inequalities. The U.S. and India are very different cultures with regards to emphasis on family and work groups and that has been reflected in the results.

Men in the United States. In the U.S., engineering has been historically framed as being a male-dominated culture. Engineering is constructed around men, after all seventy-six percent of STEM jobs are held by men (Landivar, 2013). As expected, the study showed men in the U.S. having high levels of persistence comparatively and the only significant predictor was professional networking. The men are highly individualistic, in that their career persistence was not tied to their relationships with others. Their friends who often were referenced as their former and current work colleagues have a marginal impact on their persistence. This relationship may be closely tied to the informal networking that men value. Although the social support from their families and work colleagues do not significantly impact their persistence, U.S. men value those relationships. Their friendships at work enhance their job satisfaction and when things are working well, "friendships within work groups are a huge support that foster a team attitude, conscientious work, and a willingness to help each other over work hurdles and personal issues" (Case #110).

Over a third of U.S. men referenced their struggle with work-life balance and they identified their family as impacting their decisions. For example a U.S man (Case #93) in his thirties, "having dependents has forced me to make less risky decisions regarding career paths and opportunities." Another example, Case #74 "having a working spouse (and kids) meant that I chose not to spend extra time in developing my career." They spoke highly of their spouses and their support; for example (Case #110), "My spouse is always ready to listen to both success stories and crisis stories and provides feedback and insights. That has helped level the ups and downs of a career in engineering."

On a final note, there were four references from U.S. men who felt reverse gender bias was occurring. The comments implied the bar was either being lowered to achieve gender diversity or preference would be given to women because of their gender. The sentiment highlights the balancing act required by diversity and inclusion initiatives.

Women in the United States. Recent studies on women in the United States identified managerial support as a significant contributor to persistence. (Fouad, Singh, Cappaert, Chang, & Wan, 2016). This study has reaffirmed that finding. A positive leader – member exchange contributes to engagement, personal development and can help balance the stress when women encounter work-life challenges. Due to workplace culture, women may lack the same access to mentors and sponsors afforded to the men, therefore a supervisor who can support them is important. Supervisors can also provide a buffer to the challenges in engineering, regardless of gender, as expressed by a U.S woman (Case #130):

> I believe that the immediate supervisor has the ability to "make or break" the environment. Corporate assignments have unrealistic expectations and everyone struggles to meet the schedule and still maintain their integrity and pride in a job well done. Over the course of the 30 year career, the priority of schedule over quality in my assignments have taken over. A good supervisor can "put a stop" to it and "protect" a high performing team from the outside pressures of schedule over quality.

For U.S. women their persistence was only marginally influenced by their friends. Although many of the women were involved in professional networking, they also spoke of their network of friends, family and colleagues. In their responses they intermingled references to work colleagues and friends, such as Case #113 “Work friends who became outside of work friends.” Their comments spoke of the value of a friend’s perspective, such as Case #120, “Friends and colleagues going through the same things and ones who have gone through it before (can offer perspective and can advise).”

Almost two-thirds of the U.S. women referenced work-life balance as an issue and a recurring tone was expressed by an engineer in her thirties (Case #20), “Having children has put tremendous pressure to rebalance priorities away from career and focus on home. This is a constant personal pressure/balance and feelings of being mediocre at both instead of excelling in one.” From interviews and open questions, the women spoke of their husbands and the support and encouragement they provide and to a lesser degree their frustration from the lack of support from a spouse. Husbands tend to be sounding boards, such as the comments expressed by Focus-F3 when she deals with struggles at work, “My social support is my husband. I go home and vent on him, he has to listen to me and pep talk me and then I'll go back and look at it from a different view.”

Men and Women in India. Social support had a significant positive effect on persistence in engineering and explains over 25% of the variation, but was mainly due to Indian engineers. A closer look at the data shows that social supports are significant for engineers in India and only marginally significant in the United States. This study identified the source of social support as gender dependent, such that women’s persistence is significantly related to a “special person” and family. Whereas, Indian men’s persistence is significantly related to their supervisors, coworkers and friends. For men their family support is marginally significant and for women their supervisor support is marginally significant. As a collectivist culture, India values their relationships. Culture in India, although changing, is one where women are subordinate. They defer to their parents out of respect to their elders and are groomed to move in with the husband’s family after marriage, where “the burden of adjustment is clearly heavier for a woman” (Nanda, 2016). It is a culture that has a large power distance and the less powerful female should be dependent on their family and on their spouse (Samovar, Porter, McDaniel, & Roy, 2013, p. 72).

Almost one-third of both the Indian men and women expressed their struggles with balancing work and raising a family. A glimpse of their everyday life was expressed by an Indian woman (Case #14), “Work life Balance is a challenge with growing up kids. … Work does not stop at 8 hours, some days are challenging when we have to support kids school related activities, exams, homework and also have too much work at the office.” They also have the stressors of taking care of their parents, but it was equally noted that the parents provided a stress relief. Indian men spoke highly of their spouses, their family as well as their friends, regarding the positive support they get from them. They referenced sacrifices their spouses made, such as sacrificing a technical career to support their career. The married Indian women also referenced the support from their husbands, and were homogenous in that only one was not married to someone in STEM. It leads one to question if there is a high dropout rate for those women who marry someone not in STEM, although the arranged marriages are known to find matches in education.

Comparing Women from India and the United States. In the literature, women noted being pushed into management positions, process or other less technical areas of engineering and not being provided the opportunities to pursue technical paths. Working in management is a growth opportunity and whether it is a positive or negative depends on perspective, goals and aspirations. In the survey demographics for both the U.S. and India, the women were in management positions at a higher rate than the men. More women in management provides greater visibility and opportunities to have more influence.

U.S. women and Indian women raised the similar issues, such as the bias they experienced and having to work harder to get recognized. Both Indian and U.S. women struggled with the burden of having a family. Some Indian women felt the maternity breaks impacted their career, causing them to start over and Case #13 expressed there was "less appreciation for women employees, if she has home priorities." A U.S. woman (Case #116) shared her experience, "Following maternity leave, I stayed in the same role but was given reduced responsibility until I complained to my leadership. I also believe I was passed over for leadership positions although I was a senior contributor to the team." One U.S. woman (Case #141) explained, "My boss loves to give women administrative tasks that he considers below himself. I work on more programs at my work but my compensation and level is beneath all men who may have less responsibilities." An Indian woman (Case #25) expressed similar concerns, "Being a women employee, felt like sometimes people try to exploit you; for example, assigning more work." It was common for the women to feel they had to work harder to prove themselves, as explained by an Indian woman (Case #153), "Some of the opportunities don't come easily. I have to prove my capabilities many number of times and for quite many months when compared with male employees. Even the compensation - I feel I am underpaid." Women felt they had to work harder to get promotions and that their gender affected their career, often due to the demands of raising children. A U.S. woman (Focus-F1) gave advice to other women engineers, "never volunteer to take notes", because it tends to marginalize how you're viewed technically. She felt women "tend to not get the cool jobs or the cool assignments" and 'taking notes' feeds into the unconscious bias that exists.

The Indian women made no references to the work climate, whereas the women in the U.S. did. The difficulty of the U.S. work environment was referenced, such as, "It's awkward being the only woman in the room" and "sometimes it feels like you're not part of the club" (Case #63). U.S. women also spoke of the positive effects of support from others. In a few instances, women referenced how their gender helped them. A woman in her 30's (Case #119) noted that being female gave "career opportunities that I would not have been given as a male (i.e. being invited to interview for projects early on in my career to help balance the team, working on certain projects because the client is a female, etc.)."

CHAPTER 6

CONCLUSION

Due to the high rate of exodus of women from the United States engineering workforce, researchers are attempting to find what supports retention. Companies are re-thinking their organizational environment and attempting to change culture and attitudes. Many agree the culture and climate in the male-dominated engineering environment needs to undergo change, which will take time. All engineers, regardless of gender, need to be aware of the unconscious and second-generation bias that is prevalent; often the person with the bias doesn't even know it. Bias is blind to gender; in fact, it could be the female engineer that has the bias. Women cannot sit idly by; to accelerate necessary change, they need to be actively engaged in learning and looking for opportunities to be an agent for change. The intent of this research was to identify factors that female engineers can pursue that support persistence in engineering. The existing research points to personal characteristics that can be developed such as self-efficacy, an engineering identity, personal vision, adaptability and resiliency, which can improve the ability to persevere in hard or changing times.

This study reinforces existing qualitative research regarding the role of social support to U.S. women's persistence in engineering and extends its applicability to the Indian community (Bornsen, 2012). Building a strong web of support is an action that strengthens an individual's ability to persist, regardless of societal culture. The support from family, friends, community, work colleagues and networking are all social support factors that can strengthen persistence. The existing literature identifies the value of family and specifically a spouse trained in STEM, which was supported by this study.

Although family is inherited, a spouse is chosen. For female engineers, selecting a spouse who is willing to understand the challenges a female engineer may face, supports their growth and shares in the responsibilities of home will indirectly support career satisfaction and persistence. It is a possible source of social support. Friends, neighbors and even paid help are other possible sources of social support. In addition, this study supported the existing literature on the value of the supervisor/leader relationship; women need to be cognizant of its importance. They should expect and ask for support in finding the relationships that will support their success. They should ask for guidance from those who lead, seek their advice and use it to better their situation and others.

This research links the value of professional networking to career persistence and satisfaction regardless of gender or culture. In the engineering community, friends, colleagues and coworkers tend to be used interchangeably. Involvement in networking opportunities that build connections, not only help during the tough times, but can contribute to growth and opportunities. The value of your “web of support” often can’t be seen during the good times, it is akin to “career insurance” providing value and protection during difficult times. Reaching out to others to encourage, support and befriend, benefits the industry, benefits those who are helped, and benefits the individual. When we engage in networking, formal or informal, it increases an individual’s career commitment and career satisfaction, it supports the persistence of others and invariably contributes to changing culture and attitudes. As women engineers build a web of support, they open up the possibility of accelerating change and becoming an agent for change. As Sonia Gandhi said, “Together we can face any challenges as deep as the ocean and as high as the sky.”

Limitations of the Study

Social survey research is reliant on self-reporting by the individuals, which may limit the validity of the findings. The sample for this study was limiting due to a number of reasons. The method of collection, for the United States women demographic was through women networking groups, including “Mommy engineer” social networks. It skewed the demographic in marriage and children, since the sample did not match the marriage and children distributions of previous research. It may have also skewed the data for networking. Men and the India demographics were almost exclusively from one MNC and a large percentage of the respondents were in Aerospace. Different industries and smaller, local firms may have different climates and results. There was a low response rate and for Indian women there was the bare minimum of 30 responses, which left no room to clean the data for outliers. Finding interviewees and conducting interviews was difficult for the Indian demographic, so the qualitative data is limited. This study may have been impacted due to migration to the United States from other countries and specifically from India since 10% of the sample were Indians who migrated to the United States.

The focus of the literature review was related to retention of women engineers. Since networking is important for all demographics, the literature search could have been expanded to include a wider selection of networking research. This study created a perceived persistence indicator based off career commitment and satisfaction, accounting for time spent in the field as well as if an engineer had ever left the field. The time in the field, penalized younger engineers and the decision to leave engineering was gendered. The indicator could have been more robust if it had included the engineering occupation turnover intentions measure used in the study by Fouad et.al. (Fouad, Singh, Cappaert, Chang, & Wan, 2016, p. 86).

Recommendations for Future Research

This study uncovered possible future research in the area of women in engineering and networking. The recommendation is to revisit existing career persistence models using networking as a variable. Another possible area to study with regards to persistence in engineering is how age makes a difference. Do the significant factors change as a person traverses through their career? The recommendation is to delve further into the types of networking that contributes to persistence. For women in the engineering community, does networking lead to opportunities for advancement? A measure for networking was not found, therefore, create a measure that could be validated for the United States and India. The career satisfaction measure was lower for the engineers in India as compared to the engineers in the United States. What are the cultural and job factors that impact career satisfaction?

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APPENDIX A

INSTITUTIONAL REVIEW BOARD (IRB) APPROVAL

The approval from the IRB to start research:

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Mary Jane Parmentier
Future of Innovation in Society, School for the
480/727-1156
MJ.Parmentier@asu.edu

Dear Mary Jane Parmentier:

On 3/29/2016 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Impact of Social Supports to Persistence in Engineering
Investigator:	Mary Jane Parmentier
IRB ID:	STUDY00004119
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• HRP-503a-JoanFerrellMaster_PROTOCOL_SocialBehavioralV02-10-15.docx, Category: IRB Protocol; • Survey-JoanFerrell-Initial-request.pdf, Category: Recruitment Materials; • Survey-JoanFerrell-Reminder-Request#3-Closing.pdf, Category: Recruitment Materials; • JoanFerrell-Thesis-recruitment-script.pdf, Category: Recruitment Materials; • Survey-HRP-502c - JoanFerrellThesis-CONSENT DOCUMENT.pdf, Category: Consent Form; • Survey Example, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • JoanFerrell-Informed-Consent-Focus-Group-2016-0324.pdf, Category: Consent Form; • Survey-JoanFerrell-Reminder-Request#1.pdf, Category: Recruitment Materials; • Focus Group Discussion, Category: Measures

	(Survey questions/Interview questions /interview guides/focus group questions); • Survey-JoanFerrell-Reminder-Request#2.pdf, Category: Recruitment Materials;

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 3/29/2016.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Joan Ferrell
Jennifer Richter
Joan Ferrell
Emma Frow

APPENDIX B

FOCUS GROUP/INTERVIEW DISCUSSION GUIDE

Focus group discussions and interviews will be held. Some will be local in Phoenix and some will be held through virtual meetings depending on the selected participants. Each focus group will have a main objective and 8-10 prepared questions.

Main Objectives:

The objectives may change slightly after analysis of the survey. The focus group objectives align with the study and survey objectives:

- Pre-survey Concept Discussion: Discuss and understand the abstract concepts and variables to be investigated in the study and in the on-line survey. Identify terminology that has the same meaning for each major sub-group (US female, US male, India female, India male).

- Post-survey Focus Group and Interviews: Identify the social supports (work, organizations, family, friends and community) that are perceived to have the biggest impact on career commitment, career success and retention in engineering. Why are they important? How were they developed and enhanced?

Pre-survey Key Questions:

The questions will address the following concepts to determine what they mean, how they should be defined and/or worded and used within the study.

- Social supports
- Career Persistence
- "The costs associated with engineering sometimes seem too great."
- Networking
  - "Networking includes belonging to professional groups related to engineering like the Society of Women Engineers (SWE) and Institute of Electrical and Electronic Engineers (IEEE). It also includes internal company groups and external networking groups."
- Career commitment
- Career satisfaction

Post-survey Key Questions:

The grouping of questions will be determined after analysis of the survey

- **Engagement Questions:**
  1. Looking back over your life, whose support has been the most effective in helping you become and stay working as an engineer? (round robin)
  2. Looking back over your career and when things were going the best, what relationships at work (professional, family, friends, community) contributed to your feelings of satisfaction?
  3. Looking back over your career and when things were at their worst, what relationships at work (professional, family, friends, community) sustained you?

4. What social supports have you developed to ensure your success in engineering?

- **Exploration Questions:**

5. What did they do?
6. Explain the significance of their support.
7. How did you build and sustain that relationship?
8. Please give me examples.

- **Exit Questions:**

9. Of all the things we discussed, what to you is the most important?
10. What were the individual efforts you took to develop and enhance the social supports that support career commitment, career success and retention in engineering?
11. Were there supports you wished you had?

<u>Focus Group Agenda:</u>

- Present “Informed Consent” forms. Get them signed and collected.
- Name tags
- Lunch/dinner/snacks
- Welcome
  - Introduction of moderators
  - Results used for research on Social Supports of persistent engineers
  - Explain the **main objective** of the focus group
- Establish ground rules
  - First name basis
  - Participants will do the talking, talk to each other
  - No right or wrong answers
  - Interested in negative comments as well as positive comments
  - Don’t need to agree with others, but listen respectfully
  - Turn off phones or pagers. If you can’t and must respond, please do so quietly and rejoin us as quickly as possible
  - What is said in the room stays in the room
  - Refrain from using the names of people and companies
  - Tape recording and taking notes, one person speaks at a time
  - Participants can request we stop the recorder at any time
- Round robin Introduction of focus group participants (names, where live, engineering background, how many years)
- Ask **key questions** (ensure even participation)
- Conclusion:
  - Summarize the session to reflect the opinions
  - Review the objective and ask if anything has been missed
  - Thank everyone for support

Housekeeping:

- Location and meeting setup:
  - Discussions will be 45 minutes; participants should plan for 90 minutes.
  - The session will be audio recorded
  - An assistant will be identified to take notes and run the audio recorder.
  - Location will be based on where the participants will be coming from, as central a location as possible. If a virtual meeting early setup to ensure no technical difficulties.
  - Some focus groups may be held as a lunch meeting, so a location that has a private room facility must be found.
  - Food and drink – lunch, dinner or snacks
  - Copies of informed consent document
  - Name tags
- Recruitment:
  - Participants will be selected based on volunteering through the survey or from known contacts. All participants should be comfortable, but do not know each other.
  - Focus groups may be selected based off of
    - Location - from India or the United States
    - Gender based groups
    - Married/Single
    - Children/dependents
    - Professional position
  - 4-6 participants will be expected, but 8 participants will be identified to cover those who may not show.
  - Collect demographic information when selecting participants.

APPENDIX C

SURVEY

This survey collected data from both men and women in the United States and India. SurveyMonkey was used to build the survey instrument and for collecting the data.

Introduction - Informed Consent

I am a graduate student under the direction of Professor Mary Jane Parmentier in the School for the Future of Innovation in Society at Arizona State University. I am also an engineer with over 30 years of experience in data communications, telecommunications and aerospace. The survey intent is to understand the social supports that impact career persistence in engineering both in the United States and in India. The goal of the survey and this research is to help women engineers understand the social supports they need to develop to persist in the engineering industry.

The survey will take approximately 15-30 minutes to complete.

This survey is to be completed by participants who meet all of the following criteria:

- Women or men engineers in the United States or India
- Have worked or are working in the field of engineering for at least five years

You are being asked to participate in a master's thesis research. Be aware of the following:

- Your participation in this survey is voluntary.
- If you choose not to participate or to withdraw from the study at any time, there will be no penalty.
- There are no foreseeable risks or discomforts to your participation.
- There are no direct benefits to you, but possible benefits of your participation is raising your awareness of the network of support that enables career persistence and career satisfaction.
- There will be no costs to you, other than your time involved.
- Your responses will be anonymous and will be kept private and confidential. No identifying information will be associated with any one survey.
- All information will be collected using a survey system provided by a third party, SurveyMonkey where only the researcher will have access. Any personal information you submit as part of this survey will be stored and processed by SurveyMonkey on my behalf, in accordance with its Privacy Policy at www.surveymonkey.com/privacypolicy.aspx.
- The results of this study may be used in reports, presentations, or publications and results will only be shared in the aggregate form. Your name will not be used and is not required to participate.
- If you have any questions concerning the research study, please contact me at: Joan.Ferrell@asu.edu or Professor Mary Jane Parmentier at MJ.Parmentier@asu.edu.
- If you have any questions about your rights as a participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at research.integrity@asu.edu or call (480) 965-6788.

By continuing with this survey, you consent to the transfer of your information to SurveyMonkey and the use of your information in my research.

Thank you for participating. Your feedback is important.
Joan Ferrell

Education Information

This study focuses on people with degrees in engineering and/or working in an engineering field.

* 1. Please select your field of study. You may choose more than one.

- [ ] Aerospace Engineering
- [ ] Biomedical Engineering
- [ ] Chemical Engineering
- [ ] Civil and/or Structural Engineering
- [ ] Computer Engineering/Computer Science (any kind)
- [ ] Electrical and/or Electronic Engineering
- [ ] Industrial Engineering
- [ ] Mechanical Engineering
- [ ] I do not have an engineering degree but I have worked as an engineer or technical manager. Please also select "Other Degree" and write in your degree.
- [ ] Other Degree (please specify)

* 2. What is the highest degree you have received?

- ○ Some college but no degree
- ○ Associate degree
- ○ Bachelor degree
- ○ Graduate/Master's degree
- ○ Doctoral Degree
- ○ Professional Degree (JD, MD)

3. In what year (or years if you have multiple degrees) did you receive your engineering degree?

Degree #1

Degree #2

Degree #3

Degree #4

* 4. What country did you live and attend college or university? You may choose more than one.

- [ ] India
- [ ] United States
- [ ] Other (please specify)

* 5. In what country do you currently reside?

- ( ) India
- ( ) United States
- ( ) Other (please specify)

Career Information

* 6. Please choose the response that most fits your current situation

- ◯ I am currently employed in an engineering role.
- ◯ I am currently employed in a technical management or engineering management role.
- ◯ I am currently employed in a position that was a normal promotional move from my engineering career (but not in engineering or technical management).
- ◯ I am employed in a role that has no relation to my engineering degree.
- ◯ I am a stay-at-home parent.
- ◯ I am retired.
- ◯ I have returned to school full time. I am pursuing a non-engineering (or non-technical degree).
- ◯ I have returned to school full time pursuing an engineering or engineering management degree.
- ◯ I am not currently employed and not actively looking for a job - but NOT because I am staying home with my children.

Specify your current situation

* 7. How long have you worked as an engineer and/or in technical management?

- ◯ Never worked in engineering
- ◯ less than 1 year to 4 years
- ◯ 5 to 10 years
- ◯ 11 to 15 years
- ◯ 16 to 20 years
- ◯ 21 to 25 years
- ◯ 26 to 30 years
- ◯ 31 to 35 years
- ◯ 36 to 40 years
- ◯ More than 40 years

* 8. Pick the industry sector that you have worked in the most.

- ◯ Aerospace
- ◯ Automotive
- ◯ Education
- ◯ Engineering
- ◯ Health Care
- ◯ Information Technology (IT)
- ◯ Manufacturing
- ◯ Other (please specify)

9. What field of work are you currently employed?

- ◯ Corporate
- ◯ Non-profit
- ◯ Academic
- ◯ Self-employed
- ◯ Government
- ◯ Other (please specify)

* 10. Did you ever choose to leave engineering or a technical career?

- ◯ Yes
- ◯ No
- ◯ Yes, I left but I have returned

If "Yes", please explain.

Career Attitudes

* 11. Please choose the response that most fits you

	Strongly disagree	Somewhat disagree	I neither agree or disagree	Somewhat agree	Strongly agree
Engineering is an important part of who I am.	◯	◯	◯	◯	◯
Engineering has a great deal of personal meaning to me.	◯	◯	◯	◯	◯
I do not feel "emotionally attached" to engineering.	◯	◯	◯	◯	◯
I strongly identify with engineering.	◯	◯	◯	◯	◯
I do not have a strategy for achieving my goals in engineering.	◯	◯	◯	◯	◯
I have created a plan for my development in engineering.	◯	◯	◯	◯	◯
I do not identify specific goals for my development in engineering.	◯	◯	◯	◯	◯
I do not often think about my personal development in engineering.	◯	◯	◯	◯	◯
The personal costs associated with engineering sometimes seem too great.	◯	◯	◯	◯	◯
Given the problems I encounter in engineering, I sometimes wonder if I get enough out of it.	◯	◯	◯	◯	◯
Given the problems I encounter in engineering, I sometimes wonder if the personal burden is worth it.	◯	◯	◯	◯	◯
The discomforts associated with engineering sometimes seem too great.	◯	◯	◯	◯	◯

* 12. Please choose the response that most fits you

	Strongly disagree	Somewhat disagree	I neither agree or disagree	Somewhat agree	Strongly agree
I am satisfied with the success I have achieved in my career.	◯	◯	◯	◯	◯
I am satisfied with the progress I have made toward meeting my overall career goals.	◯	◯	◯	◯	◯
I am satisfied with the progress I have made toward meeting my goals for income.	◯	◯	◯	◯	◯
I am satisfied with the progress I have made toward meeting my goals for advancement.	◯	◯	◯	◯	◯
I am satisfied with the progress I have made toward meeting my goals for the development of new skills.	◯	◯	◯	◯	◯

Social Supports

Thinking about the support you have had from your supervisor (boss, leader), coworkers, family, friends and relatives OVER THE MAJORITY OF YOUR ENGINEERING CAREER, answer the following questions.

* 13. How much does each of these people go out of their way to do things to make your work life easier for you?

	Not at all	A little	Somewhat	Very Much	Don't have any such person
Your immediate supervisor (boss, leader) ...	◯	◯	◯	◯	◯
Other people at work ...	◯	◯	◯	◯	◯
Your spouse, friends and relatives ...	◯	◯	◯	◯	◯

* 14. How easy is it to talk with each of the following people?

	Not at all	A little	Somewhat	Very Much	Don't have any such person
Your immediate supervisor (boss, leader) ...	◯	◯	◯	◯	◯
Other people at work ...	◯	◯	◯	◯	◯
Your spouse, friends and relatives ...	◯	◯	◯	◯	◯

* 15. How much can each of these people be relied on when things get tough at work?

	Not at all	A little	Somewhat	Very Much	Don't have any such person
Your immediate supervisor (boss, leader) ...	◯	◯	◯	◯	◯
Other people at work ...	◯	◯	◯	◯	◯
Your spouse, friends and relatives ...	◯	◯	◯	◯	◯

* 16. How much is each of the following people willing to listen to your personal problems?

	Not at all	A little	Somewhat	Very Much	Don't have any such person
Your immediate supervisor (boss, leader) ...	◯	◯	◯	◯	◯
Other people at work ...	◯	◯	◯	◯	◯
Your spouse, friends and relatives ...	◯	◯	◯	◯	◯

* 17. Thinking about the SUPPORT you have had from family, friends, and/or significant others OVER THE MAJORITY OF YOUR ENGINEERING CAREER, how strongly would you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Mildly Disagree	Neutral	Mildly Agree	Agree	Strongly Agree
There is a special person who is around when I am in need.	◯	◯	◯	◯	◯	◯	◯
There is a special person with whom I can share my joys and sorrows.	◯	◯	◯	◯	◯	◯	◯
My family really tries to help me.	◯	◯	◯	◯	◯	◯	◯
I get the emotional help and support I need from my family.	◯	◯	◯	◯	◯	◯	◯
I have a special person who is a real source of comfort to me.	◯	◯	◯	◯	◯	◯	◯
My friends really try to help me.	◯	◯	◯	◯	◯	◯	◯
I can count on my friends when things go wrong.	◯	◯	◯	◯	◯	◯	◯
I can talk about my problems with my family.	◯	◯	◯	◯	◯	◯	◯
I have friends with whom I can share my joys and sorrows.	◯	◯	◯	◯	◯	◯	◯
There is a special person in my life who cares about my feelings	◯	◯	◯	◯	◯	◯	◯
My family is willing to help me make decisions.	◯	◯	◯	◯	◯	◯	◯
I can talk about my problems with my friends.	◯	◯	◯	◯	◯	◯	◯

18. Thinking back over your career, what, if any, social support factors particularly affected your engineering career the most and why.

Networking

Networking includes belonging to professional groups related to engineering like the Society of Women Engineers (SWE) and Institute of Electrical and Electronic Engineers (IEEE). It also includes internal company groups and external networking groups.

* 19. Over the course of your career, have you been given the opportunity to be involved in networking opportunities?

- YES - FREQUENTLY Available During My Career
- YES - OCCASIONALLY Available During My Career
- NO - Not available During My Career

Examples or any comments you would like to share

* 20. Please choose the response that most fits you

	Strongly Disagree	Disagree	Mildly Disagree	Neutral	Mildly Agree	Agree	Strongly Agree	Not Applicable (N/A)
How strongly do you agree or disagree that these networking opportunities were important to your CAREER COMMITMENT?	◯	◯	◯	◯	◯	◯	◯	◯
How strongly do you agree or disagree that these networking opportunities were important to your CAREER SATISFACTION?	◯	◯	◯	◯	◯	◯	◯	◯
I am satisfied with the AMOUNT of networking opportunities given to me.	◯	◯	◯	◯	◯	◯	◯	◯
I am satisfied with the QUALITY of networking opportunities given to me.	◯	◯	◯	◯	◯	◯	◯	◯

21. Thinking back over your career, what, if any, networking opportunities particularly affected your engineering career the most and why.

Demographics

Demographics are collected to better analyze the results.

* 22. Which of the following best describes your current relationship status?

- ◯ Married without children
- ◯ Married with children
- ◯ Widowed
- ◯ Divorced
- ◯ Separated
- ◯ In a domestic partnership or civil union
- ◯ Single, but cohabiting with a significant other
- ◯ Single, never married

23. In what ways, if any, did your marital status affect your engineering career? Please describe.

* 24. If you are married or with a partner, are they educated in or working in Science, Engineering or Technology?

- ◯ Not married or in a relationship
- ◯ No
- ◯ Yes (please specify degree major or industry)

* 25. Did you have dependent responsibilities at anytime during your career? Check all that apply.

- ☐ Children
- ☐ Parents
- ☐ Siblings
- ☐ Other Family Members
- ☐ None

* 26. How many children do you have (including step children)?

- 0
- 1
- 2
- 3
- 4 or more

27. In what ways, if any, did having dependents affect your career? Please describe.

* 28. Are you male or female?

- Male
- Female

29. What is your age?

- 18-20
- 21-29
- 30-39
- 40-49
- 50-59
- 60 or older

APPENDIX D

DESCRIPTIVE STATISTICS

This appendix contains the descriptive demographic and statistics for the data collected from the survey. Table 13 is the percentage of the respondents who responded to each descriptive category and each option.

Table 13

Descriptive Demographics

Descriptive Category	Descriptive Options	% Total	% US Women	% US Men	% India Women	% India Men
Degree	Bachelor degree	54.0%	64.1%	57.1%	56.7%	36.4%
	Graduate/ Master's degree	43.8%	35.9%	40.0%	40.0%	60.6%
	Doctoral Degree	1.5%		2.9%	3.3%	
	Professional Degree (JD, MD)	0.7%				3.0%
Field of Study	Aerospace	27.3%	9.8%	46.7%	17.6%	31.7%
	Computer	29.2%	19.5%	22.2%	41.2%	36.6%
	Electrical	28.6%	26.8%	17.8%	41.2%	31.7%
	Other*	14.9%	43.9%	13.3%		
Country attended college	India	46.9%	2.5%	7.9%	93.8%	100.0%
	United States	46.9%	87.5%	81.6%	3.1%	
	Other**	6.3%	10.0%	10.5%	3.1%	
Country reside	India	46.0%			100.0%	100.0%
	United States	54.0%	100.0%	100.0%		
Career situation	Engineering position	65.0%	64.1%	82.9%	50.0%	60.6%
	Management position	29.2%	20.5%	14.3%	46.7%	39.4%
	Higher level position	3.6%	10.3%		3.3%	
	Non-engineering position	0.7%	2.6%			
	Stay-at-home parent	0.7%	2.6%			
	Unemployed	0.7%		2.9%		

Descriptive Category	Descriptive Options	% Total	% US Women	% US Men	% India Women	% India Men
Years in engineering	05 to 10 years	34.3%	25.6%	20.0%	46.7%	48.5%
	11 to 15 years	30.7%	25.6%	17.1%	43.3%	39.4%
	16 to 20 years	12.4%	20.5%	8.6%	10.0%	9.1%
	21 to 25 years	6.6%	7.7%	17.1%		
	26 to 30 years	7.3%	10.3%	17.1%		
	31 to 35 years	4.4%	7.7%	8.6%		
	36 to 40 years	3.6%	2.6%	8.6%		3.0%
	More than 40 years	0.7%		2.9%		
Industry sector	Aerospace	81.0%	59.0%	82.9%	86.7%	100.0%
	Engineering	10.2%	17.9%	14.3%	6.7%	
	Other***	9%	23.1%	2.9%	6.7%	
Field of work	Corporate	94.9%	89.7%	94.3%	100.0%	96.9%
	Government	2.2%	5.1%	2.9%		
	Other	2.9%	5.1%	2.9%		3.1%
Chose to leave engineering	No	87.6%	71.8%	94.3%	90.0%	97.0%
	Yes	6.6%	17.9%		3.3%	3.0%
	Yes, I left but I returned	5.8%	10.3%	5.7%	6.7%	
Networking opportunities	NO - Not available During My Career	21.2%	5.1%	14.3%	43.3%	27.3%
	YES - FREQUENTLY Available During My Career	24.1%	43.6%	11.4%	13.3%	24.2%
	YES - OCCASIONALLY Available During My Career	54.7%	51.3%	74.3%	43.3%	48.5%

Descriptive Category	Descriptive Options	% Total	% US Women	% US Men	% India Women	% India Men
Relationship Status	Divorced	4.4%	7.7%	8.6%		
	Married with children	72.3%	79.5%	60.0%	70.0%	78.8%
	Married without children	12.4%	5.1%	17.1%	16.7%	12.1%
	Separated	0.7%			3.3%	
	Single, but cohabiting with a significant other	2.2%	5.1%	2.9%		
	Single, never married	7.3%		11.4%	10.0%	9.1%
	Widowed	0.7%	2.6%			
Partner in engineering	Yes	66.7%	76.3%	29.0%	96.3%	66.7%
	No	33.3%	23.7%	71.0%	3.7%	33.3%
Dependent responsibilities	Children	49.8%	71.4%	59.0%	38.6%	36.2%
	Parents	26.6%	14.3%	10.3%	35.1%	39.7%
	Siblings	7.4%		2.6%	15.8%	8.6%
	Other Family	8.9%	8.2%	10.3%	8.8%	8.6%
	None	7.4%	6.1%	17.9%	1.8%	6.9%
Number of children	No Children	21.9%	7.7%	34.3%	26.7%	21.2%
	1 child	28.5%	23.1%	11.4%	50.0%	33.3%
	2 children	35.8%	38.5%	34.3%	23.3%	45.5%
	3 children	9.5%	20.5%	14.3%		
	4 or more	4.4%	10.3%	5.7%		
Age	21-29	8.9%	5.3%		23.3%	9.4%
	30-39	51.9%	42.1%	28.6%	66.7%	75.0%
	40-49	17.0%	18.4%	25.7%	10.0%	12.5%
	50-59	18.5%	34.2%	31.4%		3.1%
	60 or older	3.7%		14.3%		

* Other degrees include Chemical, Civil, Industrial, Mechanical, Physics, Math
** Other countries attend school include Europe, Canada, Mexico
*** Other Industry sectors engineers have worked include oil and gas, government and semiconductors

BIOGRAPHICAL SKETCH

Joan Ferrell grew up a military brat, having lived outside the United States for 10 years by the time she was 18 years old. She went to 12 different schools by the time she graduated from her beloved Zweibrucken American High School. It was there that her passion for software development was ignited by her favorite math teacher – Mr. Duane Kroseman. He introduced her to writing software using the schools key punch machine and sending the Fortran deck of punched cards by carrier to Kruezburg Army Base to run on the IBM mainframe. Before leaving Germany she received her Certificate in Data Processing after learning COBOL. She graduated from Weber State University in software development and worked in data communications, telecommunications and aerospace. She has worked for Sperry Univac, Unisys, GTE, AG Communications, as a consultant for Motorola and McDonalds and is currently working for Honeywell International. She has performed in the role of software developer, software tester, contractor, project lead, planner and manager. She has enjoyed the work, the relationships and comradery with her coworkers and peers. Joan's love of the international community came at a young age, starting with the time spent in Japan. When her company was looking to kick off a new process for short-term assignments, she volunteered taking her family to India for the summer. She and her family have traveled extensively. Her immediate family is very international where the family members have lived in foreign locales such as France, Japan, Germany, Argentina, Poland, Spain, Russia, Korea, South Africa, Slovak Republic and Greece. Pursuing a master's in Global Technology and Development was the perfect combination of her passions. For many years, Joan was heads down raising her family and working. After her kids were grown, she was able to finally pursue her master's degree and also began looking for ways to get involved in her community. She was disappointed that the ratio of women to men in engineering had seen little improvement from when she started in 1979. That disappoint gave birth to her thesis topic and spurred her to get involved in the women's engineering networks – Women in Honeywell Engineering Network (WHEN), Aerospace Women's Council (AWC) and the Society of Women Engineers (SWE). Her passion and mission is to give back to the engineering community making it a better environment for all engineers. She currently lives in Phoenix, Arizona with her husband and is attending Arizona State University with her youngest son. She has four grown children and four grandchildren. She is active in her faith and is filled with gratitude, because through Him all blessings flow.