WOMEN PERSISTING IN THE ENGINEERING PROFESSION:
A PARADOXICAL EXPLANATION ADAPTING INTENTIONAL
CHANGE THEORY

by

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DEDICATION

For Fred, Jen, Freddy and Kristen
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Women Persisting In the Engineering Profession:  A Paradoxical Explanation Adapting Intentional Change Theory

Abstract

by

KATHLEEN BUSE

Women remain underrepresented in the engineering profession comprising only 10% of the employed engineers in 2010 while in that same year women exceeded more than half of those employed in professional, managerial and related occupations according to the US Bureau of Labor Statistics.  While others studies have identified the reasons women leave engineering, this study focuses on women who persist in the profession.  A complex, three stage mixed methods study has been conducted.  The first stage was a qualitative research study based on semi-structured interviews with 31 women engineers, ten of whom had left an engineering career and 21 persisting for an average 21 years leading to a conceptual model and the development of a new construct to measure the ideal self.  Next, a field experiment was conducted which surveyed 495 women ages 21 to 70 with engineering degrees.  A structural equation model has been developed showing that women’s commitment to an engineering career is impacted by their levels of self efficacy, the interaction of age and number of children, and their ability to articulate a personal vision as operationalized by the ideal self.  A woman’s
relationship with her manager and level of work engagement also impact career commitment. The final stage of this research compared the factors and relationships important to a woman’s career commitment to engineering to a sample of 138 male engineers. Findings show that the factors important to persistence for women engineers have little or no impact on a man’s commitment to an engineering career. Women engineers have lower levels of self efficacy than men, and for men self efficacy has no statistically significant relationship to career commitment to engineering. Further both the relationship with the manager, one’s ideal self, and work engagement influence a woman’s career commitment to engineering more than for a man.

A conceptual model adapted from the intentional change theory (Boyatzis, 2008) is presented that integrates the findings from each of the studies to explain women’s persistence in an engineering career. The model describes a woman’s persistence in engineering as a complex system where a recursive relationship exists between the dynamic of the ideal self and the real self or between one’s dreams and one’s reality. The discontinuities involved with adapting and learning within an engineering career, the supporting nature of one’s relationships and the multiple levels of individual, family, organizational and occupational are shown as impacting career persistence.

The findings from this study can be used by both practitioners and scholars to design systems that that will enable sustainable careers for women in the engineering profession.

**Key words:** women engineer; STEM; gender; persistence; women’s careers; Intentional Change Theory; ideal self
CHAPTER I: INTRODUCTION

Problem of Practice

Since the 1970’s there has been substantial increases in the number of women employed in the US to where in 2010, women comprised 51% of all management, professional and related occupations, 46% of those employed in life, physical, and social science occupations, 67% of psychologists, 60% of accountants, 53% of pharmacists, 32% of lawyers, 32% of physicians and surgeons, 25% of dentists, and 24% of architects (BLS, 2011). However women are only 10% of full-time employed engineers and 7.7% of engineering managers at a time when demand for engineers continues to grow (BLS, 2009). As Figure 1 shows the level of women’s entry into the engineering profession grew from the late 1970’s into the early 1990’s but has been stagnant between 10 and 11% since the mid-1990.

FIGURE 1
Women in the Engineering Profession 1980 to 2009

% Women as Employed Engineers
2009 Bureau of Labor Statistics

0% 5% 10% 15% 20% 25%

1980 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009
Numerous studies have been undertaken to understand how to recruit middle school and high school girls to engineering while other studies have focused on retaining women in academic programs (Betz & Hackett, 1981; Blum, 2001; Cuny & Aspray, 2002; Hackett, Betz, Casas, & Rocha-Singh, 1992; National Academies Committee on Science, Engineering, and Public Policy, 2007; Nauta, Epperson, & Kahn, 1998). These studies have shown success in that the number of women graduating with engineering degrees at all levels has increased from less than 5% in 1980 to 22% in 2008 (NSF, 2008).

FIGURE 2
Women Receiving Engineering Degrees 1980 to 2006

But in a study by the Society of Women Engineering Frehill (2008) found that most women have left their engineering career 15 years post degree, unlike their male colleagues. Several studies have focused on why women leave the engineering
profession and suggest improvements to the cultural and organizational aspects (Gill, Sharp, Mills, & Franzway, 2008; Hewlett et al., 2008). For example Fouad & Singh (2011) recommend creating a culture within organizations that values women engineers’ contributions by providing clear paths towards advancement, offering opportunities for mentoring both formal and informal, and supporting work-life balance.

**Importance of Research on Women in the Engineering Profession**

Understanding the factors that enable women to remain in engineering will offer vital clues about who to recruit to the field and how to retain them. Doing so, it is argued, will benefit women, industry and society (Margolis, Fisher, & Miller, 1999/2000). For women the gain is high paying and rewarding work with abundant opportunities (BLS, 2009); for industry a reduction in the troublesome shortage of skilled technical workers in the US (NSF, 2006); and for society the broadened perspective and diversified talent women bring to the field (Margolis et al., 1999/2000).

The US in particular needs to aggressively address the retention problem of women in science and engineering to maintain global leadership in technology according to the National Academies (National Academies Committee on Science, Engineering, and Public Policy, 2007). Because the number and percent of women majoring in science and engineering continue to increase the barriers and bias’ preventing women’s full intellectual potential must be eliminated.

Four compelling reasons were given by the National Academies for addressing disparities and bias towards women in science and engineering careers: global competitiveness, the law, economics and ethics (National Academies Committee on Science, Engineering, and Public Policy, 2007). The US has depended on its technical
resources to provide security from our enemies and to provide a high standard of living for its citizens. Other countries are making strong gains in science and technology and the US needs to rely on its best talent to remain competitive in a global economy.

The US has strong anti-discrimination laws prohibiting employment bias due to gender, race, and religion. Title IX prohibits discrimination on the basis of gender for educational institutions and provides for equality in the opportunity to receive an education. And beyond these laws, the official policy of the US is that there will be equal opportunities for men and women in education, training and employment in scientific and technical fields as per the Science and Engineering Equal Opportunities Act of 1980.

The training of scientists and engineers is funded by the federal government as well as the private sector. The lack of opportunity that women face is a foolish waste of the money that was spent to educate them. Ethically, women should have the same opportunities as men to work in a challenging position and to be rewarded for providing technical solutions to societal issues.

Recruiting and retaining women in science, technology, engineering and mathematics (STEM) professions are important goals of both the US government and non-profit organizations. The National Science Foundation, between 1993 and 2006 offered 350 grants totaling between $7 and $11 million per year for the production of knowledge to broaden girls’ attitudes and perceptions on STEM careers and to increase the number of women participating in these undergraduate and graduate programs.

Another NSF funded program, ADVANCE, has invested over $130 million since 2001 in more than 100 academic and non-profit institutions (NSF, 2009) to aid women in academic STEM careers.
Considerable research has focused on women in academic careers involving science, engineering and technology, but few on women in the same fields in the private sector (Hewlett et al., 2008). Among the latter, the focus of research, including studies conducted by the Society of Women Engineers (Frehill, 2008) and the Center for Work Life Policy (Hewlett et al., 2008) have focused on why women leave STEM careers. Frehill (2008), for example, categorized 146 women’s responses to the question “what caused you to leave engineering” into six areas: interest in other careers (47%), advancement opportunities (20%), time/family-related issues (18%), boredom or lack of challenge (16%), other job issues (15%), and negative work climate (14%).

**Business Case For Gender Diversity**

Numerous quantitative studies show a compelling business case for expanding the participation of women in the workforce. In their report on rebuilding the world economy Ernst & Young state that studies completed by Catalyst, Columbia University, McKinsey, Goldman Sachs and others show undisputedly that having more women in leadership improves the financial performance of corporations (Ernst & Young, 2009).

Catalyst is a non-profit focusing on research and advisory to businesses especially related to inclusive environments and opportunities for women. In 2004 Catalyst published a report linking gender diversity and corporate financial performance (Catalyst, 2004). Using two measures of corporate financial performance for 353 Fortune 500 companies in the period 1995 to 1999 Catalyst found that those companies with the highest representation of women in top management positions outperformed other companies with the lowest representation of women. In the five types of industries analyzed, companies with the highest representation of women in leadership were higher
in Return on Equity (ROE) than those with lowest representation of women in leadership. For Total Return to Shareholders (TRS) four out of five of the industries showed that companies having higher representations of women in leadership outperformed those with low representation (Catalyst, 2004).

The London School of Business studied the impact of gender diversity in knowledge based work specifically related to professional teams and innovation (London School of Business, 2007). The study included surveying more than 100 teams in 21 organizations including Volvo, Cargill, L’Oreal, Corning and others resulting in more than 850 individuals’ responses. Findings from this study show that gender balanced teams (50% men, 50% women) consistently outperformed other teams. As a minority on a team neither men nor women flourish. To optimize team’s innovation potential the report recommends that teams should be constructed with gender balance including individual who have boundary spanning capability and who bring diverse views to the team.

According to the studies compiled by the Anita Borg Institute for Women and Technology, women influence 80% of consumer purchases and that companies with a diverse workforce are perceived better in the marketplace (Anita Borg Institute for Women and Technology, 2007).

**Brief Literature Review**

Various streams of research provide the theoretical framework for this study including the intentional change theory (Boyatzis, 2008; Boyatzis & Akrivou, 2006) and the social cognitive career theory (Lent, Brown, & Hackett, 1994; Lent, 2005) with
consideration of the gendered organization theory (Acker, 1990) and kaleidoscope career theory (Mainiero & Sullivan, 2005).

**The Intentional Change Theory and the Ideal Self**

The intentional change theory (Boyatzis, 2008) provides an explanation for achieving sustainable change at the individual, organizational, and societal level but because intentional effort is necessary to maintain a current career, the intentional change theory (ICT) provides a framework for this study. The ICT builds on complexity theory where intentional change is described as a series of discontinuities where change occurs through a series of five discoveries or emergences.

Discovering one’s ideal self is the initial emergence, where, in a broad sense, the ideal self is the concept of who a person wants to become. The notion of the ideal self is rooted in the psychology literature, specifically in work on motivation. Self discrepancy theory as posited by Higgins (1987) distinguished between two guiding end states, the ideal self and the ought self. The ideal self is guided by the individual’s hopes, wishes, and aspirations, while the ought self is guided by demands regarding duties, obligations, and responsibilities. Building on self discrepancy theory, Higgins, Roney, Crowe, & Hymes (1994) showed that some people are motivated to move as closely as possible to a desired end state while others avoid anything unaligned with it.

The ideal self is considered to have three major components: an image of a desired future, hope and one’s core identity (Boyatzis, 2008). The concept of the core identity comes from strength-based approaches and is the awareness of one’s strengths.
Social Cognitive Career Theory

Building on previous work aimed at understanding the choice of undergraduate majors particularly those involving women and STEM careers, Lent et al. (1994) developed the social cognitive career theory (SCCT). The framework provides for an understanding of career decisions including interests, career choice, and persistence in educational pursuits and as a result has potential in examining the persistence of women in engineering careers.

Beginning with Bandura’s (1986) Social Cognitive Theory, the SCCT brings together both individual and contextual concepts to explain career decisions. SCCT addresses the dynamics involved with individual factors surrounded by an ever-changing environment or culture to predict outcomes. The recognition that people can change and will change separates this theory from others and provides the opportunity for its use in understanding how careers develop. The theory also allows for changing life roles and the salience of these roles for individuals related to their career options. Individuals can and do assert agency in the decisions impacting their careers (Lent, 2005).

Career Theories and Gender

Two models have dominated the careers literature over the last decade (Clarke, 2009), the protean career (Hall, 2004), and the boundaryless career (Sullivan & Arthur, 2006). Individuals – not organizations – drive protean careers according to Hall (2004) and like the Greek god Proteus, these careers could change shape at will. Psychological success is the ultimate goal of the protean career unlike traditional careers where climbing the ladder to make more money was the only measure of success.
Boundaryless career theory involves physical and psychological career mobility (Sullivan & Arthur, 2006). The level of physical and psychological mobility as well as the interdependence between them varies and women’s career’s are likely to be different than men’s careers because of social and psychological differences.

The Kaleidoscope career model (KCM) was developed to understand women’s choices in their career and to specifically address the “opt-out revolution” (Mainiero & Sullivan, 2005). The model is of particular relevance to both work and non-work realms and salient to our proposed study addressing women’s retention in the engineering profession as KCM explains career interruptions, gaps, topping out, and opting out.

Theory of Gendered Organizations

To explain the cultural aspects involved with a woman’s career we turn toward research within organizations, specifically theory of gendered organizations (Acker, 1990). In developing her theory Acker (1990) posits that organizations were not gender neutral, but conversely that assumptions about gender are the foundation of the organization. And because organizations are gendered, they cannot be accurately understood unless gender is used to as an underlying construct in the organizational processes which control the organization. How employees develop meaning and identity within the organization, and how the organization distinguishes male and female are critical mechanisms of the organization.

Research Questions

The overarching research questions for this study are:

• What factors influence career persistence in the engineering profession for women?
• How do these factors compare to men in the engineering profession?

• What can we learn from these factors that could improve the retention of women in the engineering profession?

**Research Design**

Our research has taken the approach of hypothesizing that those women who persist in an engineering career have unique individual and contextual factors that promote persistence in the engineering profession post degree. Understanding these individual and contextual factors and developing plans for educating women can aid in the retention of women in the engineering profession.

For this research on women in engineering careers we took a complex, three stage study approach. The first stage was a qualitative research study which led to a conceptual model. The conceptual model led to the development of a new construct, the ideal self, and a quantitative study which concluded by developing a structural equation model for women’s commitment to the engineering profession. The last stage of this research was comparing the factors and relationships important to a woman’s career commitment to engineering to a sample of men engineers.

For the qualitative research study, we interviewed 31 women engineers to understand the individual and contextual factors influencing persistence in an engineering career. The interviews were recorded, transcribed, coded an analyzed. The analysis resulted in the development of a conceptual model that included the ideal self as a mediator relating individual factors to career persistence for women in engineering.
A new construct for the ideal self has been developed. Several small scale assessments refined the new construct and a pilot study with 112 responses was conducted to assess the validity and reliability of the ideal self as a 5 factor construct.

The conceptual model for a woman’s persistence in engineering was used as a framework for a quantitative study using a survey method to collect data from both women and men who had engineering degrees. Seven constructs well document in the literature, the new ideal self constructs and demographic data were included in the survey questions. Using a snowball survey distribution method, data was collected from 495 women and 138 men. The analysis included data screening, the development of a measurement model and a structural equation model. PLS-Graph was used to develop the SEM as the ideal self construct has been conceptualized as a formative construct.

Basic statistical analyses as well as regression techniques were used to further explore the data on the women engineers. The structural equation model that was developed to explain women’s career commitment to engineering was neither valid nor reliable as applied to the sample of men engineers, leading to additional analysis of which factors and which relationships differed for men and women.

**Contribution of this Research**

The major contributions of this research are:

1. The development and validation of a construct to measure the ideal self that supports the theory as proposed by Boyatzis & Akrivou (2006).
2. The utilization of the ideal self construct in a study that identifies factors for women persisting in engineering.
3. The development of a structural equation model that defines the factors relating to women persisting in the engineering profession.
4. Validation that the factors important to women’s persistence in engineering are different from their male colleagues.

5. The development of a theoretical model that integrates the findings from both qualitative and quantitative research to explain career persistence for women in engineering. The model has potential to explain career persistence in other male-dominated professions.
CHAPTER II: LITERATURE REVIEW, GAPS AND HYPOTHESES

Theoretical Framework

Intentional Change Theory

The intentional change theory (Boyatzis, 2008) provides an explanation for achieving sustainable change at the individual level but because intentional effort is necessary to maintain a current career, the ICT is considered as a framework for our study as the ability to maintain a current state or a career requires an investment of energy. Building on complexity theory, intentional change is described as a series of discontinuities where change occurs through a series of five discoveries or emergences.

The ideal self, the initial emergence, is guided by the individual’s hopes, wishes and aspiration. Discovering one’s ideal self is recognizing who a person wants to become. Since the ideal self engages in behavior consistent with one’s desired end state, sacrifices are sometimes made in the short term to accomplish more important longer-term goals (Boyatzis & Akrivou, 2006). This aspect of the ideal self has potential to explain why women persist in a male-dominated profession especially in light of the literature describing the difficulties women experience (Fouad & Singh, 2011; Frehill, 2008; Hewlett et al., 2008).

The ideal self is considered to have three major components: an image of a desired future, hope and one’s core identity (Boyatzis, 2008). Hope is defined as the feeling that something desirable is likely to happen and is proposed by Boyatzis as constituted by self efficacy and optimism. The concept of the core identity comes from strength-based approaches and is the awareness of one’s strengths.
The second emergence in the intentional change theory is termed the real self (Boyatzis, 2008) and this is the awareness of the current self. Taylor (2006) discusses two attributes of the ideal self: accurate knowledge of one’s self and the correct assessment of how others view one’s competencies. Having an accurate assessment of one’s competences is essential to achieving goals and the real self serves as a check from which to measure progress towards one’s ideal self. Multiple methods can be employed leading to the real self discovery including 360 degree assessments, behavioral feedback through video recordings, psychological tests, or coaching from a professional (Taylor, 2006).

Development of a learning agenda using one’s strengths and building one’s weaknesses is the third emergence of the intentional change theory (Boyatzis, 2008). The development of a plan focused on improvement requires the use of positive emotional attractors (PEA) and negative emotional attractors (NEA).

Experimentation with new behaviors and then practicing these behaviors in various situations comprise the fourth emergence in the intentional change theory. Boyatzis (2008) states that flexibility is needed to practice these new behaviors as one may possibly fail and then succeed. Settings are important in that the practice should be in a realistic context and the use of a coach to provide feedback is recommended.

The last emergence of the intentional change theory is the use of supportive relationships as sustained, desired change for individuals requires the guidance and support of others (Boyatzis, 2008). These so-called resonant relationships must be grounded in trust as the feedback and support that is provided acts as a safety net which allows the change to occur and be sustained.
Studies related to the intentional change theory have been focused on leadership development capabilities. At a mid-western university a course based on the intentional change theory was implemented to develop leadership skills in MBA students. In a longitudinal study comparing retained competencies before and after implementation, a dramatic improvement was shown in students’ emotional and social competencies immediately after the course and in studies completed up to two years after graduation (Wheeler, 2008). Further Van Oosten (2006) showed that an organization improved dramatically after employing the ICT in the context of a leadership development program.

Career Theories

Dramatic changes in established firms and the rise of novel industries over the last several decades have been attributed to new technologies, especially those using electronic information and communication technologies (Dosi, Gambardella, Grazzi, & Orsenigo, 2008). As firms have transformed, so have careers and career theory. Once viewed from a rigid and hierarchically structured organizational perspective in which success was defined by upward mobility (Baruch, 2004) careers are now increasingly multidirectional and individually centered.

Two models have dominated the careers literature over the last decade (Clarke, 2009), the boundaryless career (Sullivan & Arthur, 2006) and the protean career (Hall, 2004). The Kaleidoscope career model (KCM) was developed to understand women’s choices in their career and to specifically address the “opt-out revolution” (Mainiero & Sullivan, 2005). The Social Cognitive Career Theory (Lent et al., 1994; Lent, 2005) was initially developed to explain persistence of undergraduates in engineering programs and
was later updated to provide a theory of career development. The next section describes these four career theories.

**Boundaryless.** Boundaryless career theory involves physical and psychological career mobility (Sullivan & Arthur, 2006). The theory has evolved as contemporary careers have been viewed as increasing complex, depending more on the individual than the organization. The interconnection of factors including competencies, gender, culture and individual differences are recognized as influencing career decisions.

Boundaryless career can be represented by a model with four quadrants and axis of physical mobility and psychological mobility. In this way careers are characterized by varying levels of physical and psychological mobility. Those with careers characterized as being low in physical and psychological mobility may enjoy job security and unique challenges of the job but may be threatened by mergers and acquisitions. For those careers having high levels of physical mobility and low levels of psychological mobility travel may be important however there is concern that these careers may become dysfunctional over time as the need for skills changes. Individual with careers characterized by low levels of physical mobility and high psychological mobility have high expectations of their own employability without changing employers. These individuals seek personal growth. High levels of both physical and psychological mobility are characterized by individuals making numerous physical changes and changing jobs often.

Career competences within a boundaryless career are described as the ways of knowing specifically: knowing why, knowing how, and knowing whom (DeFillippi & Arthur, 1994). These competencies can be used to understand differing career
opportunities and career choices. Knowing why involves an individual’s unique motivation and identity, knowing how is about one’s skills and expertise, and knowing whom includes one’s reputation and network. Sullivan & Arthur (2006) describe the three ways of knowing as interdependent and the accumulation of career competencies leads to greater perceived career success.

The level of physical and psychological mobility as well as the interdependence between them varies and women’s career’s are likely to be different because of social and psychological differences. Women’s education and career choice opportunities have been restricted due to societal norms and expectations (Sullivan & Arthur, 2006). As a result women in general may have less physical mobility than men, however there may be more opportunity for women to engage in psychological mobility than men as men are expected to conform to traditional work roles.

**Protean.** Individuals – not organizations – drive protean careers according to Hall (2004) and like the Greek god Proteus, these careers could change shape at will. Psychological success is the ultimate goal of the protean career unlike traditional careers where climbing the ladder to make more money was the only measure of success (Hall, 1996). This career theory is characterized by continuous learning and identity changes with sources of development in the work challenges and relationships. Career learning comes from work assignments that cause the individual to stretch in new ways. Interconnections with people at work form both formal and informal networks from which new learning takes place.

The protean career theory posits that demand for workers will shift from one where skills are important to one where the ability to learn new skills is important. Job
security will no longer be expected or offered rather the concept of employability is the goal. Self-awareness and personal responsibility are vital for a protean career where comfort with autonomy is essential (Hall, 1996).

Identity and adaptability are discussed as career meta-competencies as these equip people to learn from experience and develop new competencies. The idea of a meta-competency is described as the ability to obtain additional competencies from learned experiences (Hall & Chandler, 2005). Identity or self-awareness is described by Hall & Chandler as the ability to recognize oneself and to change when appropriate. This ability helps an individual to recognize when and how to update career skills. When one has a clear sense of identity there is clarity in regard to one’s values, life purpose, and aptitudes.

Adaptability is described as both the recognition of competencies necessary for future performance and the ability to make personal changes to meet these future performance needs (Hall & Chandler, 2005). The ability to proactively establish goals, to show initiative and to achieve success comes from the competency of adaptability. Here self exploration and reflection support an individual’s ability to adapt and augments the ability to take action consistent with one’s characteristic identity.

Because self-directedness and personal value congruence are the foundations of the protean career Cabrera (2009) argues that the protean career theory is well suited to the study of women’s careers.

**Kaleidoscope career model.** The Kaleidoscope career model (KCM) was developed to understand women’s choices in their career and to specifically address the “opt-out revolution” (Mainiero & Sullivan, 2005). The model is of particular relevance
to both work and non-work realms and salient to our proposed study addressing women’s retention in the engineering profession as KCM explains career interruptions, gaps, topping out, and opting out.

Women’s career decisions include interconnected aspects such as children, spouses, aging parents, friends, and work colleagues posits Mainiero & Sullivan where men generally make career decisions independently, oriented towards goals separate from non-work issues.

KCM discusses career decisions based on three parameters: authenticity, balance and challenge. As a kaleidoscope has three mirrors that create an infinite number of patterns, the kaleidoscope career model has three unique parameters reflecting an infinite number of career patterns of a woman’s career (Mainiero & Sullivan, 2005).

**Social cognitive career theory.** Building on previous work aimed at understanding the choice of undergraduate majors particularly those involving women and STEM careers, Lent et al. (1994) developed the social cognitive career theory (SCCT). The framework provides for an understanding of career decisions including interests, career choice, and persistence in educational pursuits and as a result has potential in examining the persistence of women in engineering careers.

Beginning with Bandura’s (1986) Social Cognitive Theory, the SCCT brings together both individual and contextual concepts to explain career decisions. SCCT addresses the dynamics involved with individual factors surrounded by an ever-changing environment or culture to predict outcomes. The recognition that people can change and will change separates this theory from others and provides the opportunity for its use in understanding how careers develop. The theory also allows for changing life roles and
the salience of these roles for individuals related to their career options. Individuals can and do assert agency in the decisions impacting their careers (Lent, 2005).

The framework for SCCT, according to Lent includes the three person variables from the social cognitive theory – self efficacy beliefs, outcome expectations, and personal goals (Lent, 2005). The interplay between these variables impacts an individual’s ability to make decisions regarding one’s career development.

Although knowledge and skills are necessary to perform an accomplishment, self-referent thought mediates the relationship between knowledge and action (Bandura, 1982). How individuals judge their capabilities impacts their motivation and behavior. Further, numerous (Lent, 2005) studies have proven that self efficacy is developed and can be improved by one or a combination of four mechanisms: performance accomplishments, vicarious experience, verbal persuasion and psychological states (Bandura, 1977, 1982).

Self efficacy in the social cognitive theory is viewed as a set of beliefs that are dynamic and linked to a domain of performance (Lent, 2005). The concept of self efficacy was theorized to have applicability to career development initially by Hackett & Betz (1981) where they posited that especially for women the strength and level of efficacy expectations are important in understanding career development. Hackett & Betz advocate that while a variety of factors, both social and individual impact the career development of women, a focus on cognitive factors such as self efficacy will aid in developing theory and models.

While self efficacy is one’s beliefs that he or she will succeed in a particular situation, outcome expectations are one’s beliefs about the consequences of performing
particular behaviors (Lent, 2005). Both self efficacy and outcome expectations were
theorized by Bandura to determine which activities individual choose to undertake.

Personal goals within the SCCT are separated into those which are choice content
goals and performance goals. The career choice or the types of activities chosen by an
individual are the choice content goals, where the level and quality of performing to
achieve one’s goals are defined as the performance goals (Lent, 2005).

The SCCT was developed initially for career entry for those in the late adolescent
and early adulthood periods of life (Lent et al., 1994). The career choice model is
embedded within a larger conceptual scheme that recognizes the influence of precursors
on choice. Both self efficacy and outcome expectations impact career interests, which
impact choice goals and motivate action toward performance. Contextual factors
moderate the influence of interests on goals as well as the influence of goals on actions.
Performance may then have an influence on learning experience which impact self
efficacy and outcome expectations.

Within the scope of the SCCT a model for career interests takes into account
one’s environmental factors that may affect these interests. The psychological and social
effects of gender and race are linked to career interests and choice from the social and
cultural context in which the individuals are socialized and from which they may see
opportunities. As a result Lent posits, gender and ethnicity may influence career decisions
as the development of self efficacy and outcomes expectations may depend on how one is
socialized. Gender role socialization has been shown to bias the beliefs and expectations
that boys and girls have around male or female-dominated professions leading to
outcomes culturally defined as appropriated for their own gender (Hackett & Betz, 1981).
Gender as well as other socially constructed influences can limit career interests and may impact the opportunities and affect an individual’s career goals (Lent, 2005).

**Social cognitive career theory and undergraduate persistence in STEM majors.** A rich body of literature exists thanks to a landmark study by Hackett & Betz (1981) where they posited that self efficacy expectations have relevance to women’s career development. The level and strength of an individual’s self efficacy expectations were found to influence persistence in non-traditional career choices especially for women. Because the socialization of women is less likely than males to facilitate strong career related self efficacy expectations Betz & Hackett (1981) postulate that women are more likely not to choose professions such as law, medicine and those in science, technology, engineering or math.

To test this hypothesis, 134 females and 101 male undergraduate volunteers were surveyed using two career related self efficacy measures (Betz & Hackett, 1981). One assessed self efficacy related to the educational requirements and the other self efficacy related to job duties of an occupation. They found that the occupations of physician, engineer and mathematician were perceived as most difficult and teacher, social worker, and travel agent were perceived as least difficult. Additionally Betz & Hackett found that there were significant differences in the proportion of males and females who indicated they could successfully complete the coursework to attain the degree. Males indicated that physician would be the most difficult where women indicated engineering. The profession where there was the greatest difference between men and women was engineering. Additional findings confirmed consistent and significant differences related to gender for non-traditional career choices.
Several studies reported (Lent, Brown, & Larkin, 1984; Lent, Brown, & Larkin, 1986; Lent et al., 1994) tested the relationship of efficacy expectations to persistence in educational objectives. Academic performance specifically higher grades were found to be related to the student’s beliefs about their ability to complete the required science and engineering curriculum (Lent et al., 1984).

In the follow up study, 75 men and 30 women in an undergraduate science or engineering planning course completed a survey measuring self efficacy, career indecision, self-esteem, interests, and perceived options. As in the previous studies, they found that self efficacy expectations were related to academic performance, and additionally found that self efficacy was related to vocational interests and perceived career options (Lent et al., 1986).

After 15 years of research and more than 100 studies Betz & Hackett (1997) described the application of self efficacy theory to the career assessment of women. Gender role socialization has been shown to influence the career choices and outcomes of both men and women and has been the focus of research and theory development. Building on their finding (Hackett & Betz, 1981) that self efficacy expectations mediated the effects of gender role socialization, Hackett & Betz proposed three hypotheses. First, that the under representation of women in STEM field was due to lower career relevant efficacy expectations. Secondly, they postulated that women’s efficacy expectations were lower than men’s in traditionally male-dominated fields identified by them as mathematically related fields. And lastly, gender differences in vocational interests may be explained by differential self efficacy expectations.
Research on self efficacy and career interests has found that interventions to increase self efficacy expectations can increase an individual’s career interest. Because gender role socialization may lead to fewer opportunities for experiences or access to non-traditional professions for both men and women, interest in those professions may be influenced (Betz & Hackett, 1997).

Expanding on the self efficacy aspect of Bandura’s social cognitive theory, Lent, Lopez & Bieschke (1991) and Betz & Hackett (1997) empirically tested the social cognitive model. They found that self efficacy mediates interests and choice intentions. Nauta et al. (1998) chose to test the theorized relationships of ability and role model influence on higher level career aspirations. In their study on women in STEM majors, they found that higher level career aspirations were predicted self efficacy mediating both ability and role model influence, and these career aspirations were impacted by role model influence mediated by role conflict.

To explain the cultural aspects involved with a woman’s career we turn toward theory within organizations, specifically Ely, Ibarra & Kolb (2011) theory and design for women’s leadership development and Acker’s theory of gendered organizations.

**Women’s Leadership Development Theory**

Subtle and persuasive forms of gender bias exist in today’s organizations and are viewed as impediments to women’s progress according to Ely et al. (2011). Underrepresentation of women in leadership roles is a result of this so-called second generation gender bias and is considered as an underlying factor in the low representation of women in STEM careers.
Because most organizations have institutionalized practices prohibiting sex
discrimination women have been afforded numerous opportunities unavailable to them a
quarter century ago. However in 2011 women comprise 14% of the executive officers,
16% of the board seats, 7.5% of the top earners and only 3.6% of chief executive officers
in the Fortune 500 (Catalyst, 2012). Research has shifted according to Ely, Ibarra &
Kolb from a focus on intentional exclusionary practices aimed at women to the so-called
second generation forms of gender bias. Cultural beliefs about gender, as well as the
workplace structures, patterns of interaction and practices that inadvertently favor men,
create this type of gender bias.

Practices that equate leadership or other work roles as behaviors believed to be
not only more common but more appropriate for men promote gender bias. Because
people tend to stick with others like themselves, men in organizations with the power to
promote others are more likely to sponsor and promote other men. Ely et al. (2011) posit
that these subtle but persuasive forms of gender bias impede women’s progress into
leadership roles. As these biases accumulate they interfere with the identity development
process necessary for a woman to construct and internalize a leadership identity. A
leader’s identity is important to the process of becoming a leader. This identity
development is particularly difficult for women in leadership as there are few role models
for women, career paths and work have gender associations, women lack access to
sponsors and networks, and women receive greater scrutiny as they rise in organizational
hierarchies.

To overcome these challenges Ely et al. (2011) offer a framework for women’s
leadership development grounded in theories of leadership and gender. While others
have suggested that gender should not matter for leadership development or that a focus should be on changing women. Ely et al. suggest that leadership development should neither blame nor victimize the women. Women’s leadership development should be separate from men because gender shapes a woman’s path to leadership.

A leader identity is comprised of relational and social processes that are not only internalized but are seen by others. As a leader takes actions others affirm or disaffirm the actions in a recursive and mutually reinforcing leader identity constructing process. One’s identity as a leader is affirmed by recognition and provides additional opportunities for growth and bolsters self confidence thereby increasing the motivation to lead.

If one fails to obtain validation as a leader, self confidence may be diminished and as well as the motivation to lead. This hinders the process of obtaining and experimenting with development opportunities and weakens one’s identity as a leader.

One’s sense of purpose is thought to be important to the development of a leader identity as most effective leaders have alignment between personal values and their leadership role. When leaders share their sense of purpose within the organization with others trust results and employees can be inspired. Leaders who connect can aid employees in finding a greater sense of meaning in their own work. Developing this sense of purse and having the ability to convey this purpose to others is described by Ely et al. (2011) as an important part of constructing a leader identity and being seen as a leader.

Three design principles are offered by Ely et al. (2011) for women’s leadership development programs: 1) Situate topics and tools in an analysis of second generation
gender bias, 2) Create an environment to support women’s identity work and 3) Anchor participants on their leadership purpose.

**Gendered Organizations**

In developing her theory Acker (1990) posits that organizations were not gender neutral, but conversely that assumptions about gender are the foundation of the organization. And because organizations are gendered, they cannot be accurately understood unless gender is used as an underlying construct in the organizational processes which control the organization. How employees develop meaning and identity within the organization, and how the organization distinguishes male and female are critical mechanisms of the organization.

Further Acker discusses how organizational practices create gender segregation at work, how organizational processes create income and stature inequalities, and how organizations are inventing and disseminating cultural images of gender. Additionally, Acker posits, an individual’s gender identity is constructed by organizational processes and that an important goal of feminist work is to support the evolution of work organizations to ones more humane.

Gendering within organization includes the division of labor as well as allowed behaviors. The divisions in work have been documented since the seminal work of Kanter (1977) describing the roles of men and women within a specific corporation. Acker argues that manager’s, who are mostly men, continue to make decisions that proliferate organizational differences relating to gender.

Assumptions about gender are the underpinning of the organization as masculine images pervade organizational processes. Acker discusses the sources including the
images, including that of a business mogul as successful and always masculine. Within an organization, the daily interactions manifest dominance and/or submission related to gender, where at times men are the actors and women the emotional supporters. One example of these gender roles is the classic example of a male business manager and his supportive secretary.

Organizational processes produce identities which include gendered components Acker suggests because gendered designated choices of appropriate work, language, dress and presentation of self within an organization. And while most organizational logic, as well as organizational theories appear to be gender neutral, the fundamental structure and processes are part of a larger social structure that is clearly gendered.

Women’s jobs are of lower authority and lower pay which are justified, argues Acker because of the identification of women as child-bearers and women’s role in domestic life. Gendered hierarchy is maintained by blaming women’s reproduction, emotionality, and sexuality for lower-level mobility tracks.

**Studies on Women in STEM**

**Women in the Engineering Profession**

Engineering is a profession in which the number of jobs will continue to grow (BLS, 2006) and starting salaries are high (BLS, 2009) up to $59,000 per year for bachelor level chemical engineers and $92,500 for PhD computer engineers in 2007. However, women have low representation in engineering and other STEM professions and leave at higher rates than men (Frehill, DiFabio, Hill, Traeger, & Buono, 2008). Empirical studies focused on women in engineering are rare as compared to research on women in other professions (Jorgenson, 2002). Many studies on women engineers are
based on samples of engineering students (Blum, 2001; Chiu, Chiu, Chiu, & Chiu, 2002; Cuny & Aspray, 2002; Shull & Weiner, 2000) or women in academic engineering roles (Bilimoria, Joy, & Liang, 2008; National Science Foundation, 2007).

The Society of Women Engineers (SWE) published a study in 2008 on men and women with engineering bachelor’s degree earned between 1985 and 2005 to gauge their reasons for leaving the profession (Frehill, 2008). Men were shown to leave for advancement opportunities at higher rates than women, while women were more likely to leave than men due to negative work climate.

Hewlett et al. (2008) found that SET (science, engineering, and technology) organizations are hostile and macho where women become isolated and marginalized. Career paths are described as mysterious and because women do not share the support of men within their organizations they fail to achieve at the same rate as their male peers. These factors cause more than half of the women in SET to leave these careers by their late to mid 30’s as they face serious career hurdles. Hewlett et al. suggest that women need targeted support from management at this time to stop them from opting out of SET careers.

Frehill’s (2008) study supports Hewlett et al. as she found that only one in three women engineers remain in the profession 18 years post degree. Further, in this study funded by the Society of Women Engineers Frehill categorized 146 women’s responses to the question “what caused you to leave engineering” into six areas: interest in other careers (47%), advancement opportunities (20%), time/family-related issues (18%), bored or lack of challenge (16%), other job issues (15%), and negative work climate (14%).
In her article on the changes worldwide for women in engineering Hersh (2000) reported comparative data on women’s careers by countries. She concludes that the low representation of women is a strong disincentive to other women entering engineering and suggests that measures be taken to ensure women are promoted on the same terms as men.

Jorgenson (2002) studied 15 women engineers ages 29 to 45 to understand how women engineers position themselves within the prevailing discourse on gender and technical work and concluded that the women positioned themselves as career identified and able to cope in male-dominated workplaces while being good mothers struggling with balance between work and families. Additionally the women were found to be non-feminist because they did not want to organize as women, and were resistant to being perceived as a homogenous group.

An empirical study of women engineer’s mid-career satisfaction conducted by Auster & Ekstein (2005) found organizational, job and stress factors are related to, but not predictive of women mid-career satisfaction. While expecting that organizational characteristics would predict job satisfaction, their findings suggest that the effects of job and stress factors over rode them. The study included individual characteristics of the women such as child care responsibilities, but did not include any measure of personality, motivation, or identity which we believe may be important in achieving job satisfaction.

Research conducted by Gill et al. (2008) focused on women engineers as professionals in the workplace, where they concluded that the women’s positive self image based on school success was impacted and in many cases diminished by the workplace culture. The study was nationally funded in Australia where engineering is
considered a respected profession with high paying jobs and low levels of unemployment; however, only 10% of professional engineers are women at a time when the country is experiencing a severe shortage in the engineering profession (Gill et al., 2008).

Building on social systemic issues such as gendering and lack of role models Gill et al. (2008) theorized that women engineers and their work environment are interrelated and that a woman’s identity is constructed by individual and environmental interactions. Workplaces are seen as communities of practice (Wenger, 1998) and as such produce, maintain, and change identities. Gill et al. (2008) go on to explain that engineering work is mostly performed within teams, even stating that engineering work is possibly more collaborative than that of other professions. Moreover, for people who are “different” working in teams pose challenges leading Gill et al. to postulate that, especially for young and highly qualified women, working in engineering teams can be problematic. Conclusions from the study focused on the gendered nature of engineering and that women are not prepared for dealing with the engineering culture.

Gill et al. (2008) recommend changes to the engineering educational process to include the development of skills that would enable women to fit into the workplace culture. They found that women are well prepared technically, but do not understand the politics of the workplace nor could they develop strategies to position themselves effectively. In order to develop a more equitable and diverse workplace, the authors argue that the workplace culture must change, but do not give clear direction on how this change could occur. Interestingly, they found that senior management appeared to be aware of issues for women in engineering in that they allowed the research to occur.
within their companies. However, men working as engineers appeared to be unaware of the issues impacting their women colleagues.

The engineering profession has been studied in the context of gendered organizations (Miller, 2004) and in “doing gender” (Faulkner, 2009; Powers, Bagilhole, & Dainty, 2009). Faulkner, in her ethnographic field study on engineers in three different disciplines (building design, software development, and oil field production in the UK) considered to what extent and how the workplace cultures were more comfortable and supportive to men than women. Faulkner concluded that gender is not always predictive of engineering generalities in that not all women are marginalized in an engineering workplace. However, the dynamics of an engineering culture support men’s membership more than that of women.

Faulkner (2009) observed that engineers are collaborative in the nature of their work and are respectful to others, but are clearly work focused in that interactions are seldom of a personal nature for both men and women. Taking pride and pleasure in the technologies they help create was found to be the same for both men and women; however Faulkner noted differences in gender for non-work conversations.

An extreme example of women working in the engineering field is found in Miller (2004) who interviewed 20 women engineers who worked in the Alberta Canada oil industry. She found cultural evidence of paternalism and condescending chivalry where women were treated as novelties and as pioneers. A comparison of the Alberta oil industry is made with the cowboys and the hero myth with Miller concluding that the oil industry in Alberta is gendered and intensely masculine: overt and macho on the oil rigs and subtle in the executive offices.
Women who work in the oil industry are confronted with masculine values, in the focus on technology and in the individualistic cowboy-like approach to work. The oil industry is presented as a gendered culture to women engineers and as a result barriers to success exist for these women (Miller, 2002).

In their study funded by an NSF grant Fouad & Singh (2011) surveyed women with undergraduate engineering degrees from 30 universities. By word of mouth, women from an additional 200 universities responded resulting in more than 3700 women completing the survey at the time the report was published. Most of the women were current engineers (57%), 21% left engineering more than 5 years ago, 15% of these women never entered the engineering profession and the smallest group had left engineering less than 5 years ago (7%).

The survey collected demographics and 26 additional measures that were theorized to impact a woman’s decision to leave the engineering profession. Using the Social Cognitive Career Theory as a basis, the women were surveyed on vocational interests, job and career satisfaction, work-family conflict, withdrawal intentions, commitment to the current organization as well as the engineering profession, training and development opportunities, workplace difficulties and supports.

Their findings showed that more than half of women who left engineering described difficult working conditions as their reason for leaving citing too much travel, lack of advancement and low salaries. Time with family was cited by one quarter of the respondents. For those women who never entered engineering after graduating with an engineering degree one third said they perceived engineering as inflexible and especially difficult for women.
A key finding from Fouad & Singh was that for those women still in the engineering profession their confidence in their abilities to navigate the political landscape and juggle multiple life roles were highly satisfied with their current jobs and their engineering careers.

The study recommends that organizations create clear, visible, and transparent paths to advancement, invest in training, provide goals related to engineering work, improve the culture by valuing employee’s contributions, eliminating damaging workplace behaviors and create a supportive, respective environment.

It is clear from these studies on the culture of engineering that women engineers face numerous obstacles in their career that lead to low retention rates for women in the profession. Women come into the workplace disadvantaged – while they are prepared to perform the technical work, the educational process has not prepared them to handle the cultural aspects of the workplace that have been established to support men. Senior management may be aware that workplace cultures are more comfortable and accommodating to men than women, but other than allowing studies to occur within their organizations they are either unwilling or unable to change the culture. Additionally, male peers seem completely unaware of the issues impacting women in engineering further marginalizing women and leading to them to opt out of the professions.

**STEM Women in Academia**

Talking to an economics conference in January 2005, Lawrence H. Summers then President of Harvard University said that the “innate” differences between men and women were the reason for women’s under-representation in science at universities (Hemel, 2005). Summers is widely quoted as having said this to provoke discussion and
so it has. One report issued by the National Academies provides significant support against the innate differences argument.

On October 17, 2007, Donna Shalala reported to Congress on the findings of the National Academies study on “Maximizing the Potential of Women in Academic Science and Engineering” (National Academies, 2007). Among other findings the study found that women have the ability and drive to succeed in science and engineering but are lost at every educational transition and face discrimination in every field. Biases lead to arbitrary and subjective components that disadvantage women. As a result women are paid less, are less likely to be promoted or to receive honors and hold fewer leadership roles.

The study recommends that all science funding agencies should hold workshops on gender bias and expand funding for research in this area. Further opportunities for funding should include dependent care support as well as supporting research on how well organizational programs reduce gender bias. There should be clear guidelines and enforcement of these guidelines for discrimination in all higher education institutions.

As far as understanding any differences relating to gender in science and engineering the report states that a large amount of research has reviewed differences in cognitive ability related to gender (National Academies, 2006). Studies of the brain, hormonal modulation of performance, cognitive development and evolution have revealed no significant differences between men and women that accounts for the lower representation of women in science and engineering. Further the academic success of girls equals or exceeds boys in the US at the high school and college level. Social pressures and influences are different for boys and girls and these appear to have an
impact the differing motivations and preferences for science and engineering. The report concludes that the underrepresentation of women in science and engineering profession is a result of the interplay between individual, institutional, social and cultural factors and calls for continued research to improve performance.

The report closely examined women in academic science and engineering with their findings showing that while both men and women leaves these fields fewer girls in high school choose science and engineering, and more leave while in undergraduate studies. Of those completing undergraduate work, fewer women go on to complete science and engineering graduate programs, and few of these are recruited for tenure-track positions (National Academies, 2006).

Differences were noted in the number of papers published, meeting attended and grants written between men and women. Men and women overall come up for tenure at similar rates however field and race or ethnicity show differences were African American women were 10% less likely to obtain tenure than men. Promotions and awards were most likely to be obtained by men. Recommendations include on-going work with organizations to recruit high school girls, conscious recruitment of faculty that includes women, especially minorities, studies on faculty turnover and additional data on education and employment of scientists and engineering (National Academies, 2006).

Since 2001 the National Science Foundation (NSF) has provided over $130 million in funding to increase the representation and advancement of women in academic science and engineering careers (NSF, 2009). This grant labeled ADVANCE encourages higher education institutions to address the culture of the institute so that women faculty and administrators are not differentially disadvantaged. More than one hundred
institutions of higher education have received funding including more than 75 public institutes and more than 25 private institutes.

In a study of 19 of these institutions receiving ADVANCE grants Bilimoria et al. (2008) discuss the transformations undergone to increase the representation and participation of women. A model is presented that shows the necessary organizational transformation to enhance the representation and inclusion of women and minority groups. Included in the identified initiatives are efforts to recruit, promote and advance individuals within the institute. Further the initiatives include equipping women with skills to successfully progress including career stage specifics inputs.

Organizational transformations are also discussed to remove barriers and create inclusiveness (Bilimoria et al., 2008). These include improving the awareness of decision makers to the unique problems of the underrepresented as well as bias’. Additionally micro climates within departments should be improved to pay attention to diversity, equity and inclusion.

Internal and external factors are discussed in terms of transformation. Internal factors include the support and involvement of senior administrators within the institute, a clear vision, and visibility of outcomes. External factors include engagement of industry trade groups, professional associations and funding organizations (Bilimoria et al., 2008). Institutionalizing the transformation and on-going tracking of the key indicators of success along with the continued transformation initiatives lead to the outcome of increased representation of women and minorities at all levels and in leadership. Further an equitable, inclusive, and energizing workplace can be established.
Undergraduate STEM Women

Chiu et al. (2002) state that a well-planned retention program is needed to keep women and underrepresented minorities in engineering and technology undergraduate and graduate classes. The retention program should include: visible, successful role models for women; opportunities for women undergraduate students to interact with faculty; and group projects that are managed so that women have the same opportunity as the men to perform higher status tasks and so that the women are not relegated to the less important responsibilities.

Cultural changes were necessary to recruit and retain women in the computer science department at Carnegie Mellon University (Blum, 2001). The admissions process was changed so that previous programming experience was not necessary. Recruitment efforts shifted to focus on those students with an interest in logic and problem solving as well as leadership skills. An advisory council was established for women in computer science with its top priority being community building. The council, which included undergraduates from all four years of study as well as graduate students, met weekly. Community building events include student-faculty dinners, undergraduate-graduate dinners, and discussions with women computer scientists. The success of the program is attributed to: the vision of the faculty and the administration for a more diverse student body; using research to enable the culture change; and the support for the program from current students, faculty and the administration. By implementing these research based strategies to change the culture of computer science, Carnegie Mellon grew the number of women enrolled in computer science from 7% in 1995 to 37% in 2001.
Recommendations to improve the retention of women graduate students in computer science and engineering was the focus of a workshop organized by the Computer Research Association (Cuny & Aspray 2002). Mentoring programs, social networks, as well as work life balance were reported to be important. Additionally, changes in the infrastructure of the academic departments were recommended to allow more equal participation by women. The changes included taking active steps to avoid sexual harassment and to provide diversity education.

In addition to mentoring and role models being important for women’s retention in STEM undergraduate and graduate programs, Gurer and Camp (2002) discuss a woman’s self confidence. The actions of professors have been found to be causes for decreases in women student’s self confidence. Men do not hesitate to take credit for their achievements, where women are more reluctant to take credit for their same achievements.

Changes to stereotypical attitudes about women in science and engineering are the focus of retention efforts at Penn State Altoona (Shull & Weiner, 2000). A course was developed using experiential learning that is used to challenge women to recognize their own beliefs about engineering.

Persistence in undergraduate engineering programs from freshman to senior year and future career plans has been conceptualized by Cech, Rubineau, Silbey and Seron (2011) as relating to an undergraduate’s family plans, self-assessment and professional role confidence. Because normative gender beliefs influence career choices, Cech et al. hypothesized that interactive, cognitive and embodied experiences during the undergraduate years may lead women to form different levels of confidence than their
male peers to successfully fulfill the role of a professional engineer. Men and women develop different levels of professional role confidence because of cultural beliefs about what is appropriate for each gender and factors specific to engineering. Since engineering has been historically masculine, women are less likely to develop professional role confidence due to socialization processes and work culture.

A study of 288 engineering students at four different universities from freshman to senior years was undertaken by (Cech et al., 2011). Here data on professional role confidence, persistence and other variables was collected using on-line surveys. Their findings showed no relationship between women’s traditional family plans and persistence in undergraduate engineering, further no relationship was found between math self assessment and persistence. Cech et al. (2011) did find that professional role confidence has a statistically significant relationship to engineering persistence and that men and women have different levels of professional role confidence related to engineering. As Frehill (2008) found women are more likely to leave engineering than men and professional role confidence may aid in explaining the differences. Because of differential expertise obtained in their formal education according to Cech et al. (2011), men may be better prepared to make the transition from undergraduate programs of study to work in the engineering profession.

High School & Middle School Efforts to Encourage Girls to Enter STEM Professions

A number of efforts have been initiated to encourage girls at the middle school and high school level to pursue degrees in science, technology, engineering and math.
Many of these efforts have been in response to concerns around the United States being able to compete in technology at a global level (Patel-Preed, 2005).

The National Academies is a private, not-for-profit institution which advises the nation on scientific and technical affairs. The National Academies is comprised of four organizations, The National Academy of Science (NAS), The National Academy of Engineering (NAE), the Institute of Medicine, and the National Research Council. Both the NAS and the NAE have established programs to encourage girls’ interest in science and engineering. The NAE and NSF have established websites targeting girls, their parents, and their teachers (NAE, 2004; NSF, 2004). These websites provide information on engineering careers, including job descriptions, salary information, types of engineering degrees, and positive women role models.

The Girl Scouts of USA have programs that teach young girls about how science, technology, and math is all around them (Girl Scouts USA, 2009). A robotics program has been established to engage girls in activities through competition, and a website has been established that not only has games that appeal to young girls like cryptology but it also includes information on technical careers.

Colleges and universities have programs promoting engineering and technology studies. “We Are IT” is a program in the state of Ohio that has been designed to encourage girls in grades 7 to 10 to consider IT or Information Technology as a career choice (http://itcs.lakelandcc.edu/we_are_it/index.htm). Funding from the Ohio Department of Education enabled 4000 girls to attend an event on November 14, 2008 at 23 different colleges and universities throughout the state of Ohio. The mission of the
one-day event is to “attract girls to the in-demand and highly compensated” careers in information technology.

Top tier engineering programs such as Massachusetts Institute of Technology (MIT, 2008) and Carnegie Mellon University (CMU, 2008) have summer programs for girls interested in engineering. MIT’s program is for girls after their junior year of high school. The purpose is to “spark high school girls’ interest in the future study of engineering and computer science.” The program at CMU is aimed at girls entering 8th or 9th grade. The goal is to “get girls excited about engineering and science.” The program focused on hands-on activities involving energy usage in an environmentally friendly way.

National organizations have developed programs and have funded efforts to promote engineering and science careers to girls. The Society of Women Engineers Aspire program is an outreach to girls in kindergarten through 12th grade (SWE, 2008). Tools are provided for parents and teachers to help girls make informed decision on pursuing engineering and technology degrees.

Ten reasons why “you will love” engineering are detailed on the NAE website (NAE, 2004). Here claims such as “Engineering…will leave you time for all other things you love in your life!” and “Engineers are… highly paid” are used to encourage girls to pursue engineering and other STEM professions.

Lakeland Community College in Kirtland, Ohio has a video on its website promoting the “We are IT” event. The video shows the girls going through their day while having lots of laughs and being highly creative. The event includes only girls and is presented mostly by women (http://itcs.lakelandcc.edu/we_are_it/index.htm).
Initiatives found on the SWE website provide PowerPoint presentations to parents and teachers to help explain engineering careers to young girls. These initiatives are funded by IBM, Disney and other employers. One PowerPoint slide states “Women Engineers move quickly into management positions” and “The engineering work environment wants and welcomes women” (SWE 2008).

**Women’s Employment in the US**

Significant changes in women’s employment over the past several decades have been noted by the Bureau of Labor Statistics (BLS, 2009). More women (including many with children) are participating in the work force and claiming more jobs requiring higher levels of education. In 2008, women comprised more than half (51%) of management, professional and related occupations. But despite almost equal overall participation in the workforce women comprise only 10% of the US engineering and only 7.7% of all engineering management positions (BLS, 2011).

Studies on careers and career choices are abundant in the literature with an increasing number focused on the differences in men’s and women’s careers. Mainiero & Sullivan (2005) use the term “kaleidoscope career” to distinguish female work trajectories from, they claim, far more linear male work patterns – noting women are more apt to construct careers that suit their own objectives, needs, and life criteria and more often make choices influenced by relationships and self fulfillment.

Findings from several studies show that women leave their careers at a higher rate than men and suggest that four in ten highly qualified women leave work voluntarily at some point in their careers influenced by both push and pull factors. Push factors include lack of job satisfaction, lack of opportunity and excessive demands, while pull
factors include family pressures and personal health. Among highly qualified women 
off-ramped from their careers, Hewlett and Luce (2005) found 93% intending to return. 

It is unclear the extent to which discrimination plays in derailing women’s careers 
today. Meyerson & Fletcher (2000) argue that laws and heightened organizational 
knowledge about bias has all but eliminated blatant discrimination, but work practices 
and cultural norms that appear unbiased still create systemic disadvantage for women – 
blocking many from career opportunities.

A number of studies on women’s careers have sought to identify factors that 
distinguish women’s careers from men’s, O’Neill & Bilimoria (2005), for example, 
discuss women’s careers as different from men’s because of family responsibilities, a 
woman’s relational emphasis, and under-representation in higher organizational levels. 

**Gaps in the Literature**

As described above, the literature provides theories on change, theories on careers 
and career choice, and theories on organizational behavior especially related to women. 
Additionally there are studies that describe why women leave engineering, and how the 
US government and other non-profits have funded efforts to transform academia to 
provide a more inclusive student body and workforce. These efforts have supported 
interventions that have provided opportunities for high school and middle school girls to 
learn about STEM careers. Statistics and analyses show that while the pace has been 
slow and steady, the number and percent of women receiving degrees at all levels in the 
STEM fields has increased over the last 30 years (see Figure 2). Surprisingly, the 
number and percent of women employed full time as engineers has been stagnant for 
about the last 15 years (see Figure 1).
With more than 2.4 million employed engineers in the US and 83% of these working in industry or business (NSF, 2011) surprisingly few studies have focused on women engineers in industry. Among the few studies on non-academic women engineers most are concerned with why women leave the engineering profession with Hewlett et al. (2008) describing it as a hostile and macho domain where women are isolated and marginalized. More than two-thirds of women leave engineering 15-years post degree which is double the rate of men (Frehill, 2008). To retain more women in engineering the studies suggest improvements to the cultural and organizational aspects, for example Fouad & Singh (2011) recommend creating a culture within organizations that values women engineers’ contributions by providing clear paths towards advancement, offering opportunities for mentoring both formal and informal, and supporting work-life balance.

Despite the well-researched and well documented literature on why women leave engineering careers our experience and statistics show that many women do persist. Therefore our research has taken the approach of focusing on women in industry and hypothesizing that women who persist in engineering have unique characteristics that promote their commitment to the profession post-degree.

No theories, models or empirical studies have been found that specifically explain a woman’s persistence in the engineering profession. We sought to close this gap by first theorizing about why a woman would persist in the engineering profession and then undertaking a mixed methods study to gather empirical evidence to understand the individual and contextual factors that explain a woman’s persistence in an engineering career.
Model and Hypotheses

Women in industry are the focus of this research specifically those women who persist in the technology driven and male dominated profession of engineering. Our hypothesis is that women who persist in engineering have unique characteristics that promote their commitment to the profession post-degree. The mixed method approach to this study on women persisting in the engineering profession began with a qualitative study because as described by Glaser and Strauss (1967) it is most suited to efforts to understand the process by which participants take meaning from their experience.

Beginning with the research question: “What factors explain career persistence of women engineers in industry in the US” then building on theory and the results from the qualitative study we next developed a model to guide the quantitative study, see Figure 3.

FIGURE 3
Conceptual Model of Career Commitment and Engagement for Women Engineers
The dependent variables in the hypothesized model are career commitment and engagement. We chose these two constructs based on the findings from the qualitative study where long tenured women in engineering careers discussed their commitment to engineering as a profession. These persistent women engineers spoke of their careers in terms of fulfillment through challenging assignments, novel work experiences and continuous learning. Additionally these women discussed engineering as a part of their core identity which are all characteristic of work engagement.

**Career commitment** has been defined by Blau (1985) as one’s attitude towards one’s profession and would lead to career retention, where career retention is a measure of the length of an engineering career. This construct has been used mostly in the medical field studying nurses (Meyer, Allen, & Smith, 1993) and medical technologists (Blau, 1999).

A previous finding was that women who persisted as engineers conflated career and personal achievement, revealing that career accomplishments provided personal fulfillment. Contrarily, women who opted-out articulated a tension between work-related and personal goals, often citing the need to fulfill personal aspirations not satisfied by work as the motivation for leaving their jobs.

**Engagement** in one’s job and/or in one’s career has been studied in a number of professions with engagement defined as the degree to which a person gives themselves to their work role. Kahn (1990) was first to discuss engagement where he describes engagement as the simultaneous employment and expression of a person’s preferred self in task behaviors that promote connections to work and to others.
A key finding in our qualitative study on why women stay in engineering was that persistent women engineers, even after many years on the job, were found to exude enthusiasm, energy and commitment to their work – while the women who opted out described their experiences in engineering as not happy where they lacked fulfillment and felt detached from their work, creating our hypothesis that the ideal self is directly responsible for career engagement.

The Ideal Self has been hypothesized to be a mediator in this study on women persisting in engineering careers. The concept of one’s ideal self is fixed in the psychology literature specifically in work on motivation. Since the ideal self engages in behavior consistent with one’s desired end state, sacrifices are sometimes made in the short term to accomplish more important longer-term goals (Boyatzis & Akrivou, 2006). This aspect of the ideal self has potential to explain why women persist in a male-dominated profession.

The ideal self is guided by the individual’s hopes, wishes, and aspirations (Boyatzis & Akrivou, 2006). Women who persisted in engineering seem to realize their careers as their ideal self since the ideal self engages in behavior consistent with one’s desired end state. According to the ideal self theoretical framework hope, a desired future state, and a person’s core identity influence one’s ability to achieve the ideal self.

Furthermore, the previous research showed that a woman’s ability to articulate her ideal self was directly related to her career longevity in engineering and we hypothesize:

_Hypothesis 1a. The ideal self has a positive effect on career commitment for engineers._

_Hypothesis 1b. The ideal self has a positive effect on engagement for engineers._
The independent variables build on the findings from our earlier previous research study as applied to the model of the Ideal Self (Boyatzis & Akrivou, 2006). The study associated higher levels of self efficacy, optimism, and hope with career longevity for women engineers as well as a strong sense of identity as an engineer. Because the literature is rich with descriptions of the culture of engineering we include an independent variable that measures relational culture. From Boyatzis and Akrivou (2006) the ideal self is comprised of self efficacy, optimism, hope and identity and from our previous study the articulation of the ideal self acts as a go-between or a mediator of the relationship between self efficacy, optimism, hope, and identity – and the dependent variables career commitment and engagement.

**Self efficacy** determines how much effort will be expended and how long one will persist when facing difficult circumstances (Bandura, 1982). Self efficacy can be defined as one’s belief that he or she will succeed in a particular situation. Confidence is closely related to self efficacy and these terms have been used interchangeably. Several recent publications highlight confidence in the role of successful women and in successful firms. In discussing key factors for career success for women (Vinnicombe & Bank, 2003) highlight self confidence as the bedrock of their success. The women were described as highly successful in corporate roles but had no career strategies, nor formal business education or professional networks. They expected to have success and were described as resilient in overcoming the barriers that women face within organizations. And Kanter (2004) titles her book “Confidence” describing it as consisting of “positive expectations for favorable outcomes” (Kanter, 2004: 7) providing the motivation for the effort necessary persevere.
In a previous study on women engineers we found that each women interviewed who persisted in engineering narrated experiences in which she demonstrated initiative and seized control of or manipulated difficult situations to affect personally favorable outcomes. Self efficacy and confidence was expressed in relation to finding new assignments, dealing with difficult work situations and in tackling tough technical problems. Often it was associated with the employment of skills developed over the course of a career. In contrast, women who opted out of engineering careers told stories where uncertainty, confusion, self doubt or low confidence predominated.

Based on findings in the literature on women professionals and self efficacy as well as the previous study on persistent engineer it is hypothesized that:

Hypothesis 2a. Self efficacy has a positive effect on career commitment for engineers.

Hypothesis 2b. The ideal self mediates the relationship between self efficacy and career commitment.

Hypothesis 3a. Self efficacy has a positive effect on career engagement for engineers.

Hypothesis 3b. The ideal self mediates the relationship between self efficacy and engagement.

Optimism is the tendency to believe or expect that things will turn out well; it is an attitude of someone who feels positive or confident. We chose optimism as an individual factor that effects career commitment and engagement in part because of the model of the ideal self (Boyatzis & Akrivou, 2006). Additionally Buse and Pierce (2010) found that women who persisted in engineering were optimistic about their engineering careers where women who opted out of engineering were more likely to complain about their experiences as an engineer, therefore it is hypothesized that:
Hypothesis 4a. Optimism has a positive effect on career commitment.

Hypothesis 4b. The ideal self mediates the relationship between optimism and career commitment.

Hypothesis 5a. Optimism has a positive effect on career engagement.

Hypothesis 5b. The ideal self mediates the relationship between optimism and engagement.

**Hope** is defined as the feeling that something desirable is likely to happen, or the perceived capability to derive pathways to desired goals and motivate oneself to those pathways. Hope is the emotional driver of the ideal self (Boyatzis & Akrivou, 2006). The psychological literature describes hope as caused by one’s degree of optimism and is expressed by one’s level of self efficacy. Hope is thought to generate the cognitive processes that judge and assess the feasibility of options, separating false hope from real possibilities. Women who persisted in their engineering careers were found to exude hope (Buse & Pierce, 2010) and as a result it is hypothesized that:

Hypothesis 6a. Hope has a positive effect on career commitment.

Hypothesis 6b. The ideal self mediates the relationship between hope and career commitment.

Hypothesis 7a. Hope has a positive effect on engagement for engineers.

Hypothesis 7b. The ideal self mediates the relationship between hope and engagement.

**Identity** is defined as an unconscious set of enduring individual characteristics and includes one’s strengths, context and resources. Identity is relatively stable and is a compilation of a person’s enduring dispositions, involving a set of individual characteristics. Core identity is theorized as the third component of the ideal self by Boyatzis and Akrivou and is defined as one’s set of enduring individual characteristics.
The core identity is theorized to be relatively stable over time and includes one’s roles, underlying the historical and continuing aspects of a person’s ideal self. Buse and Pierce (2010) found that women who persisted in their engineering careers, but not those who had left the field, consistently and repeatedly self-identified as engineers, demonstrating an embracement of the profession as part of their core identity. Based on these findings, we hypothesize that:

*Hypothesis 8a.* Identity has a positive effect on career commitment for engineers.

*Hypothesis 8b.* The ideal self mediates the relationship between identity and career commitment.

*Hypothesis 9a.* Identity has a positive effect on engagement for engineers.

*Hypothesis 9b.* The ideal self mediates the relationship between identity and engagement.

**Relational Culture:** Another key independent variable in this study is the culture of engineering, where engineering has been described as hostile and macho (Hewlett et al., 2008), and gendered (Gill et al., 2008; Jorgenson, 2002). Previously we found that narratives describing the difficult nature of the engineering profession for both persistent and out opting engineers were usually mentioned in terms of the person who directly managed her. As a result we hypothesize one more independent variable measuring the relational culture of engineering is important in predicting career commitment and engagement for women in engineering. Consequently, we have chosen to measure the relational culture in terms of the leader member exchange and hypothesize:

*Hypothesis 10.* Leader-member-exchange has a positive effect on career commitment for engineers.

*Hypothesis 11.* Leader-member-exchange has a positive effect on career engagement for engineers.
Hypotheses Explaining Gender Differences

Self efficacy helps to explain gender differences in persistence in non-traditional career choices especially for women students with the Social Cognitive Career Theory (Lent, 2005). Research shows that most women leave engineering within 15 years of receiving their degree (Frehill, 2008).

Hypothesis 12. Self efficacy will be higher for women employed as engineers over 40 than for women under 30.

The Kaleidoscope career model discusses how women’s career decisions include interconnected aspects such as children (Mainiero & Sullivan, 2005).

Hypothesis 13. Age and number of children will influence a woman’s career commitment to engineering.

Most men stay in their engineering careers (Frehill, 2008). Self efficacy influences career commitment to engineering for women but is not likely to influence men.

Hypothesis 14. Self efficacy will be less influential on career commitment for men than for women.

The theory of gendered organizations discusses a division of labor and discrimination within organizations where male managers continue to make decisions that propagate organizational differences due to gender (Acker, 1990). The Bureau of Labor statistics reports that in 2010 more than 93% of engineering managers in the US were male (BLS, 2011). Leader member exchange influences career commitment to engineering for women (Buse, 2011).

Hypothesis 15. Leader member exchange will be less influential on career commitment for men than for women.
The Kaleidoscope career model discusses how women’s career decisions include interconnected aspects such as children and spouses, where men generally make career decisions independently (Mainiero & Sullivan, 2005).

*Hypothesis 16. Age and number of children will be less influential on career commitment for men than for women.*

The ideal self is comprised of one’s calling, hope and dreams, and one’s core identity (Boyatzis, 2008). Authenticity within the Kaleidoscope career model is about being true to oneself and making decisions based on one’s own needs (Mainiero & Sullivan, 2005). Outcome expectations and beliefs about outcomes influence career choices. The articulation of the ideal self influences career commitment to engineering for women (Buse, 2011).

*Hypothesis 17. The articulation of the ideal self will be less influential on career commitment for men than for women.*

Women strive to obtain greater job challenge and personal fulfillment where men demonstrate extremely linear career paths following traditional career paths associated with industry (Mainiero & Sullivan, 2005). Work engagement is the simultaneous employment and expression of a person’s preferred self in task behaviors that promote connections to work and to others (Kahn, 1990). Work engagement influences women’s career commitment to engineering (Buse, 2011).

*Hypothesis 18. Work engagement is less likely to influence a man’s career commitment to engineering.*
CHAPTER III: METHODS

Summary of Methods

For this research on women in engineering careers we took a complex, three stage study approach. The first stage was a qualitative research study which led to a conceptual model. The conceptual model led to the development of a new construct, the ideal self, and a quantitative study which concluded by developing a structural equation model for women’s commitment to the engineering profession. The last stage of this research was comparing the factors and relationships important to a woman’s career commitment to engineering to a sample of men engineers.

For the qualitative research study, we interviewed 31 women engineers to understand the individual and contextual factors influencing persistence in an engineering career. The interviews were recorded, transcribed, coded and analyzed. The analysis resulted in the development of a conceptual model that included the ideal self as a mediator relating individual factors to career persistence for women in engineering.

A new construct for the ideal self has been developed. Several small scale assessments refined the new construct and a pilot study with 112 responses was conducted to assess the validity and reliability of the ideal self as a 5 factor construct.

The conceptual model for a woman’s persistence in engineering was used as a framework for a quantitative study using a survey method to collect data from both women and men who had engineering degrees. Seven constructs well documented in the literature, the new ideal self constructs and demographic data were included in the survey questions. Using a snowball survey distribution method, data was collected from 495 women and 138 men. The analysis included data screening, the development of a
measurement model and a structural equation model. PLS-Graph was used to develop the SEM as the ideal self construct has been conceptualized as a formative construct.

Regression techniques were used to further analyze the data on the women engineers. The structural equation model developed for the women was not valid for men, leading to additional analysis of which factors and which relationships differed for men and women.

**Qualitative Study**

We considered qualitative research appropriate for this study because as described by Glaser and Strauss (1967) it is most suited to efforts to understand the process by which participants take meaning from their experience. The strengths of qualitative research, according to Maxwell (2005), derive from its inductive approach, its focus on specific situations or people, and its emphasis on words. Among several intellectual goals described by Maxwell as appropriate for qualitative inquiry, one is the identification of unanticipated phenomena and influences on which to generate grounded theory.

Corbin & Strauss (2008) explain that a researcher can use comparative analysis to understand why there is a difference between groups and that by building comparative analysis into a research study design one can uncover various dimensions and properties that help explain these differences. As such, our research design includes interviews with both women who persisted in an engineering career as well as those who chose to leave to explore those factors that differentiate the two groups.
Sample

Our sample consisted of thirty-one women aged 34 to 60, all with experience as an engineer or as a manager of engineering or manager of any technical area within a corporation located in the US. All of the respondents were identified through the personal network of the primary researcher who had worked as an engineer for more than 25 years in four different Fortune 500 corporations. Some of the respondents were classmates from the 1980’s, others were former work colleagues, and others were friends of friends. At the time of the interviews the primary researcher had not seen nor worked with any of the respondents for at least three years. In all cases women were recruited to the study using either an introductory email or phone call asking the respondent to participate in the interview.

Specific degrees of the respondents included one in science and thirty in engineering: biomedical (1), chemical (12), civil (4), industrial (4), electrical (2) material/metallurgical (2), or mechanical (5). More than half of the women had master’s degrees – nine in engineering, seven MBA’s, one masters of education, and one masters in counseling. Three had doctorate degrees (two in engineering, one in business) and two others were in the process of obtaining doctorate degrees.

At the time of the interviews, 21 of the women were working in a technical role for an average of 21 years. These persistent women engineers never choose to leave an engineering career and were either working as an engineer or were in a management role normally afforded those with a successful engineering career. The remaining ten women had chosen to leave an engineering or technical management career prior to the time of the study after an average of 12 years of experience. Some exited for non-engineering
careers (6); others to be stay-at-home mothers (4). Employer industries included: chemical, pharmaceutical, electronics, oil, food, metals, fluid technology, communications, electronics, entertainment, consumer products, automobile manufacturers, automobile suppliers, and consulting. A summary of key personal data on the respondents is given in Table 1. Additional information on the respondents is included in Appendix A Table A1.

**TABLE 1**
Personal Data

<table>
<thead>
<tr>
<th>Personal Data</th>
<th>Persistent Engineers</th>
<th>Out-Opting Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>Average Age</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>Average Years Worked in Engineering</td>
<td>21</td>
<td>12</td>
</tr>
<tr>
<td>Never Married</td>
<td>4*</td>
<td>1</td>
</tr>
<tr>
<td>% Never Married</td>
<td>19%*</td>
<td>10%</td>
</tr>
<tr>
<td>Women with Children</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>% Women with Children</td>
<td>62%</td>
<td>80%</td>
</tr>
</tbody>
</table>

* Two women mentioned long term male partners of 16 & 25 years

**Data Collection and Analysis**

The data was collected during a four month period from May to August 2009. Thirty-one semi-structured interviews of approximately one hour duration were conducted. The researcher used an interview protocol designed a priori to guide the interviews but, consistent with the semi-structured approach to interviewing, allowed respondents freedom of expression. The key interview questions focused on personal and career histories, examples of fulfilling and non-fulfilling career experiences, early and current career expectations, and beliefs about the pros and cons of an engineering career for a woman. Women currently employed in engineering were also asked to explain their persistence and women who left engineering were asked why they opted-out.
The data analysis began with the researcher repeatedly listening to each audio recording and reviewing each interview transcript numerous times. A software program, Qualrus v2.1.0.0 (Idea Works, 2002) was used to code and analyze the data. Using a software package is particularly helpful when there is a large amount of data as the software performs basic statistics allowing the researchers to be aware of the highest ranking emergent themes and key words.

Initially, we identified almost 1800 words, phrases or longer segments of text and assigned to them 151 labels. Further refinement and reduction of the codes ensued, yielding 49 codes. Most of these codes were ones related to career theory for example from the SCCT we used codes such as self efficacy expectations and outcome expectations. From these codes we compared the two groups of women those who persisted and those who did not and identified individual and contextual differences between the two groups to use as our findings. These findings were reviewed and validated by four individuals to check for reliability and consistency.

**Pilot Study for Ideal Self**

In the previous study of women in the engineering profession we found that women who were long-tenured in engineering were able to articulate their ideal self, and that the ability to articulate the ideal self was a factor in career longevity. To validate this finding we developed an instrument to measure one’s ability to articulate the ideal self.

To assess the ideal self as a construct, a pilot study was undertaken. A survey was developed that had three parts. First we asked the respondent an open-ended question, to think about their ideal life in 10 to 15 years and how it might include, for example, their legacy, values, and sense of purpose. Next respondents were presented with 20 items,
listed randomly, which asked them to assess using a scale of 1 (strongly disagree) to 7 (strongly agree). Lastly, demographic data were obtained on age and gender. These efforts resulted in 112 completed surveys with 16 of the surveys completed on paper by business students at a mid-western university and the other 96 were completed using an on-line survey instrument.

Prior to data analysis, sufficient data screening techniques were employed specifically addressing missing values and non-normality. Missing values totaled about 1% and for analysis purposes we imputed the missing values using a mean value. No significant issues were identified in the data screening process.

A key step before assessing factorial validity is to determine whether a construct is formative or reflective. Using the three broad theoretical considerations outlined in Coltman, Devinney, Midgley and Venaik, (2008), the nature of the construct, the direction of causality and the characteristics of the indicators, it is concluded that the ideal self is a formative construct. The ideal self as the latent construct is formed by its indicators, variation in the item measures causes variation in the construct and the items do not share a theme and are not interchangeable.

The choice of a measurement perspective and evaluation procedure for construct development according to Diamantopoulos and Sigauw (2006) has five implications. The first implication is to critically assess the causality between the items and the construct during the construct definition phase. Unidimensionality should not automatically be considered and appropriate literature should be consulted to aid in determining type and analysis.
Secondly, if the data does not support the causality, a researcher should not change direction as that would knowingly create a Type II error. If measures are specified as formative then researchers must establish validity using concrete guidelines such as those in Jarvis, MacKenzie and Podsakoff (2003) or Geffen and Straub (2005) is the third consideration. Diamantopoulos and Sigauw (2006) go on to suggest that for model estimation the formative construct(s) should be related to some reflective measures.

A fourth consideration when constructing a measure is that the researcher must reconcile the theory with the empirical test results, balancing content adequacy with statistical analysis. If this balance is not struck, the construct is not likely to be robust and replicable. Lastly, the consideration of a higher-order construct may be the result of an abstract conceptualization of the measure, which may result in a multiple formative and/or a combination of reflective and formative specifications.

With this background and knowing that the ideal self was theorized as formative in nature, but not concluding whether or not there were multiple levels, we began the analysis using PLS-Graph software. Geffen and Straub (2005) state that convergent validity is established when the t-values of the outer model loadings are above 1.96. Discriminate validity is established when the square root of the average variance extracted (AVE) of each construct is greater than the correlation of this construct to all other constructs. Reliability is established when the construct reliability (CR) is above 0.70.

Sample size is a consideration in the development of a construct. For exploratory factor analysis a minimum of 5 to 10 cases per measure are recommended by Comrey
and Lee (1992) and Gorsuch (1983), but MacCallum, Widaman, Zhang and Hong (1999) found that communalities of 0.60 or greater were more likely to predict populations from a sample size of fewer than 100. Communalities of 0.50 and higher are suggested in samples of 100 to 200 to accurately reproduce the population loadings.

Although the unidimensional conceptualization strategy can be effective and straightforward, it cannot discern the complex nature of one’s ideal self which may be operationalized effectively in a formative way by a composite across different unique sources of the construct. Hence support for unidimensionality was not obtained. As a result a more sophisticated structure was needed to understand and define an individual’s ideal self. An examination of various solutions indicated a 5 factor solution best fit the ideal self construct.

As suggested by Churchill (1979), the research paradigm was used to build a scale for measuring the ideal self construct. The domain sampling technique was employed to create measurement scales with adequate content validity. As such, the initial instrument contained 32 items that were measured on a 7-point Likert scale (1=strongly disagree; 7=strongly agree). These 32 items were postulated to cause the ideal self rather than be influenced by it resulting in formative indicators that structure the construct as a composite.

Next, these items were evaluated by respondents in four pre-tests and a focus group and were assessed for content and face validity. From these efforts, 20 items were selected for appropriateness, uniqueness, and ability to convey to respondents the ideal self construct and are shown in Table 2.
Quantitative Study Research Design and Methods

The data for empirical assessment and validation of the research model were collected using a standard survey administration technique while incorporating practices that have been noted as being beneficial to increasing the effective response rate. The respondents were individuals who had obtained degrees in the engineering field. The research model was tested using Partial Least Squares, specifically PLS-Graph (Chin, 2001). PLS is particularly well suited for this analysis given its flexibility to handle constructs with both reflective and formative indicators (Chin & Gopal, 1995).

Measurement and Instrument Development

Where possible, previously validated construct were used; otherwise, indigenous items were developed based on a review of pertinent literature. The multi-item scales for each of the constructs are summarized in Table 2.

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Constructs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct/Dimension</td>
<td>Items</td>
</tr>
<tr>
<td>Self Efficacy (SE): A person’s belief in his or her own ability to succeed in a particular situation.</td>
<td>Scoring: 1 Not at all True 2 Hardly True 3 Moderately True 4 Exactly True SE1. I am confident that I could deal efficiently with unexpected events. SE2. Thanks to my resourcefulness, I know how to handle unforeseen situations. SE3. If I am in trouble, I can usually think of a solution. SE4. I can usually handle whatever comes my way.</td>
</tr>
<tr>
<td>Optimism (OP): The attitude of someone who feels positive or confident.</td>
<td>LOT-R (Life Orientation Test Revised) Scoring: 1=I agree a lot 2=I agree a little 3= I neither agree or disagree 4=I disagree a little 5= I disagree a lot Adapted to: OP1. If something can go right for me, it will. OP2. I'm always optimistic about my future. OP3. I usually expect things to go my way. OP4. I usually count on good things happening to me. OP5. Overall, I expect more good things to happen to me than bad.</td>
</tr>
<tr>
<td>Hope (HO): The perceived capability to derive pathways to desired goals and motivate oneself to those pathways.</td>
<td>The State Hope Scale Scoring 1=Definitely False 2=Mostly False 3=Somewhat False 4=Slightly False 5=Slightly True 6=Somewhat True 7=Mostly True 8=Definitely True HO1. If I should find myself in a jam, I could think of many ways to get out of it.</td>
</tr>
</tbody>
</table>
HO2. At the present time, I am energetically pursuing my goals.
HO3. There are lots of ways around any problem that I am facing now.
HO4. Right now I see myself as being pretty successful.
HO5. I can think of many ways to reach my current goals.
HO6. At this time, I am meeting the goals that I have set for myself.

Identity (ID):
An unconscious set of enduring individual characteristics.

Scoring: 1=Not important to who I am
2=Slightly important to my sense of who I am
3=Somewhat important to my sense of who I am
4=Very important to my sense of who I am
5=Extremely Important to my sense of who I am

ID1. Knowing that I continue to be essentially the same inside even though life changes.
ID2. My self-knowledge, my ideas about what kind of person I really am.
ID3. My personal self-evaluation, the private opinion I have of myself.

Leader Member Exchange (LM)

LM1. Do you know where you stand with your leader…do you usually know how satisfied your leader is with what you do?
1=Rarely 2= Occasionally 3=Sometimes 4=Fairly Often 5=Very Often
LM2. How well does your leader understand your job problems and needs?
1=Not a bit 2=A Little 3= A Fair Amount 4=Quite a Bit 5=A Great Deal
LM3. How well does your leader recognize your potential?
1=Not a bit 2=A Little 3=Moderately 4= Mostly 5= Fully
LM4. Regardless of how much formal authority he/she has built into his/her position, what are the chances that your leader would use his/her power to help you solve problems in your work?
1=None 2=Small 3=Moderate 4=High 5=Very High
LM5. Again regardless of the amount of formal authority your leader has, what are the chances that he/she would "bail you out" at his/her expense?
1=None 2=Small 3=Moderate 4=High 5=Very High
LM6. I have enough confidence in my leader that I would defend and justify his/her decision if he/she were not present to do so?
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree
LM7. How would you characterize your working relationship with your leader?
1=Extremely Ineffective 2=Worse than Average 3=Average 4= Better than Average 5=Extremely Effective

Ideal Self (IS)
The ideal self is the core mechanism for self-regulation and intrinsic motivation, harnessing the will or drive for self direction, intentional and desired future accomplishments, or in some cases providing the energy to maintain and sustain current ideal states in life and work.

Dream of your ideal life that would be 10 to 15 years from now. The following categories may help stimulate your reflection:
• Your passion, calling, and sense of purpose
• Your legacy
• Your values and philosophy
• Your dreams, fantasies and aspirations
• How you feel about your future possibilities
• Other components or elements of your dream

Describe in as much detail as possible your dream of your ideal life (optional).

20 questions as below with scale 1= Strongly disagree to 7 = Strongly agree

IS1. I feel inspired by my vision of the future.
IS2. My vision reflects many possibilities.
IS3. My vision includes fun activities.
IS4. My vision includes my work in terms of my jobs and career.
IS5. My vision includes my family relationships.
IS6. I am excited about my vision.
IS7. My vision includes leisurely activities.
IS8. I feel hopeful about my vision.
IS9. My vision includes my physical health.
IS10. My vision includes my values and philosophy.
IS11. I feel optimistic about my vision.
IS12. My vision includes my contributions to others and the community.
IS13. My vision includes relative priorities of things important to me.
IS14. My vision includes my intimate/love relationships.
IS15. My vision includes my spiritual health.
IS16. I have a clear vision of my desired future.
IS17. My vision includes my desired legacy in life.
IS18. My vision of the future reflects the things most important to me.
IS19. My passion, calling, and sense of purpose are clear to me.
IS20. I see many possibilities in my future.

Career Commitment (CC): is defined by one’s attitude toward engineering as a profession.

Adapted from Blau 1985, 1999
CC1. I definitely want a career for myself in engineering or technical management.
CC2. If I could do it all over again, I would choose to work in engineering.
CC3. I would recommend a career in engineering to others.
CC4. I am not disappointed that I ever entered the engineering profession.

Engagement (EN): The simultaneous employment and expression of a person's preferred self in task behaviors that promote connections to work and to others is Kahn’s (1990) description of engagement.

UWES Work and Well Being Survey
Scoring: 1=Never 2=Almost Never (A few times a year or less) 3=Rarely (Once a month or less) 4=Sometimes (a few times a month) 5=Often (Once a week) 6=Very Often (A few times a week) 7=Always (everyday)
EN1. At my work, I feel bursting with energy.
EN2. I find the work that I do full of meaning and purpose.
EN3. Time flies when I am working.
EN4. At my job, I feel strong and vigorous.
EN5. I am enthusiastic about my job.
EN6. When I am working, I forget everything else around me.
EN7. My job inspires me.
EN8. When I get up in the morning, I feel like going to work.
EN9. I feel happy when I am working intensely.
EN10. I am proud of the work that I do.
EN11. I am immersed in my work.
EN12. I can continue working for very long periods at a time.
EN13. To me, my job is challenging.
EN14. I get carried away when I am working.
EN15. At my job, I am very resilient, mentally.

Operationalization of Constructs

**Dependent variables. Career commitment** was measured using four items adapted from Blau (1985). Reliabilities have been reported at 0.86 or greater and have been examined for age, tenure in career, and marital status.

For **Engagement**, the UWES work and well being survey (Schaufeli, Bakker and Salanova, 2006) was adapted using 15 items. Christian and Slaughter (2007) state that
the UWES scale can be used as unidimensional because of the high mean corrected inter-correlations of the previously reported three dimensions of engagement, where these factors are Vigor (VI), Dedication (DE) and Absorption (AB) (Schaufeli, Salanova, Gonzalez-Roma, & Bakker, 2002). Cronbach’s α is reported to be between 0.60 and 0.88 dependent on the country.

**Independent variables.** For **Self Efficacy** Schwarzer and Jerusalem (1993) was adapted to include four items. In samples from 23 nations, Cronbach’s alphas ranged from 0.76 to 0.90 with most in the high 0.80’s. The scale is unidimensional.

For **Optimism**, the LOT-R or life orientation test revised (Scheier, Carver, & Bridges, 1994) was adapted to five items. Reliability is reported as high with Cronbach’s α equal to 0.82.

The **Hope** state scale, developed by Snyder, Sympson, Ybasco, Babyak and Higgins (1996) was used in this study. Snyder et al. discuss four studies completed to validate the construct with Cronbach’s α ranging from 0.83 to 0.95. Additionally convergent and discriminate validity were tested in each of the four studies with the authors using correlational and causal designs concluding construct validity.

**Identity** as defined by Cheek, Smith & Tropp (2002) was measured using three items. Reliability was reported to be 0.82 (Seta, Schmidt, & Bookhout, 2006).

**Leader-Member-Exchange** was chosen as a construct to measure relational culture. This construct included seven items developed by Graen and Uhl-Bien (1995). Cronbach’s α’s are reported to be between 0.80 to 0.90.

**Ideal Self** - Boyatzis and Akrivou (2006) have described the Ideal Self as the core mechanism for self regulation and intrinsic motivation driving the intentional change
process. The manifestation of the ideal self is one’s image of a personal vision, including accomplishments in life. Activation of the ideal self functions as a motivational force, guiding the individual’s actions and decisions to ensure self satisfaction.

**Data Collection**

Empirical data to test the hypothesized relationships were obtained by using an online survey targeted to respondents. The survey was designed using the constructs shown in Table 2 and a copy of the survey is included as Appendix C. The survey informed respondents of the research project, encouraged participation, and conveyed assurance of confidentiality and data security. To continue completing the survey, respondents were required to have a degree in engineering and to indicate the specific area of specialization.

A snowball sampling technique was used to identify respondents. Survey administration occurred over a two month period from August to October 2010 where the primary author sent about 50 email requests to executives, managers, and engineers asking them to take the survey and to forward the survey to anyone they knew who had an engineering degree. Phi Sigma Rho, an engineering sorority and the Triangle Fraternity forwarded the survey to their alumni membership. Additionally, the survey link email was sent to four high level managers in four different Fortune 500 companies that employ engineers.

Following receipt of our email, several professional groups included the survey link in periodic e-newsletters: several sections of the Society of Women Engineers, Phi Sigma Rho, and the IEEE Women in Engineering Network.
Sample

A total of 633 usable surveys were received from 138 men and 495 women. Data screening and analysis on the sample of women engineers was completed. Of the 495 women respondents, 226 (45.7%) identified their current job as engineering, 125 (25.3%) as a technical or engineering manager, 67 (13.5%) in a job that engineers would normally be promoted to, and 77 (15.6%) in other roles. Of these 77, 37 identified their current job as a non-engineering role, 5 were unemployed and looking, 1 was unemployed and not looking, 5 were stay-at-home parents, 1 was retired, 1 was a student in a non-engineering degree program, 14 were in school seeking another engineering degree, and 13 listed “other.” Figure 4 shows the number of women by age and current position.

FIGURE 4
Women Survey Respondents by Age and Current Employment

![Image of pie chart showing women respondents by age and current employment roles.]

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Other</th>
<th>Prom</th>
<th>EngMgr</th>
<th>Eng</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-25</td>
<td>21</td>
<td>3</td>
<td>6</td>
<td>54</td>
</tr>
<tr>
<td>26-30</td>
<td>15</td>
<td>9</td>
<td>11</td>
<td>61</td>
</tr>
<tr>
<td>31-35</td>
<td>7</td>
<td>10</td>
<td>14</td>
<td>33</td>
</tr>
<tr>
<td>36-40</td>
<td>6</td>
<td>12</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>41-45</td>
<td>13</td>
<td>13</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>46-50</td>
<td>4</td>
<td>13</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>51-55</td>
<td>10</td>
<td>9</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>56-60</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>61-65</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
TABLE 3
Years Women Worked in Engineering

<table>
<thead>
<tr>
<th>Years Worked in Engineering or Technical Management</th>
<th># Women</th>
<th>% Women</th>
<th>Men</th>
<th>% Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never worked in engineering</td>
<td>19</td>
<td>3.65%</td>
<td>2</td>
<td>1.45%</td>
</tr>
<tr>
<td>&lt; 1 to 5</td>
<td>156</td>
<td>30.00%</td>
<td>27</td>
<td>19.57%</td>
</tr>
<tr>
<td>6 to 10</td>
<td>88</td>
<td>16.92%</td>
<td>12</td>
<td>8.70%</td>
</tr>
<tr>
<td>11 to 15</td>
<td>80</td>
<td>15.38%</td>
<td>22</td>
<td>15.94%</td>
</tr>
<tr>
<td>16 to 20</td>
<td>58</td>
<td>11.15%</td>
<td>17</td>
<td>12.32%</td>
</tr>
<tr>
<td>21 to 25</td>
<td>67</td>
<td>12.88%</td>
<td>23</td>
<td>16.67%</td>
</tr>
<tr>
<td>26 to 30</td>
<td>34</td>
<td>6.54%</td>
<td>18</td>
<td>13.04%</td>
</tr>
<tr>
<td>30 to 35</td>
<td>18</td>
<td>3.46%</td>
<td>15</td>
<td>10.87%</td>
</tr>
<tr>
<td>36 to 40</td>
<td>0</td>
<td>0.00%</td>
<td>1</td>
<td>0.72%</td>
</tr>
<tr>
<td>&gt; 40</td>
<td>0</td>
<td>0.00%</td>
<td>1</td>
<td>0.72%</td>
</tr>
<tr>
<td>Total</td>
<td>520</td>
<td>138</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Numerous engineering degrees were identified, with the most women having chemical engineering degrees 46%, 12% mechanical engineering, and 8% other as shown in the pareto in Figure 5 and in the pie chart Figure 6.

FIGURE 5
Women’s Engineering Degrees Pareto
Demographic data was collected including marital status and number of children. 130 women or 25% were never married, 96 or 18% were married with no children, 234 or 45% were married with children, 6% divorced, 25 or 5% living with partner. The breakdown is shown in Figure 7.
48% of the women engineers had no children, 11% had one child, 28% had 2 children, 10% had 3 children and 3% had four or more children. A distribution of children by age for the women is shown in Figure 8.

**FIGURE 8**
Number of Children and Age of Women Engineers

<table>
<thead>
<tr>
<th>Number of Children</th>
<th>21-25</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
<th>41-45</th>
<th>46-50</th>
<th>51-55</th>
<th>56-60</th>
<th>61-65</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 or more</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>5</td>
<td>22</td>
<td>33</td>
<td>33</td>
<td>35</td>
<td>13</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>11</td>
<td>8</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>None</td>
<td>81</td>
<td>80</td>
<td>28</td>
<td>8</td>
<td>17</td>
<td>9</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**TABLE 4**
Current Position of Women

<table>
<thead>
<tr>
<th>Current Employment</th>
<th>N</th>
<th>% of Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Engineer</td>
<td>226</td>
<td>45.7%</td>
</tr>
<tr>
<td>2 Engineering Manager</td>
<td>125</td>
<td>25.3%</td>
</tr>
<tr>
<td>3 Higher Level Manager Related to Engineering</td>
<td>67</td>
<td>13.5%</td>
</tr>
<tr>
<td>4 Employed not engineering</td>
<td>37</td>
<td>7.5%</td>
</tr>
<tr>
<td>5 Not employed and seeking employment</td>
<td>5</td>
<td>1.0%</td>
</tr>
<tr>
<td>6 Not employed and not seeking employment</td>
<td>1</td>
<td>0.2%</td>
</tr>
<tr>
<td>7 Stay at home mom</td>
<td>5</td>
<td>1.0%</td>
</tr>
<tr>
<td>8 Retired</td>
<td>1</td>
<td>0.2%</td>
</tr>
<tr>
<td>9 Full Time student not engineering</td>
<td>1</td>
<td>0.2%</td>
</tr>
<tr>
<td>10 Full time student in engineering</td>
<td>14</td>
<td>2.8%</td>
</tr>
<tr>
<td>11 Other</td>
<td>13</td>
<td>2.6%</td>
</tr>
<tr>
<td>Total</td>
<td>495</td>
<td></td>
</tr>
</tbody>
</table>
Measurement Model Analysis

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were employed to build and verify the validity, unidimensionality, and reliability of the measurement models corresponding to the model constructs. SPSS for Windows (PASW Statistics Gradpack 17.0, 2009) was used to conduct the EFA on the seven reflective measures using principal axis factoring and Promax oblique rotation method. This choice was found fitting since the underlying factors were suspected to non-orthogonal and the factors were to be used in subsequent analysis of structural relationships.

Further the Bartlett’s test of sphericity was used to explore the strength of the relations among the relationships of variables. The Kaiser-Meyer-Olkin (KMO) was used to measure sampling adequacy. Cronbach’s α was calculated using SPSS to determine the reliability of the reflective constructs.

The measurement model was analyzed using Partial Least Squares (PLS-Graph, v3.0, Build 1060, Chin, 2001). PLS-Graph was chosen to continue the measurement model analysis and to perform the structural equation model because the ideal self constructs were identified as formative in nature.

Common Method Bias

Common method bias (CMB) is a frequent concern when conducting cross-sectional, self-report research as it refers to variance that is attributable to the measurement method rather than to the constructs. Method biases are one of the main sources of measurement error and most researchers agree that common method variance is a potential problem in behavioral research (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).
Pavlou, Liang and Xue (2007) recommend examination of the correlation table of the latent variables and that if correlations are above 0.90 a common method bias may be indicated.

**Structural Equation Model**

The research model was tested using Partial Least Squares, specifically PLS-Graph (Chin, 2001). PLS is particularly well suited for this analysis given its flexibility to handle constructs with both reflective and formative indicators (Chin & Gopal, 1995).

To verify that a relation exists between persistence in an engineering career and career commitment to engineering an independent sample t-test was performed comparing those women over 40 who persisted in an engineering career and those women who opted out of engineering.

**Further Analysis of the Sample of Women Engineers**

SPSS ANOVA was used for comparing means and standard deviations of the identified constructs. Linear regression was used to establish relationships between the constructs. Where comparisons both showed significant relationships as a result of the linear regression method MANOVA used to compare the regression results.

Means were compared means with an independent sample t-test. SPSS and AMOS were to analyze the relationship of age and children on career commitment. PLS-Graph was used to do the analyses related to the ideal self as this construct has been conceptualized as a formative construct.
Analysis of the Sample of Men Engineers

The data on men engineers was collected at the same time as the data for the women engineers using the same methods as described above for the measurement and instrument development and the operationalization of constructs.

Sample of Men Engineers

For the men in the survey the age distribution as well as the distribution of degrees was different than for the women. For the women the age was skewed toward the younger, while for the men the age was more normally distributed as shown in Figure 9, with 13% under 30, 24% between 31 and 40, 35% between ages 41 and 50, 29% over 50.

*FIGURE 9*
Age Distribution of Men

As far as marital status, 64% of the men were married with children, 13% either married with no children or single, 5% divorced, and 4% living with a partner. The distribution is shown in Figure 10.
The top 3 degrees for the men were chemical engineering (29%), mechanical engineering (21%) and electrical engineering (11%). The distribution of degrees for men is shown in Figure 11.
Methodological Approach

In the same manner as in our previous study on the women respondents (Buse, 2011) data analysis and exploratory factor analysis was completed using SPSS for Windows (PASW Statistics Gradpack 17.0, 2009). The data was screened and tested for normality, multicollinearity, and outliers. Most of the data had some level of skewness or kurtosis; however no action was taken to modify the data set based on these analyses.

Exploratory factor analysis (EFA) was used to verify the validity of the constructs. SPSS for Windows (PASW Statistics Gradpack 17.0, 2009) was used to conduct the EFA on the 3 reflective measures using principal axis factoring and Promax oblique rotation method. The Bartlett’s test of sphericity was highly significant ($\chi^2 = 12786; \text{df} = 496; p = 0.000$) implying that the strength of the relationship among variables is strong. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.942, well above the acceptable level of 0.70 indicating adequate sampling to predict that the data will factor well based on correlation. Cronbach’s $\alpha$ for each of the constructs are all above 0.80 (Churchill, 1979) and are detailed in Table 5.

**TABLE 5**
**Exploratory Factor Analysis**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Items</th>
<th>Cronbach's $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self Efficacy</td>
<td>10</td>
<td>0.840</td>
</tr>
<tr>
<td>Career Commitment</td>
<td>5</td>
<td>0.803</td>
</tr>
<tr>
<td>Engagement</td>
<td>17</td>
<td>0.957</td>
</tr>
</tbody>
</table>

PLS-Graph was used to develop a structural equation model including the sample of men engineers. The same methods as detailed in section 3.4.6 were used to assess the reliability and validity of the SEM.
And as in section 3.5, SPSS ANOVA was used for comparing means and standard deviations with MANOVA used to compare the linear regression results. Means were compared means with an independent sample t-test. SPSS and AMOS were to analyze the relationship of age and children on career commitment. PLS-Graph was used to do the analyses related to the ideal self as this construct has been conceptualized as a formative construct.

**Ideal Self Analysis**

PLS-Graph was used to analyze the ideal self construct. As theorized by (Boyatzis & Akrivou, 2006) the ideal self is comprised of hope, identity and desired image of one’s future. Hope is theorized to be comprised of self efficacy and optimism. We use PLS-Graph and the data collected in the survey of engineering careers to assess the relationships of self efficacy, optimism, hope and identity on the five factor ideal self construct.
CHAPTER IV: RESULTS

Summary of Results

This chapter begins by detailing the findings from the qualitative study followed by a brief review of the model resulting from this study. Next the results from the pilot study on the ideal self construct are presented followed by the structural equation model developed for a women’s career commitment to engineering. Additional analyses related to the women in engineering are presented. The last section details the findings related to men in engineering careers and how this compares to women.

Qualitative Study Results

Distinct patterns separating the persistent engineers from the out-opting engineers emerged from the data at two levels: those related to individual factors and those related to the contextual experiences of the women. The individual factors included self efficacy, identity as an engineer, other orientation, adaptability and engagement in work. The particular contextual experiences were those in a woman’s background related to her choice of engineering, work experiences as an engineer; and the family situation. Table 6 provides a summary of the findings.
TABLE 6
Findings Summary Qualitative Study

<table>
<thead>
<tr>
<th>Findings</th>
<th>Persistent Engineers</th>
<th>Out Opting Engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self efficacy and confidence</td>
<td>21 of 21</td>
<td>5 of 10</td>
</tr>
<tr>
<td>Self doubt and lack of confidence</td>
<td>1 of 21</td>
<td>9 of 10</td>
</tr>
<tr>
<td>Identity as an engineer</td>
<td>21 of 21</td>
<td>0 of 10</td>
</tr>
<tr>
<td>Adaptability at work</td>
<td>16 of 21</td>
<td>2 of 10</td>
</tr>
<tr>
<td>Other orientation</td>
<td>17 of 20</td>
<td>2 of 8</td>
</tr>
<tr>
<td>Work engagement</td>
<td>19 of 21</td>
<td>NA</td>
</tr>
<tr>
<td>Career Choice Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pushed into engineering</td>
<td>2 of 11</td>
<td>6 of 8</td>
</tr>
<tr>
<td>Own choice of engineering</td>
<td>9 of 11</td>
<td>2 of 8</td>
</tr>
<tr>
<td>Contextual Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulties in male-dominated work</td>
<td>17 of 21</td>
<td>7 of 10</td>
</tr>
<tr>
<td>environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>17 of 21</td>
<td>9 of 10</td>
</tr>
<tr>
<td>Women with children</td>
<td>13 of 21</td>
<td>8 of 10</td>
</tr>
<tr>
<td>Number of children (average)</td>
<td>1.1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Self Efficacy

Each of the persistent engineers narrated experiences in which they demonstrated initiative and seized control of or manipulated difficult situations drawing upon what they judged as superior capabilities and/or training to effect personally favorable outcomes. Self efficacy was expressed in relation to finding new assignments, dealing with difficult work situations, or tackling tough technical problems. Often it was associated with the employment of skills developed over the course of a career to maneuver out of an uncomfortable or threatening situation. Examples included managing conflict with superiors or coworkers and effecting formal job changes. Additionally we found self efficacy expressed in relation to balancing work and life demands.

In contrast, nine of the ten engineers who had exited the field, told stories in which uncertainty, confusion, self doubt or low confidence predominated. The comparative quotes in Table 7 exemplify the difference in self efficacy expressed by our
two groups of respondents. Only one of the twenty one persistent engineers articulated self doubt.

### TABLE 7
Specific Quotes Related to Self Efficacy and Confidence

<table>
<thead>
<tr>
<th>Context</th>
<th>Persistent Engineers Expressing self efficacy &amp; confidence</th>
<th>Out-Opting Engineers Expressing self doubt &amp; lack of confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finding a Job</td>
<td>...after a volleyball game everybody went out for a beverage, and there must have been 20 people at the table, and I just stood up and said, &quot;Excuse me. Excuse me. Everyone? Question. I have a degree in engineering from Purdue University, and I need a job.&quot; ... Somebody called me the next day. He was sitting at the table. (Manufacturing Engineer with 19 years experience age 40)</td>
<td>When I graduated from (college), I had a tough time finding a job. I really was low on confidence even though I had this great engineering degree and all this stuff, it was still tough for me to have the confidence to go and interview. (12 year engineering career now a stay-at-home Mom age 43)</td>
</tr>
<tr>
<td>Work</td>
<td>So then I had to prove him wrong. It kind of gave me the confidence or at least the verification, that I knew what I was talking about ... and all these complicated systems, and I was able to demonstrate knowledge and ability to present that well. (Technical Manager with 13 years experience age 35)</td>
<td>It was a tough year for me because I had to learn just on-the-job basically, and it was frustrating because I didn't know so much. And I think people expected me to know things, and I didn't. So it was kind of humbling because you had to basically to acknowledge, &quot;I don't know anything.&quot; (11 year engineering career now working in purchasing age 35)</td>
</tr>
<tr>
<td>Work</td>
<td>I purposeful progressively changed my voice to create more of a louder voice, an aggressive voice with an aggressive position. Not that I was being angry, but I was doing this very purposely. And at the end, it's like, &quot;That's what he wanted.&quot; Not that he knew to tell me that, or not that he knew to change himself because I was a different type of personality. He wanted somebody who could be as aggressive and in-your-face as he was. (Consultant with 21 years experience age 45)</td>
<td>I think I had very little confidence, and I kind of waited for the other shoe to drop that somebody was going to find out that I really didn't know what was going on, and so if I had a boss who wasn't confident in me, who treated me with no respect, then I got into that completely. (11 year engineering career now a college business professor age 52)</td>
</tr>
<tr>
<td>Work-life balance</td>
<td>I had my first child... I began to work part time, which I recognized could slow down my rate of progress within the working world for my career, but I made the conscious decision that I didn't want to do everything, and I did want to have time to be with my child. (Production Manager with 25 years experience age 52)</td>
<td>When you have a family you run up against this, can I do everything? And obviously the answer for me was no. (8 year engineering career now an office manager at family business age 43)</td>
</tr>
<tr>
<td></td>
<td>One of the things that I wanted to do was to get more of a research position 'cause I wanted to be able to balance my work life and my home life. So I applied at X and I've been here for almost ten years. (Research Manager with 18 years experience age 40)</td>
<td>I really was committed to being a stay-at-home mom. It was more than just for my daughter, it was for me. I think it's a way to feel things for myself-to be really devoted to my child at that time. (12 year engineering career now a stay-at-home Mom age 43)</td>
</tr>
</tbody>
</table>
Identity

Persistent engineers are more likely than out-opting engineers to describe their attributes, values and experiences in terms of their identity as a professional engineer.

*I'm a hopeless geek. I love solving problems. I love working with users. My husband tells me that I am so analytical about everything that he just wants to run from the room screaming sometimes. I love to solve problems.* (Consultant with 28 years experience age 50)

and to find work opportunities that enable its expression.

*I voiced my opinions to the chairman of the Energy Policy Committee. He asked me to be co-chair for this policy committee. We are looking at the impact with the transportation industry and the impact on the electrical infrastructure. I like to be in situations where there are complex problems. I like to sit at the table. I want to understand - what are the challenges? I like to put a team in place.* (Technical Manager with 24 years experience)

Women who opted out of engineering professed identities inconsistent with engineering.

*I think I was always just not sure that I had chosen the right thing ... I looked at people who seemed to be in the right job, like my family members, and I thought I'm just not in the right job.* (14 year engineering career now a stay at home mom)

*It (engineering) really wasn't what I wanted to do. It was just something to get out of mom's house...I always knew I would leave. Because my mom worked, so that was something I'd always planned to stay home with my child.* (12 year engineering career now a stay at home mom)

Adaptability

Both groups of engineers described difficult workplaces where they experienced discrimination and/or harassment. What distinguished the two groups was the way these experiences were framed and addressed. Sixteen of the persistent engineers discussed
purposeful ways they adapted to the culture, but only two of ten women who left referenced adaptation and those who left were more likely to complain about the culture.

Adaptation in some cases was subtle – “dressing down,” “pulling my hair back” or “changing the tone of my voice”. More often, persistent engineers reported actively manipulating circumstances in an effort to mitigate personal discomfort caused by gender bias – bettering their own situations and, sometimes, affecting the attitudes and behaviors of others. The two quotes below contrast; in the first a persistent engineer describes how she challenged a discriminatory situation by addressing it, while in the next a woman who left engineering describes a similar situation to which she failed to respond.

*I took the exam and then I was told that I didn't get the job, but I had gotten the highest score. So, I petitioned the city and went in and sat-I can’t remember what his title was, but I made him tell me why he thought I wasn't qualified for the job. And it ended up that they had to reverse it and give me the job. And I, of course, then had to prove that I was going to be just as good as the guy who had been tapped to take the job.* (Technical Manager with 30 years experience age 60)

*There was a competition and at the end when they were going to give the prize, they wouldn't give it to me. They pulled me aside and they said, “These guys will be mortified if you get this prize.” ... They're like, “You did the best, but we can't give it to you.”* (12 year engineering career now a stay-at-home mom age 43)

**Other Orientation**

Persistent engineers (17 of 20) were more likely to describe their career experiences in terms of reciprocal engagement with others, including collaboration and providing support, counsel and advice. In many cases the women talked about the effects or consequences of their professional efforts on customers, co-workers, or direct reports. Exemplifying the broader societal effects of her work, one woman provided a narrative of
how software developed by her team saved the lives of US military operatives in a foreign country and possibly her brother.

So they had integrated our situation awareness (software) with their targeting capability...and there was a squadron of gunships that were flying missions into Afghanistan.... And my brother flies gunships and he was in Afghanistan and there's only one active duty gunship squadron. ...So they re-vectored either my brother or somebody close to him. His - it was all his squadron. (Consultant with 28 years experience age 50)

In contrast, women who opted-out were less likely to discuss their careers in terms of reciprocal engagement with others (2 of 8) instead they discussed their career experiences in terms of returns to themselves frequently associating fulfillment with recognition by others, usually a higher level manager. These women focused on what they personally learned, felt, experienced or contributed to the job.

I was working hard. I believed you had to work hard to do good work. That was being recognized, and I was being rewarded. So that was a pattern that I was in, and I have an ego, so I also was getting that fed by being rewarded, and I needed that. I needed that in some way, shape, or form. (10 year engineering career now a director of a non-profit age 48)

**Work Engagement**

In response to our question about why they stayed in their engineering career, 19 out of 21 long-tenured engineers pointed to novelty, match of interests and continuous learning opportunities. Most revealed being motivated and challenged by opportunities to work on new technologies, projects, or products – opportunities some found within the scope of their organizations, and others purposefully sought in different firms.

They were giving me assignments that were brand new, Greenfield, nobody had done before. ...My whole career has been cutting edge stuff, brand new. It was the new stuff that kept me. (Technical Manager with more than 30 years experience)

I like the type of work that I do right now because it changes all the time... I enjoy the challenges. I enjoy the people. I like the fact I can travel and
see something new. By working with the government, it's opened up a completely different situation for me.... I can't imagine anything else that would be this much fun on a regular basis. (Technical Manager with 18 years experience)

Women who persisted as engineers conflated career and personal achievement, enjoying career accomplishments as personal fulfillment. Contrarily, women who opted-out articulated a tension between work-related and personal goals, often citing the need to fulfill personal aspirations not satisfied by work as the motivation for leaving their jobs. The persistent engineers, even after many years on the job, exude enthusiasm, energy and commitment to their work.

*I can feel like I did something that made a difference... I can look around and go, yeah, I impacted the world a little bit.* (Technical Manager with 17 years experience age 38)

The women who left described their experience as engineers as “not happy,” “didn’t feel I was giving back,” “had accomplished nothing,” and felt “detached.”

*What am I doing with my kids? What do I want to be? I really didn't feel like I was giving back enough because so much of my time is spent at work and not really concerned in serving the community. ... I realized I wasn't happy anymore.* (17 year engineering career now a grade school teacher age 42 married mother of 3 sons in grade school)

*I wanted to leave a legacy and all I saw were stock prices going up and down.* (11 year engineering career now a college professor age 52 mother of son in his 20’s)

**Career Choice Factors**

Both the persistent engineers and the out-opting engineers discussed their career choice of engineering in terms of being good at math and science and both discussed the role of others in influencing their decision to pursue an engineering degree. Persistent engineers, however, (9 out of 11) were more likely to discuss their choice of engineering in terms of their own interests.
I... was very good at math and science...it just always came easy for me. Always in all the advanced or advanced placement classes there, I won a science award for our high school class. ...engineering was just a natural choice. I always used to think - ever since I knew what it was which I think was in like sixth or seventh grade I wanted to be an aeronautical engineer. (Consultant with 13 years experience)

Contrarily, most of the out opting engineers (6 of 8) said they were pushed into engineering and really wanted to do something else.

My actual dream was to be a music teacher...there was some restrictions for people in former Soviet Union where we were given certain occupations so that we can progress. So one of those were mechanical engineering...because my parents and I really wanted me to have a high education because I (did) very well in school. (15 year engineering career now a homemaker age 50)

I had very good grades, but I was just kind of a homebody and my counselors had to really push me....They're the ones who suggested engineering. (14 year engineering career now a stay at home Mom age 44)

Family Environment

The persistent engineers in this study were less likely to be married and to have children than those who opted out of the profession (see Table 1). Among those in both groups who had children, persistent engineers had fewer. Both groups of women discussed being offered or having considered working part time or flexible hours. At the time of our interviews two persistent engineers were working less than full-time to care for young children, and two others had previously worked part time. Among the out opting engineers, two discussed working part time during their engineering careers and discussed the option for flexible work schedules at the time they choose to leave engineering.

The data revealed no differences between the groups related to the role of husbands or partners in decisions regarding child care or in the woman’s decision to
persist or opt out of the profession; however three of our persistent engineers were married to stay-at-home dads. Each woman discussed unique aspects of obtaining child care covering all available options from using family members (cousins, mothers or mother-in-law) to day care facilities.

**Work Environment**

Both persistent engineers and those that left the profession acknowledged the male-dominated culture of their workplaces and both groups noted challenges associated with it. Seventeen of 21 women who remained in engineering and seven of ten women who exited discussed gender associated cultural issues including, in some cases, discrimination and/or harassment.

*I didn't get that next job up. HE did. My boss said, “We didn't know you wanted that job. You never said you were interested in that job.” ...I was like “I’d assume you would know that I want to progress my career.” That's the logical progression. I didn't realize I had to tell them what I wanted. ... I was on his leadership team.* (Technical manager with 24 years experience)

*I called a gas supply company for relief valve information. I was asking questions, and pretty much, his reply was something like, we don't service domestic accounts ... he just assumed that I was a housewife with a little propane tank in my backyard and that I was calling to ask about stuff for that. ... It’s part of the job.* (Process engineer with 16 years experience)

*Despite what anybody says in terms of equal opportunity for everyone, there is a clear discrimination for women in manufacturing in terms of giving them promotions, equal pay and treatment.* (15 year engineering career now a homemaker)

*He was really just a bad, bad boss...he would make sexual innuendos whenever he had the opportunity. I found that I was choosing my words very, very carefully so he couldn't turn it around and make it a sex joke.* (11 year engineering career now a college business professor)

While both groups of engineers discussed the role of managers in the context of their careers and compared good and bad manager experiences, no respondents
acknowledged them as influential in their career decisions. Some of the engineers
described relationships with formal and/or informal mentors, but again, no pattern was
found linking a mentor to career persistence.

Many of the women discussed working within different industries

*I've worked in so many different industries and businesses, everything
from children's hospitals...utility companies, telecommunication
companies.* (Project Manager with 13 years experience)

Or teams that were comprised of women from other occupations (such as accounting,
marketing and sales) with traditionally higher representation of women.

*I still go to a lot of meetings where I'm the only woman in the room. But I
am surrounded by a lot of women on our team. So in fact, the team that I
am on right now is mostly women.*” (Engineering Manager with 20 years
experience)

The women in our study, all from industry, discussed their roles in the workplace
as collaborative and connected

*I work with some brilliant, brilliant people that never considered the idea
of collaborating outside of the organization because it was never
something they were allowed to do. So in a lot of ways, I feel that, all
right, my role here is to break down barriers, and I do a lot of that.*
(Research Director with 15 years experience age 42)

The work context varied for the engineers depending on the industry sector and
their specific jobs but we found no specific differences in the type of work related to a
woman’s persistence in engineering. Those who worked in manufacturing were most
likely to discuss the paucity of other women in their day to day work. Others discussed
the changing role of, and challenges associated with being a woman in engineering.

*I'd call it a challenge - is there still a stigma out there for women in
engineering? It's much, much, much, much less than it used to be in the
manufacturing world where I'm working... So you're going to have to find
your own way of dealing with that. I'm not going to say I know the only
way to deal with it. I know my ways of dealing with it. (Technical manager with 13 years experience age 35)

The qualitative study revealed individual factors leading to career persistence in engineering for women. The ideal self as conceptualized by (Boyatzis & Akrivou, 2006) is comprised of hope, identity and one’s dreams and desires. The qualitative study findings are integrated to develop a model as the basis for the qualitative study.

**FIGURE 12**
Model of Women in Engineering Careers

Ideal Self Pilot Results

The analysis of the data from the ideal self pilot study yielded a 5 factor solution for the ideal self construct. The 5 factor solution based on theory yielded loadings that are all above 0.70 except for IS4=0.4578 and IS16=0.6411 (see Appendix B). All communalities are above 0.50 and with the sample size of 112 the results are likely to accurately reproduce the population loadings. Convergent validity is shown as all t-values are higher than 1.96, with IS4 lowest at 5.7660. Discriminate validity is shown for
all constructs as shown in Table 1, with the square root of AVE in bold on the diagonal. Boot strapping was used specifying 300 samples and 112 cases per sample. The resulting t-stats were all higher than 1.96.

**TABLE 8**  
Measurement Model for Ideal Self as 5 Factors n=112

<table>
<thead>
<tr>
<th>Measure</th>
<th>CR</th>
<th>AVE</th>
<th>ISHope</th>
<th>IS Sense of Prps</th>
<th>IS Hol Vision</th>
<th>IS Dpr Meaning</th>
<th>IS Fun</th>
<th>Average Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.897</td>
<td>0.526</td>
<td>0.725</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5259</td>
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<tr>
<td>IS Sense of Purpose</td>
<td>0.861</td>
<td>0.608</td>
<td>0.445</td>
<td>0.780</td>
<td></td>
<td></td>
<td></td>
<td>0.6082</td>
</tr>
<tr>
<td>IS Holistic Vision</td>
<td>0.847</td>
<td>0.581</td>
<td>0.270</td>
<td>0.527</td>
<td>0.762</td>
<td></td>
<td></td>
<td>0.5812</td>
</tr>
<tr>
<td>IS Deeper Meaning</td>
<td>0.822</td>
<td>0.698</td>
<td>0.458</td>
<td>0.362</td>
<td>0.371</td>
<td>0.835</td>
<td></td>
<td>0.6976</td>
</tr>
<tr>
<td>IS Fun</td>
<td>0.852</td>
<td>0.743</td>
<td>0.369</td>
<td>0.561</td>
<td>0.561</td>
<td>0.351</td>
<td>0.862</td>
<td>0.7427</td>
</tr>
</tbody>
</table>

Based on the results from the four pre-tests, the focus group and the pilot study the ideal self as a five dimension construct was used in the larger quantitative survey on engineers.

**Empirical Model for Women’s Career Commitment to Engineering**

**Measurement Model**

While most of the data had some level of skewness or kurtosis, no action was taken to modify the data set based on these analyses. No issues with multicollinearity were detected and while outliers existed they were few as compared to the number of total cases used – 495. Missing data was not a factor as the on-line survey was designed to force responses.
The Bartlett’s test of sphericity was highly significant ($\chi^2 = 17339; \text{df} = 1700; p < 0.000$) implying that the strength of the relationship among variables is strong. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.930, well above the acceptable level of 0.70 indicating the data was adequate for factoring. Consistent with KMO, we examined the diagonal anti-image correlations and observed for all variables they exceeded 0.5 and off-diagonals were generally less than 0.05. The reliability of each construct as measured by Cronbach’s $\alpha$ are all above 0.60 (Churchill, 1979) and are detailed in Table 9.

### TABLE 9

**Construct Validity**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Type</th>
<th>Initial Results all Items</th>
<th>Final Results used in Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#Items</td>
<td>Cronbach’s $\alpha$</td>
<td>#Items</td>
</tr>
<tr>
<td>Self Efficacy</td>
<td>Reflective</td>
<td>10</td>
<td>0.842</td>
</tr>
<tr>
<td>Optimism</td>
<td>Reflective</td>
<td>10</td>
<td>0.826</td>
</tr>
<tr>
<td>Hope</td>
<td>Reflective</td>
<td>6</td>
<td>0.874</td>
</tr>
<tr>
<td>Identity</td>
<td>Reflective</td>
<td>5</td>
<td>0.691</td>
</tr>
<tr>
<td>Leader</td>
<td>Reflective</td>
<td>7</td>
<td>0.916</td>
</tr>
<tr>
<td>Member Exchange</td>
<td>Reflective</td>
<td>17</td>
<td>0.956</td>
</tr>
<tr>
<td>ISHope</td>
<td>Formative</td>
<td>8</td>
<td>NA</td>
</tr>
<tr>
<td>IS Sense of Purpose</td>
<td>Formative</td>
<td>4</td>
<td>NA</td>
</tr>
<tr>
<td>IS Holistic Vision</td>
<td>Formative</td>
<td>4</td>
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</tr>
<tr>
<td>IS Fun</td>
<td>Formative</td>
<td>2</td>
<td>NA</td>
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<tr>
<td>IS Deeper Meaning</td>
<td>Formative</td>
<td>2</td>
<td>NA</td>
</tr>
<tr>
<td>Engagement</td>
<td>Reflective</td>
<td>17</td>
<td>0.956</td>
</tr>
<tr>
<td>Career Commitment</td>
<td>Reflective</td>
<td>5</td>
<td>0.815</td>
</tr>
</tbody>
</table>
The measurement model was analyzed using Partial Least Squares (PLS-Graph, v3.0, Build 1060, Chin, 2001). For the confirmatory factor analysis (CFA) the loadings on each of the reflective factors were above 0.70 and were therefore likely to explain more than 50% of the variance in the construct. For the new Ideal Self construct there were several loadings below 0.70 but we chose to keep them in the study as this is the first study to use this set of constructs. The reliability coefficients were all found to be above 0.70 and the average value extracted (AVE) were all above 0.50 except for three of the new ideal self construct with AVE’s just under 0.50 (see Table 4.5). The details of the entire analysis of the ideal self construct are presented in section 4.6.

T-stats for each of the constructs were well above 1.96. Discriminate validity between constructs was examined using the recommendation (Pavlou et al., 2007) that the square root of AVE for each construct should exceed the correlations between that and all other constructs. Comparing the square root of the AVE (bold figures on the diagonal) with the correlations among the constructs, shown in Table 10 indicates that each construct is more closely related to its own measures than to those of other constructs, and discriminate validity was therefore supported.
# TABLE 10
SEM Model Correlation Table for Women Engineers

<table>
<thead>
<tr>
<th></th>
<th>MEAN</th>
<th>SD</th>
<th>SE</th>
<th>ID</th>
<th>OP</th>
<th>Ho</th>
<th>IS Deep Me</th>
<th>IS Fun</th>
<th>IS Hpe</th>
<th>IS SnsofP</th>
<th>IS HolVis</th>
<th>LM</th>
<th>CC</th>
<th>EE</th>
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</thead>
<tbody>
<tr>
<td>SE</td>
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</tr>
<tr>
<td>ID</td>
<td>4.094</td>
<td>0.640</td>
<td>0.196</td>
<td>0.780</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>OP</td>
<td>3.811</td>
<td>0.778</td>
<td>0.335</td>
<td>0.154</td>
<td>0.807</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ho</td>
<td>6.586</td>
<td>0.859</td>
<td>0.555</td>
<td>0.192</td>
<td>0.480</td>
<td>0.785</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>ISDeepMe</td>
<td>5.802</td>
<td>0.869</td>
<td>0.148</td>
<td>0.052</td>
<td>0.182</td>
<td>0.241</td>
<td>0.838</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>ISFun</td>
<td>6.142</td>
<td>0.910</td>
<td>0.210</td>
<td>0.231</td>
<td>0.265</td>
<td>0.265</td>
<td>0.353</td>
<td>0.858</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>ISHope</td>
<td>5.866</td>
<td>0.774</td>
<td>0.335</td>
<td>0.233</td>
<td>0.433</td>
<td>0.583</td>
<td>0.407</td>
<td>0.388</td>
<td>0.669</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ISSnsofP</td>
<td>5.866</td>
<td>0.774</td>
<td>0.306</td>
<td>0.237</td>
<td>0.298</td>
<td>0.455</td>
<td>0.325</td>
<td>0.535</td>
<td>0.619</td>
<td>0.702</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISHolVis</td>
<td>6.277</td>
<td>0.814</td>
<td>0.111</td>
<td>0.166</td>
<td>0.280</td>
<td>0.201</td>
<td>0.397</td>
<td>0.621</td>
<td>0.292</td>
<td>0.403</td>
<td>0.705</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM</td>
<td>3.599</td>
<td>0.844</td>
<td>0.180</td>
<td>0.031</td>
<td>0.203</td>
<td>0.272</td>
<td>0.118</td>
<td>0.041</td>
<td>0.220</td>
<td>0.065</td>
<td>0.062</td>
<td>0.815</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td>4.030</td>
<td>0.887</td>
<td>0.239</td>
<td>0.143</td>
<td>0.225</td>
<td>0.344</td>
<td>0.151</td>
<td>0.083</td>
<td>0.317</td>
<td>0.182</td>
<td>0.109</td>
<td>0.235</td>
<td>0.792</td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>5.473</td>
<td>1.1409</td>
<td>0.294</td>
<td>0.145</td>
<td>0.318</td>
<td>0.481</td>
<td>0.180</td>
<td>0.263</td>
<td>0.480</td>
<td>0.405</td>
<td>0.215</td>
<td>0.375</td>
<td>0.381</td>
<td>0.797</td>
</tr>
</tbody>
</table>
Common Method Bias

Using Pavlou et al. (2007) recommendation to examine the correlation table of the latent variables and that if correlations are above 0.90 a common method bias may be indicated. As shown in Table 10 the correlations in this study are all far below 0.90. Further to assess CMB, a CFA was conducted in which the baseline model included a common method bias factor where each item was converted to a single item construct (Podsakoff et al., 2003). Each of these single item constructs is linked to a common method factor (CMF). The loadings on each item was examined for evidence of method bias by squaring the loadings on each construct, squaring the loadings of each single item construct to the CMF, then computing and comparing the means of each. The variance associated with the measurement model was more than 2.5 greater than the variance associated with the CMF and it is concluded that common method variance does not bias the results of this study.

Structural Equation Model

The path coefficients and their significance for the sample of 495 women are shown in the SEM model in Figure 13. These $R^2$ values for the endogenous variables – career commitment and engagement – are considered significant using the F-test as shown in Table 11. The explanatory power of the model is concluded to be statistically significant, demonstrating the predictive relevance of the structural model.
The model demonstrates that factors characteristic of an individual predict career commitment and engagement for women engineers. Specifically, hope and engagement positively impact career commitment where the IS Fun dimension of the ideal self negatively impacts career commitment. Control variables including age, number of children, and current job were found to be insignificant to career commitment.
Self efficacy, optimism and identity impact career commitment but are fully mediated by hope and the dimensions of the ideal self. Specifically, hope fully mediated the relationship between self efficacy and career commitment, as well as the relationship between optimism and career commitment. IS Fun fully mediates the relationship between identity and career commitment.

For engagement, hope, leader-member-exchange, and two dimensions of the ideal self – IS Hope and IS Sense of Purpose – were found to have a direct and positive impact. Control variables (age, number of children and current job) were tested and only age was found to have a significant effect on engagement.

Numerous mediation effects have been demonstrated using Baron and Kenny (1986) and are detailed.

**FIGURE 14**
Mediation Effects

**TABLE 12**
Hope as a Mediator

<table>
<thead>
<tr>
<th>Hope as Mediator</th>
<th>Loading</th>
<th>Sig</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE → HO</td>
<td>0.555 (a)</td>
<td>p&lt;0.001</td>
<td>17.0176</td>
</tr>
<tr>
<td>SE → CC</td>
<td>0.248 (c)</td>
<td>p&lt;0.001</td>
<td>6.2327</td>
</tr>
<tr>
<td>HO → CC</td>
<td>0.308 (b)</td>
<td>p&lt;0.001</td>
<td>5.2504</td>
</tr>
<tr>
<td>SE → EE</td>
<td>0.312 (c)</td>
<td>p&lt;0.001</td>
<td>8.5951</td>
</tr>
<tr>
<td>HO → EE</td>
<td>0.461 (b)</td>
<td>p&lt;0.001</td>
<td>9.5199</td>
</tr>
<tr>
<td>OP → HO</td>
<td>0.485 (a)</td>
<td>p&lt;0.001</td>
<td>11.5195</td>
</tr>
<tr>
<td>OP → CC</td>
<td>0.246 (c)</td>
<td>p&lt;0.001</td>
<td>6.0878</td>
</tr>
<tr>
<td>OP → EE</td>
<td>0.329 (c)</td>
<td>p&lt;0.001</td>
<td>8.0556</td>
</tr>
</tbody>
</table>
TABLE 13
IS Fun as a Mediator

<table>
<thead>
<tr>
<th>ISFun as Mediator</th>
<th>Loading</th>
<th>Sig</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO→ISFun</td>
<td>0.272 (a)</td>
<td>p&lt;0.001</td>
<td>6.1463</td>
</tr>
<tr>
<td>ISFun→CC</td>
<td>0.116 (b)</td>
<td>p&lt;0.010</td>
<td>1.6416</td>
</tr>
<tr>
<td>HO→CC</td>
<td>0.308 (c)</td>
<td>p&lt;0.001</td>
<td>5.2504</td>
</tr>
<tr>
<td>ID→CC</td>
<td>0.166 (c)</td>
<td>p&lt;0.001</td>
<td>4.6122</td>
</tr>
<tr>
<td>ID→ISFun</td>
<td>0.244 (a)</td>
<td>p&lt;0.001</td>
<td>4.8328</td>
</tr>
</tbody>
</table>

TABLE 14
IS Hope as a Mediator

<table>
<thead>
<tr>
<th>ISHope as Mediator</th>
<th>Loading</th>
<th>Sig</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO→ISHO</td>
<td>0.594 (a)</td>
<td>p&lt;0.001</td>
<td>20.2579</td>
</tr>
<tr>
<td>ISHope→EE</td>
<td>0.485 (b)</td>
<td>p&lt;0.001</td>
<td>13.2086</td>
</tr>
<tr>
<td>HO→EE</td>
<td>0.496 (c)</td>
<td>p&lt;0.001</td>
<td>13.2479</td>
</tr>
<tr>
<td>ID→ISHO</td>
<td>0.266 (a)</td>
<td>p&lt;0.001</td>
<td>6.3879</td>
</tr>
</tbody>
</table>

TABLE 15
Leader Member Exchange as a Mediator

<table>
<thead>
<tr>
<th>LM as Mediator</th>
<th>Loading</th>
<th>Sig</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO→LM</td>
<td>0.301 (a)</td>
<td>p&lt;0.001</td>
<td>7.7698</td>
</tr>
<tr>
<td>LM→EE</td>
<td>0.384 (b)</td>
<td>p&lt;0.001</td>
<td>10.3985</td>
</tr>
<tr>
<td>HO→EE</td>
<td>0.496 (c)</td>
<td>p&lt;0.001</td>
<td>13.2479</td>
</tr>
</tbody>
</table>

TABLE 16
IS Sense of Purpose as a Mediator

<table>
<thead>
<tr>
<th>ISSnsofPps as Med</th>
<th>Loading</th>
<th>Sig</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>HO→ISSofP</td>
<td>0.478 (a)</td>
<td>p&lt;0.001</td>
<td>12.9</td>
</tr>
<tr>
<td>ISSofP→EE</td>
<td>0.419(b)</td>
<td>p&lt;0.001</td>
<td>9.1</td>
</tr>
<tr>
<td>HO→EE</td>
<td>0.496 (c)</td>
<td>p&lt;0.001</td>
<td>13.2</td>
</tr>
<tr>
<td>ID→ISSofP</td>
<td>0.267 (a)</td>
<td>p&lt;0.001</td>
<td>5.8</td>
</tr>
</tbody>
</table>

To ensure that there is a relationship between the construct career commitment to engineering and persistence in engineering the first analysis compared women persisting
in engineering who were more than 40 years of age to women who opted out of engineering. As shown in Table 17, those women persisting in engineering have a greater and statistically significant difference in career commitment as compared to those women who opted out of engineering. Work engagement has not been shown to be different for these groups.

**TABLE 17**

Women Persisting in Engineering and Career Commitment to Engineering

<table>
<thead>
<tr>
<th></th>
<th>Women Over 40 &amp; Persisting in Engineering (N=161)</th>
<th>Women Who Opted Out of Engineering (N=43)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Career Commitment to Engineering</td>
<td>0.0976</td>
<td>0.7591</td>
</tr>
<tr>
<td>Engagement</td>
<td>0.1631</td>
<td>0.7365</td>
</tr>
</tbody>
</table>

*p<0.05, ** p<0.01, ***p<.001

**Women in Engineering**

**Age and Self Efficacy**

The means and standard deviations of both self efficacy and career commitment to engineering for women employed in engineering for two groups: women under 30 years of age and women over 40 are shown in Table 18. The analysis supports H12 as self efficacy for women over 40 is higher and statistically significantly different from the self efficacy reported by women under 30. Also of note is that there is no statistically significant difference between the two groups in the measure of career commitment to engineering.
TABLE 18
Means and Standard Deviations of Variables and Significance of the difference due to Women’s Age

<table>
<thead>
<tr>
<th></th>
<th>Women Under 30 (N=149)</th>
<th>Women over 40 (N=170)</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Self Efficacy</td>
<td>-.142</td>
<td>.615</td>
<td>.049</td>
</tr>
<tr>
<td>Career Commitment to</td>
<td>-.015</td>
<td>0.775</td>
<td>.081</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**p<0.01

Age and Children

Neither age nor number of children has been shown to influence a woman’s career commitment to engineering as shown in Table 19 however the interaction of age and children does influence a woman’s career commitment to engineering.

The Dawson’s plot showing the interaction effect is Figure 15. H13 is supported as the interaction of age and number of children influences a woman’s career commitment to engineering.

TABLE 19
Results of Analyses for Hypotheses 13a

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Variable</th>
<th>Career Commitment to Engineering</th>
<th>Regression Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>H13</td>
<td>Children</td>
<td>Women</td>
<td>-0.107 (0.08)</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>Women</td>
<td>-0.051 (0.04)</td>
</tr>
<tr>
<td></td>
<td>Age x Children</td>
<td>Women</td>
<td>0.034 (0.02)*</td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01, ***p<0.001

a Figures in the main part of this table are the unstandardized regression weights with standard errors in parentheses using a structural equation model in AMOS.
Gender and Persistence in Engineering

The means, standard deviations and the significance of the differences due to gender for each of the factors used in this analysis are shown in Table 20. Of note is that self efficacy for men was found to be statistically different (p<0.05) and greater than self efficacy for women.
TABLE 20
Means and Standard Deviations of Variables and Significance of the difference due to Gender

<table>
<thead>
<tr>
<th></th>
<th>Women (N=495)</th>
<th>Men (N=138)</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Self Efficacy</td>
<td>-.031</td>
<td>.644</td>
<td>.115</td>
</tr>
<tr>
<td>Career Commitment to Engineering</td>
<td>-.020</td>
<td>.760</td>
<td>.075</td>
</tr>
<tr>
<td>Work Engagement</td>
<td>-.0148</td>
<td>.769</td>
<td>.056</td>
</tr>
<tr>
<td>Leader Member Exchange</td>
<td>-.038</td>
<td>.824</td>
<td>.144</td>
</tr>
<tr>
<td>Age</td>
<td>3.730</td>
<td>2.005</td>
<td>5.180</td>
</tr>
<tr>
<td>Number of Children</td>
<td>2.090</td>
<td>1.186</td>
<td>2.680</td>
</tr>
</tbody>
</table>

*p<0.05, ** p<0.01, ***p<.001

H14 is supported as the findings show that self efficacy is not an influence on career commitment for men and self efficacy is influential on career commitment to engineering for women. Table 21 includes the results of the linear regression analysis.

H15 is supported as using linear regression a statistically significant relationship is found between leader member exchange and career commitment for men as there is for women as shown in Table 21. MANOVA shows that there is a statistically significant difference between the two regression results with two groups, one group being men and one group women. We conclude that H15 is supported as the Sig F Change is significant as shown in Table 21 and Table 22 and the regression results are greater for women.
TABLE 21
Results of Linear Regression Analyses for Hypotheses 14, 15, 16 & 18a

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Variable</th>
<th>Career Commitment to Engineering</th>
<th>Regression Results</th>
<th>F</th>
<th>F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>H14</td>
<td>Self Efficacy</td>
<td>Women: 0.232 (0.05)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Men: 0.127 (0.10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H15</td>
<td>Leader Member Exchange</td>
<td>Women: 0.175 (0.04)***</td>
<td>19.5</td>
<td>25.7***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Men: 0.172 (0.08)*</td>
<td>5.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H13</td>
<td>Children</td>
<td>Women: -0.107 (0.08)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>Women: -0.051 (0.04)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age x Children</td>
<td>Women: 0.034 (0.02)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H16</td>
<td>Children</td>
<td>Men: 0.051 (0.12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>Men: 0.120 (0.06)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Age x Children</td>
<td>Men: -0.015 (0.02)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H18</td>
<td>Engagement</td>
<td>Women: 0.371 (0.04)***</td>
<td>12.6</td>
<td>97.9***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Men: 0.266 (0.08)***</td>
<td>85.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.01, ***p<0.001

a Figures in the main part of this table are unstandardized regression weights with standard errors in parentheses. We used SPSS linear regression analyses to obtain these results.

TABLE 22
MANOVA Results Supporting H15

<table>
<thead>
<tr>
<th>R Squared</th>
<th>Adj. R Squared</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th>R Square</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.194</td>
<td>0.038</td>
<td>0.036</td>
<td>0.73422</td>
<td>0.038</td>
<td>25.650</td>
<td>1</td>
<td>656</td>
<td>.000</td>
</tr>
</tbody>
</table>

H16 is supported as the number of children has no impact on a man’s career commitment to engineering and while age has some impact there is no statistically significant relationship between the interaction of age and children and a man’s career commitment to engineering.
To determine if H17 is supported PLS Graph is used to determine the relationship between the ideal self and career commitment. In the previous study (Buse, 2011) the ideal self was conceptualized as formative and comprised of five constructs. Three of these constructs (IS Fun, IS Hope and IS Sense of purpose) were found to be related to career commitment to engineering for women. ISFun had a direct impact on career commitment while ISHope and IS Sense of Purpose impacted engagement which impacted career commitment.

Geffen and Straub (2005) state that convergent validity is established when the t-values of the outer model loadings are above 1.96. Discriminate validity is established when the square root of the average variance extracted (AVE) of each construct is greater than the correlation of this construct to all other constructs. Reliability is established when the construct reliability (CR) is above 0.70.

For the women there is convergent validity as the t-values of the outer model loadings are all above 1.96 and reliability as CR is above 0.70. However, for the men there are several issues: convergent validity has not been established in the ideal self constructs of IS Holistic Vision and IS Deeper Meaning, and reliability has not been established as CR for IS Holistic Vision and Deeper Meaning are below 0.70 as shown in Table 4.17.
TABLE 23
Validity & Reliability of Ideal Self Constructs for Hypothesis 17

<table>
<thead>
<tr>
<th>Construct</th>
<th># Items</th>
<th>Type</th>
<th>Women CR</th>
<th>AVE</th>
<th>R2</th>
<th>Men CR</th>
<th>AVE</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>8</td>
<td>Formative</td>
<td>0.845</td>
<td>0.411</td>
<td>0.774</td>
<td>0.321</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Sense of Purpose</td>
<td>4</td>
<td>Formative</td>
<td>0.698</td>
<td>0.407</td>
<td>0.804</td>
<td>0.515</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Holistic Vision</td>
<td>4</td>
<td>Formative</td>
<td>0.752</td>
<td>0.442</td>
<td>0.424</td>
<td>0.179</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Fun</td>
<td>2</td>
<td>Formative</td>
<td>0.849</td>
<td>0.737</td>
<td>0.807</td>
<td>0.679</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Deeper Meaning</td>
<td>2</td>
<td>Formative</td>
<td>0.786</td>
<td>0.663</td>
<td>0.545</td>
<td>0.467</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>15</td>
<td>Reflective</td>
<td>0.963</td>
<td>0.636</td>
<td>0.276</td>
<td>0.964</td>
<td>0.643</td>
<td>0.336</td>
</tr>
<tr>
<td>Career Commitment</td>
<td>4</td>
<td>Reflective</td>
<td>0.870</td>
<td>0.626</td>
<td>0.184</td>
<td>0.844</td>
<td>0.578</td>
<td>0.179</td>
</tr>
</tbody>
</table>

The correlation matrix (Table 24) with the square root of AVE for men on the diagonal shows that for these factors the discriminate validity has been established.

TABLE 24
Correlation Matrix for Men (n=138)

<table>
<thead>
<tr>
<th></th>
<th>ISHope</th>
<th>ISSenofP</th>
<th>ISHolVis</th>
<th>ISFun</th>
<th>ISDeepMe</th>
<th>CC</th>
<th>EE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISHope</td>
<td>0.567</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISSenofP</td>
<td>0.481</td>
<td>0.718</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISHolVis</td>
<td>0.114</td>
<td>0.354</td>
<td>0.423</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISFun</td>
<td>0.379</td>
<td>0.630</td>
<td>0.424</td>
<td>0.824</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISDeepMe</td>
<td>0.363</td>
<td>0.392</td>
<td>0.065</td>
<td>0.365</td>
<td>0.683</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC</td>
<td>0.208</td>
<td>0.110</td>
<td>-0.110</td>
<td>0.032</td>
<td>-0.031</td>
<td>0.760</td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>0.557</td>
<td>0.285</td>
<td>0.164</td>
<td>0.270</td>
<td>0.312</td>
<td>0.325</td>
<td>0.802</td>
</tr>
</tbody>
</table>

Finally the influence of the ideal self constructs is shown in the models for both women and men. For women, IS Hope, IS Fun and IS Sense of Purpose influence both engagement and career commitment (Figure 16 and IS Hope and IS Fun directly influence career commitment (Figure 17).
For men IS Hope influences engagement which influences career commitment. If engagement is removed from this model there is no statistically significant relationship between the ideal self and career commitment to engineering for men supporting H17.
For H18 we find that there is a statistically significant relationship between a man’s work engagement and his career commitment to engineering. Completing a MANOVA and comparing the regression results for men and women we find that there is a statistically significant difference between the regression for men and women and that the relationship is greater for women as show in Table 25 supporting H18.

**TABLE 25**
MANOVA Results Supporting H18

<table>
<thead>
<tr>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square</td>
</tr>
<tr>
<td>0.360</td>
<td>0.130</td>
<td>0.129</td>
<td>0.69813</td>
<td>0.130</td>
</tr>
</tbody>
</table>
The Ideal Self Analyses

The Ideal Self as a Dependent Variable

Using the full data set of women and men with engineering degrees we developed a structural equation model for the Ideal Self as a dependent variable. Here n=633 (495 women and 138 men). The structural equation model is shown in Figure 19.

FIGURE 19
Ideal Self as a Dependent Variable

* p<0.05
** p<0.01
*** p<0.001
+p<0.10
### TABLE 26

Correlation Table for the Ideal Self as a Dependent Variable

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>SE</th>
<th>ID</th>
<th>OP</th>
<th>Ho</th>
<th>IS DeepMe</th>
<th>IS Fun</th>
<th>IS Hope</th>
<th>IS SnsofP</th>
<th>IS HolVis</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE</td>
<td>0.876</td>
<td>0.639</td>
<td>0.800</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>0.821</td>
<td>0.607</td>
<td>0.197</td>
<td>0.779</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OP</td>
<td>0.899</td>
<td>0.641</td>
<td>0.328</td>
<td>0.162</td>
<td>0.801</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ho</td>
<td>0.900</td>
<td>0.602</td>
<td>0.528</td>
<td>0.211</td>
<td>0.474</td>
<td>0.776</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISDeepMe</td>
<td>0.778</td>
<td>0.655</td>
<td>0.153</td>
<td>0.087</td>
<td>0.211</td>
<td>0.258</td>
<td>0.809</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISFun</td>
<td>0.840</td>
<td>0.725</td>
<td>0.195</td>
<td>0.220</td>
<td>0.252</td>
<td>0.271</td>
<td>0.358</td>
<td>0.851</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISHope</td>
<td>0.871</td>
<td>0.462</td>
<td>0.299</td>
<td>0.231</td>
<td>0.415</td>
<td>0.575</td>
<td>0.439</td>
<td>0.448</td>
<td>0.680</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISSnsofP</td>
<td>0.804</td>
<td>0.517</td>
<td>0.280</td>
<td>0.248</td>
<td>0.307</td>
<td>0.463</td>
<td>0.366</td>
<td>0.570</td>
<td>0.694</td>
<td>0.719</td>
<td></td>
</tr>
<tr>
<td>ISHolVis</td>
<td>0.492</td>
<td>0.277</td>
<td>0.109</td>
<td>0.110</td>
<td>0.173</td>
<td>0.085</td>
<td>0.218</td>
<td>0.606</td>
<td>0.236</td>
<td>0.375</td>
<td>0.526</td>
</tr>
</tbody>
</table>

The Ideal Self Analyses by Management Level

**FIGURE 20**

Ideal Self Influence for Women on Engagement and Career Commitment for Job as Engineer n=227
**TABLE 27**
Correlation Table for Ideal Self Influence for Women for Job as Engineer n=227

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>IS Hope</th>
<th>IS S of P</th>
<th>IS Holistic Vision</th>
<th>IS Fun</th>
<th>IS Dpr Meaning</th>
<th>Career Commitment</th>
<th>Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.845</td>
<td>0.411</td>
<td>0.641</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS S of P</td>
<td>0.699</td>
<td>0.407</td>
<td>0.407</td>
<td>0.638</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Hol Vis</td>
<td>0.752</td>
<td>0.442</td>
<td>0.092</td>
<td>0.072</td>
<td>0.665</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Fun</td>
<td>0.849</td>
<td>0.737</td>
<td>0.244</td>
<td>0.351</td>
<td>0.414</td>
<td>0.858</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Dpr Mng</td>
<td>0.786</td>
<td>0.663</td>
<td>0.397</td>
<td>0.163</td>
<td>0.237</td>
<td>0.293</td>
<td>0.814</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career Commitment</td>
<td>0.870</td>
<td>0.626</td>
<td>0.437</td>
<td>0.283</td>
<td>0.147</td>
<td>0.018</td>
<td>0.091</td>
<td>0.791</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>0.963</td>
<td>0.636</td>
<td>0.519</td>
<td>0.451</td>
<td>0.214</td>
<td>0.260</td>
<td>0.207</td>
<td>0.425</td>
<td>0.797</td>
</tr>
</tbody>
</table>

**FIGURE 21**
Ideal Self Influence for Women on Career Commitment for Job as Engineer n=227

![IS HOPE to Career Commitment](image)

**TABLE 28**
Correlation Table for Ideal Self Influence for Women for Job as Engineer n=227

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>IS Hope</th>
<th>IS S of P</th>
<th>IS Holistic Vision</th>
<th>IS Fun</th>
<th>IS Dpr Meaning</th>
<th>Career Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.812</td>
<td>0.363</td>
<td>0.602</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS S of P</td>
<td>0.570</td>
<td>0.329</td>
<td>0.152</td>
<td>0.574</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Hol Vis</td>
<td>0.651</td>
<td>0.373</td>
<td>0.257</td>
<td>0.454</td>
<td>0.611</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Fun</td>
<td>0.846</td>
<td>0.734</td>
<td>0.175</td>
<td>0.464</td>
<td>0.396</td>
<td>0.857</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Dpr Mng</td>
<td>0.798</td>
<td>0.677</td>
<td>0.183</td>
<td>0.258</td>
<td>0.595</td>
<td>0.298</td>
<td>0.823</td>
<td></td>
</tr>
<tr>
<td>Career Commitment</td>
<td>0.870</td>
<td>0.627</td>
<td>0.333</td>
<td>0.202</td>
<td>0.288</td>
<td>0.130</td>
<td>0.259</td>
<td>0.792</td>
</tr>
</tbody>
</table>

R²=0.298
FIGURE 22
Ideal Self Influence for Women on Engagement and Career Commitment for Job as Engineering Manager n=125

TABLE 29
Correlation Table for Ideal Self Influence for Women for Job as Engineering Manager n=125

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>IS Hope</th>
<th>IS S of P</th>
<th>IS Holistic Vision</th>
<th>IS Fun</th>
<th>IS Dpr Meaning</th>
<th>Career Commitment</th>
<th>Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.845</td>
<td>0.411</td>
<td>0.641</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS S of P</td>
<td>0.699</td>
<td>0.407</td>
<td>0.498</td>
<td>0.638</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Hol Vis</td>
<td>0.752</td>
<td>0.442</td>
<td>0.236</td>
<td>0.381</td>
<td>0.665</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Fun</td>
<td>0.849</td>
<td>0.737</td>
<td>0.259</td>
<td>0.463</td>
<td>0.366</td>
<td>0.858</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Dpr Mng</td>
<td>0.786</td>
<td>0.663</td>
<td>0.159</td>
<td>0.376</td>
<td>0.602</td>
<td>0.365</td>
<td>0.814</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career Commitment</td>
<td>0.870</td>
<td>0.626</td>
<td>0.258</td>
<td>0.066</td>
<td>0.258</td>
<td>0.112</td>
<td>0.214</td>
<td>0.791</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>0.963</td>
<td>0.636</td>
<td>0.448</td>
<td>0.284</td>
<td>0.258</td>
<td>0.164</td>
<td>0.089</td>
<td>0.417</td>
<td>0.797</td>
</tr>
</tbody>
</table>

FIGURE 23
Ideal Self Influence for Women on Career Commitment for Job as Engineering Manager n=125
### TABLE 30
Correlation Table for Ideal Self Influence for Women for Job as Engineering Manager n=125

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>IS Hope</th>
<th>IS S of P</th>
<th>IS Holistic Vision</th>
<th>IS Fun</th>
<th>IS Dpr Meaning</th>
<th>Career Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.812</td>
<td>0.363</td>
<td>0.602</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS S of P</td>
<td>0.570</td>
<td>0.329</td>
<td>0.152</td>
<td>0.574</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Hol Vis</td>
<td>0.651</td>
<td>0.373</td>
<td>0.257</td>
<td>0.454</td>
<td>0.611</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Fun</td>
<td>0.846</td>
<td>0.734</td>
<td>0.175</td>
<td>0.484</td>
<td>0.396</td>
<td>0.857</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Dpr Mng</td>
<td>0.798</td>
<td>0.677</td>
<td>0.183</td>
<td>0.258</td>
<td>0.595</td>
<td>0.298</td>
<td>0.823</td>
<td></td>
</tr>
<tr>
<td>Career Commitment</td>
<td>0.870</td>
<td>0.627</td>
<td>0.333</td>
<td>0.202</td>
<td>0.288</td>
<td>0.130</td>
<td>0.259</td>
<td>0.792</td>
</tr>
</tbody>
</table>

### FIGURE 24
Ideal Self Influence for Women on Engagement and Career Commitment for Job as High Level Management n=67

![Diagram showing correlation between IS Hope and Career Commitment](attachment:image)

**R²=0.230***

**R²=0.541**

### TABLE 31
Correlation Table for Ideal Self Influence for Women for Job as High Level Management n=67

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>IS Hope</th>
<th>IS S of P</th>
<th>IS Holistic Vision</th>
<th>IS Fun</th>
<th>IS Dpr Meaning</th>
<th>Career Commitment</th>
<th>Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.845</td>
<td>0.411</td>
<td>0.641</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS S of P</td>
<td>0.699</td>
<td>0.407</td>
<td>0.526</td>
<td>0.638</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Hol Vis</td>
<td>0.752</td>
<td>0.442</td>
<td>0.496</td>
<td>0.494</td>
<td>0.665</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>0.849</td>
<td>0.737</td>
<td>0.406</td>
<td>0.403</td>
<td>0.527</td>
<td>0.858</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>IS Dpr Mng</td>
<td>0.786</td>
<td>0.663</td>
<td>0.228</td>
<td>0.102</td>
<td>0.415</td>
<td>0.397</td>
<td>0.814</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career Commitment</td>
<td>0.870</td>
<td>0.626</td>
<td>0.354</td>
<td>0.311</td>
<td>0.337</td>
<td>0.199</td>
<td>0.316</td>
<td>0.791</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>0.963</td>
<td>0.636</td>
<td>0.619</td>
<td>0.599</td>
<td>0.477</td>
<td>0.341</td>
<td>-0.015</td>
<td>0.310</td>
<td>0.797</td>
</tr>
</tbody>
</table>
FIGURE 25
Ideal Self Influence for Women on Career Commitment for Job as High Level Management n=67

TABLE 32
Correlation Table for Ideal Self Influence for Women for Job as High Level Management n=67

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>AVE</th>
<th>IS Hope</th>
<th>IS S of P</th>
<th>IS Holistic Vision</th>
<th>IS Fun</th>
<th>IS Dpr Mng</th>
<th>Career Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS Hope</td>
<td>0.812</td>
<td>0.363</td>
<td>0.602</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS S of P</td>
<td>0.570</td>
<td>0.329</td>
<td>0.473</td>
<td>0.574</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Hol Vis</td>
<td>0.651</td>
<td>0.373</td>
<td>0.450</td>
<td>0.447</td>
<td>0.611</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>IS Fun</td>
<td>0.846</td>
<td>0.734</td>
<td>0.364</td>
<td>0.248</td>
<td>0.488</td>
<td>0.857</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS Dpr Mng</td>
<td>0.798</td>
<td>0.677</td>
<td>0.383</td>
<td>0.079</td>
<td>0.378</td>
<td>0.381</td>
<td>0.823</td>
<td></td>
</tr>
<tr>
<td>Career Commitment</td>
<td>0.870</td>
<td>0.627</td>
<td>0.412</td>
<td>0.323</td>
<td>0.359</td>
<td>0.193</td>
<td>0.325</td>
<td>0.792</td>
</tr>
</tbody>
</table>

TABLE 33
Summary of Hypotheses and Findings

<table>
<thead>
<tr>
<th>HYPOTHESES</th>
<th>Supported</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1a</strong> Ideal Self has + effect on career commitment (Hypothesis)</td>
<td>Yes</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>IS Fun has – effect on career engagement (Finding)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H1b</strong> Ideal Self has + effect on engagement (hypothesis)</td>
<td>Yes</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>IS Hope &amp; IS Sense of Purpose has + effect on engagement</td>
<td></td>
<td>ISHope p&lt;0.05 IS S of P</td>
</tr>
<tr>
<td><strong>H2a</strong> Self efficacy has + effect on career commitment</td>
<td>Partially</td>
<td>Mediated</td>
</tr>
<tr>
<td><strong>H2b</strong> Ideal Self mediates self efficacy and career commitment</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>* Hope fully mediates the effect of self efficacy on career commitment</td>
<td></td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>* Self efficacy has a + effect on identity.</td>
<td></td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td><strong>H3a</strong> Self efficacy has + effect on engagement</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>H3b</strong> Ideal self mediates the relationship between self efficacy and engagement</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td><strong>H4a</strong> Optimism has + effect on career commitment</td>
<td>Indirectly</td>
<td></td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Statement</td>
<td>Supported</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>H4b</td>
<td>IS Fun fully mediates optimism and career commitment.</td>
<td>Yes</td>
</tr>
<tr>
<td>*</td>
<td>Hope fully mediates optimism and career commitment.</td>
<td>Yes</td>
</tr>
<tr>
<td>H5a</td>
<td>Optimism has + effect on career engagement.</td>
<td>No</td>
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<tr>
<td>H5b</td>
<td>IS Hope &amp; IS Sense of Purpose fully mediate optimism and engagement.</td>
<td>Yes</td>
</tr>
<tr>
<td>*</td>
<td>Hope fully mediates optimism and engagement.</td>
<td>Yes</td>
</tr>
<tr>
<td>H6a</td>
<td>Hope has + effect on career commitment.</td>
<td>Yes</td>
</tr>
<tr>
<td>H6b</td>
<td>IS Fun partially mediates hope and career commitment.</td>
<td>Yes</td>
</tr>
<tr>
<td>H7a</td>
<td>Hope has + effect on engagement.</td>
<td>Yes</td>
</tr>
<tr>
<td>H7b</td>
<td>IS Hope &amp; IS Sense of purpose partially mediate the relationship between hope and engagement.</td>
<td>Yes</td>
</tr>
<tr>
<td>H8a</td>
<td>Identity has + effect on career commitment for engineers.</td>
<td>Indirectly</td>
</tr>
<tr>
<td>H8b</td>
<td>IS Fun mediates the relationship between identity and career commitment.</td>
<td></td>
</tr>
<tr>
<td>H9a</td>
<td>Identity has + effect on engagement for engineers.</td>
<td>Indirectly</td>
</tr>
<tr>
<td>H9b</td>
<td>IS Hope &amp; IS Sense of Purpose mediate the relationship between identity and engagement.</td>
<td>Yes</td>
</tr>
<tr>
<td>H10</td>
<td>Leader-Member Exchange has + effect on career commitment.</td>
<td>Indirectly</td>
</tr>
<tr>
<td>H11</td>
<td>Leader-Member Exchange has + effect on engagement.</td>
<td>Yes</td>
</tr>
<tr>
<td>*</td>
<td>Leader-Member Exchange partially mediates hope &amp; engagement</td>
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</table>

### Additional Analyses

**Women Only**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statement</th>
<th>Supported</th>
<th>p-value</th>
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<tbody>
<tr>
<td>H12</td>
<td>Self efficacy will be higher for women employed as engineers over 40 than for women under 30.</td>
<td>Yes</td>
<td>p&lt;0.01</td>
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<tr>
<td>H13</td>
<td>Age and number of children will influence a woman’s career commitment to engineering.</td>
<td>Yes</td>
<td>p&lt;0.05</td>
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</table>

**Comparing Men to Women**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statement</th>
<th>Supported</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>H14</td>
<td>Self efficacy will be less influential on career commitment for men than for women.</td>
<td>Yes</td>
<td>p&lt;0.001</td>
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<tr>
<td>H15</td>
<td>Leader member exchange will be less influential on career commitment for men than for women.</td>
<td>Yes</td>
<td>p&lt;0.05</td>
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<tr>
<td>H16</td>
<td>Age and number of children will be less influential on career commitment for men than for women.</td>
<td>Yes</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------------------------------------------------</td>
<td>-----</td>
<td>---------</td>
</tr>
<tr>
<td>H17</td>
<td>The articulation of the ideal self will be less influential on career commitment for men than for women.</td>
<td>Yes</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>H18</td>
<td>Work engagement is less likely to influence a man's career commitment to engineering.</td>
<td>Yes</td>
<td>p&lt;0.001</td>
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</table>

**Men Only (not Hypothesized)**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Leader-Member Exchange has + effect on career commitment.</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Age has + effect on career commitment.</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Work engagement has + effect on career commitment</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>IS Hope has a + effect on work engagement</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>
CHAPTER V: DISCUSSION

Summary of Findings

Women Engineers

*The ideal self.*

- A construct has been developed to measure one’s ideal self which is one’s personal vision. A five factor solution comprised of IS Hope, IS Deeper Meaning, IS Holistic Vision, IS Fun and IS Sense of Purpose has been found that is reliable and valid.
- The ideal self construct is comprised of hope and identity where hope has been found empirically to be comprised of self efficacy and optimism.

*The ideal self and women’s persistence in engineering.*

- Women who discussed engineering in terms of their ideal self were more likely to persist in an engineering career, where women who expressed conflict between their work as an engineer and their home life were more likely to leave engineering.
- A woman engineer’s ideal self impacts her career commitment to engineering.
- A woman engineer’s ideal self impacts her work engagement.
- For women in high level management positions the IS Hope construct explains more than 50% of the variation in work engagement and 25% of her commitment to engineering.
- For women engineers who are individual contributors the IS Hope and IS Sense of Purpose constructs explain 36% of the variation in work engagement. IS Hope explains 30% of the variation in career commitment to engineering.
**Self efficacy and identity as components of the ideal self.**

- Self efficacy levels distinguish between those women who persist in an engineering career and those who opt-out of an engineering career.
- Self efficacy has a statistically significant relationship to career commitment for women engineers but not for men engineers.
- Self efficacy is greater and statistically significantly different for older women engineers than for younger women engineers.
- In the structural equation model developed for women’s career commitment to engineering, hope fully mediates the impact of self efficacy on career commitment to engineering for women engineers.
- Women who expressed an engineering identity were more likely to persist in an engineering career.
- Identity impacts one’s personal vision as measured by the ideal self constructs of IS Fun, IS Hope and IS Sense of Purpose.
- IS Fun, IS Hope and IS Sense of Purpose all fully mediate the impact of identity on a woman’s career commitment to engineering.

**Real self and women’s career commitment to engineering work environment.**

- Women who persisted in engineering explained their reasons for staying in engineering in terms of fulfillment, novelty and challenges.
- Work engagement is the strongest predictor of women’s career commitment to engineering in the structural equation model.
- A woman’s relationship with her leader impacts her career commitment to engineering.
Age and children.

• The interaction of age and children has an impact on woman’s career commitment to engineering. Younger women with fewer children have higher levels of career commitment to engineering which decreases as they age. Women with more children are less committed to engineering no matter their age.

• Neither age nor number of children has a statistically significant impact on a woman’s career commitment to engineering.

Adapting and learning.

• Both women who persisted in engineering and those who opted out discussed issues with the male-dominated work environment. Women who persisted in engineering were more likely to have adapted to the workplace.

Resonant relationships.

• A woman’s relationship with her leader impacts her career commitment to engineering.

Men Engineers

The ideal self.

• The ideal self as modeled as a five factor construct for the sample of men shows that convergent validity has been established for the IS Hope, IS Sense of Purpose and IS Fun. Further reliability has been established for IS Hope, IS Sense of Purpose, IS Fun and IS Deeper Meaning.
The ideal self and men’s persistence in engineering.

- IS Hope has been found to positively influence work engagement for men and work engagement positively influences career commitment to engineering.

Real self and men’s career commitment to engineering work environment.

- Work engagement is the strongest predictor of men’s career commitment to engineering.
- A man relationship with his leader impacts his career commitment to engineering.

Age and children.

- Age but has a statistically significant impact on a man’s career commitment to engineering.

Resonant relationships

- A man’s relationship with his leader impacts his career commitment to engineering.

Gender Differences

- There is no statistically significant relationship between a man’s ideal self and his career commitment to engineering.
- Work engagement is less likely to influence a man’s career commitment to engineering than it is for women engineers.
- Only age had a statistically significant impact on a man’s career commitment to engineering, older men had more commitment.
- For men the relationship with a leader is less influential on career commitment to engineering than for women.
Model for Career Persistence

A framework is proposed that integrates the findings from the mixed method study on why women persist in the engineering profession (Figure 26) by adapting the intentional change theory (Boyatzis, 2008).

The mixed method approach used in this study has incorporated results from both the interviews and the multivariate analysis to develop the model in Figure 26 that incorporates several features of complex systems including the non-linear nature of behavior, the role of tipping points or discontinuities, and multiple levels related to the behavior.
Adapted from Boyatzis’ (2008) intentional change theory (ICT), the model presented explains persistence in an engineering career for women and like the ICT the model includes five discoveries. Here the five discoveries are: the ideal self, the real self, career persistence, learning and adapting, and resonant relationship. At the individual level the ideal self is comprised of hope and identity where hope includes self efficacy and optimism. The real self in the career persistence model includes the reality and day-to-day functioning within work and life situations. The real self in the model includes the job itself and the level of work engagement. Also included in the real self is the family situation including spouse and children. Resonant relationships include those within the family and within the organization including the relationship a woman’s has with her manager.

The model has been developed to integrate the findings including those from women who were interviewed in the initial study who discussed complex and multi-level issues to explain their choices over the course of their careers. For both women who persisted and women who opted out of engineering there were a number of discontinuities discussed in terms of an engineering career. As argued by Boyatzis (2008) in discussing leadership development, current methods available that attempt to predict performance use statistical procedures that assume continuity as done in the development of the structural equation models in Figures 13 and 19. These models capture multiple variables related to persistence in an engineering career but cannot explain the adaptation discussed by women in the interviews such as adjusting to a new job or the tipping points leading to leaving the profession or the learning involved with balancing a family with a career.
The multivariate analysis confirmed that the ideal self is comprised of hope and identity and that a combination of factors including those inherent in an individual such as self efficacy and identity, as well as contextual factors like work engagement and age impact career commitment to the engineering profession. However as we found in the interviews a recursive relationship exists between the ideal self and the real self and where there is a discontinuity women will exit engineering.

Career persistence results from the interaction between the ideal self and the real self. While persisting in a career, women who learn and adapt continue to develop their identity and self efficacy within an engineering career which impacts the ideal self. Resonant relationships especially with one’s manager and with those in their home environment support persistence.

Where we found that persistent engineers desired and expected to maintain their professional status in the future Boyatzis (2008) posits that the intent to sustain a current state such as a career can be explained by intentional change theory (ICT). Because a career may drift into a less desired state and be susceptible to external or internal forces of change, intentions to sustain it require investment of energy. Using complexity theory to illustrate the discontinuous nature of change, Boyatzis argues that discontinuities may jolt one out of equilibrium. Gladwell (2000) described this jolt as a tipping point.

The concept of a tipping point and the recursive nature of the dynamic between the ideal self and the real self is useful in explaining the women who chose to opt out of engineering. The women we interviewed who left engineering described a tipping point that forced a realization that their engineering careers were not aligned with their personal and/or professional aspirations. These tipping points included the birth of a
child, the death of a parent, a new manager, a company-wide reorganization, or the effects of a hostile work environment. In each case the tipping point resulted in an exit from the profession to pursue another, presumably more ideal self.

Contrarily, although there is evidence of personal and professional discontinuities in the narratives of our persistent engineers, these did not jolt them to reconsider their careers. The experience of one woman who had twice lost her engineering job but persistently pursued another demonstrates that the desire to maintain a current state requires investing energy to countermand unwanted, externally motivated change (Boyatzis, 2008. Quotes on these tipping points are included in Appendix A.

The Ideal Self and Women in Engineering

The women who persisted in engineering exude hope, have a clear image of how their career fits their future state and view engineering as part of their core identity. These women were able to articulate a personal vision which included their professional experience as an engineer. As posited by Boyatzis & Akrivou (2006) the ideal self is comprised of one’s image of a desired future, core identity and hope and further, the ideal self leads to a personal vision.

An important outcome from these research efforts is not only the development of an empirical method to measure one’s ideal self but a finding that the ideal self influences a woman’s persistence in engineering. The ideal self is one’s motivational function that is individually conceptualized and socially influenced (Boyatzis & Akrivou, 2006). An individual’s will is activated through the ideal self particularly as it relates to progress toward a goal or behavior related to one’s purpose. Decisions to sacrifice or to deal with difficulties in the shorter term are explained in that they are important in accomplishing
longer term goals. The women interviewed in our study discussed difficulties in the male-dominated workplace but were able to recognize how much to adapt and/or to tolerate in order to obtain longer fulfillment and satisfaction term in their career.

This study has provided empirical support for Boyatzis & Akrivou (2006) theory that the ideal self is comprised of hope and core identity. As hypothesized by Boyatzis & Akrivou, hope has been found to be influenced by self efficacy and optimism. Self efficacy is believed to aid in determining one’s perception of possibilities, and optimism is believed to cause hope. Those who have higher levels of hope produce alternatives in meeting their goals, particularly when experiencing difficulties in achieving these goals.

Hope is described as the affective driver of change by Boyatzis & Akrivou (2006) and when one experiences hope there is positive emotion which is central to the power of the ideal self. As detailed in the results, this study provides robust support that hope is influenced by both self efficacy and optimism. For those without hope, commitment decreases.

Boyatzis (2008) argues that people who produce alternative routes when facing obstacles to goals are said to have high hope. We found references to hope abundant in stories persistent engineers told about dealing with male dominated organizational cultures but notably absent in the stories proffered by our exited engineers. Persistent women engineers not only recognized that they needed to be creative in handling situations in the context of their work culture but were able to cleverly manipulate situations to ensure positive outcomes for themselves.

Core identity is theorized by Boyatzis & Akrivou (2006) as the compilation of one’s enduring dispositions including unconscious motives, traits and roles. The ability
to create a clear image of a desired future is related to one’s ability to be aware of and to articulate one’s identity. Interestingly in our interviews with women who persisted in engineering we heard these women described themselves in engineering language, as analytical and curious. The women who opted out described conflict between their image of themselves and their role as an engineer. In order to develop a meaningful and useful ideal self according to Boyatzis & Akrivou (2006) three criteria are necessary: mindfulness, salience, and coherence. The usefulness of the ideal self construct can aid in the mindfulness criteria.

The articulation of one’s ideal self leads to a personal vision (Boyatzis & Akrivou, 2006). In some cases the discovery of an ideal self occurs as a surprise and may cause a disruption with the current state and lead to different aspirations. The ideal self may then provoke an adaptation process to achieve intentional change. It is from this concept that Boyatzis (2008) recommends the development of a personal vision to drive intentional change. Using a strength-based approach to development focuses only on the core identity component of the ideal self but does not allow for the hope component to draw in new possibilities. Coaches with an awareness of the components of the intentional change theory work to develop a well-articulated ideal self leading to a personal vision. Positive visions of the future are important in guiding future behavior.

The image of the desired future is explained by Boyatzis & Akrivou (2006) to be influenced by one’s values and philosophy, life stage, and calling in life. Important identity groups such as the family, as well as one’s history and enduring dispositions create and nurture values and philosophy. Awareness of one’s passion makes one feel as if life is worth living by fulfilling a calling in life (Boyatzis & Akrivou, 2006).
Self Efficacy and Women in Engineering

Although knowledge and skills are necessary to perform an accomplishment, self-referent thought mediates the relationship between knowledge and action (Bandura, 1982) and how individuals judge their capabilities impacts their motivation and behavior. Undoubtedly all the women in our study had the knowledge and skills necessary to be an engineer as evidenced by their engineering degree(s) as well as their own ability to work as an engineer. In the interviews, the women who persisted in engineering discussed the novelty and challenges associated with their engineering careers as their motivation to stay. The women who left discussed their need to find fulfillment outside of engineering, some because of the work itself, others because they realized another calling such as teaching.

Numerous studies have proven that self efficacy is developed and can be improved by one or a combination of four mechanisms: performance accomplishments, vicarious experience, verbal persuasion and psychological states (Bandura, 1977, 1982). Hackett & Betz (1981) posited that especially for women the strength and level of efficacy expectations are important in understanding career development and further studies found that interventions were successful in women persisting in undergraduate engineering programs (Betz & Hackett, 1997; Betz & Schifano, 2000; Hackett & Betz, 1989; Hackett et al., 1992). The identification of the role of self efficacy with career decisions has important implications in the discussion to retain female talent not only in engineering but in other professions.

For those women who opted out of engineering we found that their lower levels of self efficacy within their engineering career and their own admission that they did not
find fulfillment within engineering led to their choice to leave their career. A woman’s choice to persist or opt-out of male-dominated professions have been discussed in terms of voluntary decisions by some researchers, but underlying societal determinants need to be understood related to these decisions (Cech et al., 2011). The perceptions of one’s capabilities are differentially biased by cultural beliefs and gender according to Correll (2004). Developing an understanding of the underlying processes related to a woman’s persistence in engineering can aid in improving the retention of women in STEM professions.

Most research on women persisting in male-dominated professions especially in the social and psychological literature dismisses those factors that relate directly to how a woman experiences the profession itself according to Cech et al. (2011). Instead most research is focused on how the internalization of cultural beliefs impacts skills and competencies. Cech et al. (2011) theorize that within a professional socialization process, women and men will develop different levels of role confidence.

This concept of professional role confidence has been introduced by (Cech et al., 2011) as it relates to gendered persistence in engineering where professional role confidence is described as an ability to not only successfully perform the professional role but to also find enjoyment and fulfillment in this role. In their recent study on both behavioral and intentional persistence in undergraduate studies Cech et al. (2011) found that neither family plans nor math assessment scores predicted persistence. However both dimensions of persistence in undergraduate studies were found to be significantly associated with professional role confidence, where men are able to develop this more
successfully in undergraduate programs than women. The absence of professional role confidence contributes to a woman’s opting out of undergraduate engineering studies.

Where Cech et al. (2011) used professional role confidence to explain persistence in undergraduate engineering, the concept of professional role confidences clearly blends self efficacy within engineering with work engagement in an engineering role providing further support for our model of persistence in the engineering profession.

Our findings show that women over 40 who continue to be employed in an engineering career have higher levels of self efficacy than women under 30 in an engineering career. Further women overall have a lower level of self efficacy than men. The application of self efficacy to career decision began with the seminal work of Betz & Hackett (1981) who compared self efficacy expectations for men and women related to different career choices. By far the career with the most divergence between men and women was engineering where other professions such as law and medicine showed no statistically significant difference related to gender.

This study used a broad measure of self efficacy and determined that there were differences related to gender, and that women reported lower levels of self efficacy than men. The common link between the groups in our study was an engineering degree and this work along with Betz & Hackett (1981) suggest that women who choose engineering careers may have lower levels of self efficacy expectations than women who may choose a different profession such as law or medicine. We consider this finding remarkable as these women have all successfully completed at least an undergraduate program in engineering.
Bandura (1977, 1982) explains that self efficacy expectations are likely due to socialization which in the case of women in engineering could be impacted within their careers or as part of their experiences growing up. Undoubtedly all the women in our study had the knowledge and skills necessary to be an engineer as evidenced by their engineering degree(s) as well as their own ability to work as an engineer as 83% of women in this study were currently working as an engineer.

**Adaptation and Learning for Women in Engineering**

For the women interviewed in our study, those who persisted identified as an engineer and were able to adapt to improve the fit of the engineering profession to them. In the structural equation model developed from the survey of people with engineering degrees we showed that for women identity impacted career commitment.

Ibarra’s (1999) discussion of provisional selves provides support for the model of career persistence and helps to explain how some women persist while others opt-out. Ibarra (1999: 765) describes identity as the “constellation of attributes, beliefs, values, motives and experiences in terms of which people define themselves.” Professional identity has been discussed in relation to career and career transitions by Ibarra (1999) where she hypothesizes that adaptation processes shape identity formation within careers and especially during career transitions where various selves are tested for possible or provisional use. Adaptation is used to improve the fit between a person and the work environment with identity changing over time as difficulties and demands of roles impact one’s notion of identity.

The proposed model for career persistence has been framed using similar arguments as Ely et al. (2011) who offer a framework for women’s leadership
development. Based on theories related to both gender and leadership, this framework shows how “gender shapes women’s path to leadership without either victimizing or blaming women” (Ely et al., 2011: 475). Powerful but invisible barriers exist that limit women’s opportunities because of cultural beliefs about gender, workplace structure and patterns that inadvertently favor men – so-called second generation forms of gender bias. To overcome this bias women are encouraged to construct and internalize a leadership identity while in the process of becoming a leader. Developing as a leader is identity work and subtle forms of gender bias impact a woman’s ability to develop an identity as a leader.

Our study provides support for theorizing that an ability to develop an identity as an engineer within one’s ideal self leads to persistence in an engineering career. In the same way that Ely et al. argue that this gender bias impacts a woman’s ability to see themselves as leaders we argue that as engineering is almost always associated with men and engineering is male-dominated women may have difficulty constructing and internalizing an identity as an engineer.

Because our study focused on discovering the characteristics of persistent engineers we found that the women in our study adapted and experienced engineering in a manner which aided the development of an identity of an engineer. The persistent women developed an identity as an engineer through the ability to adapt and collaborate, and were able to align professional and personal aspirations.

Real Self of Women in Engineering: Work Engagement and Work-Life Balance

While numerous studies on women in STEM careers identify the cultural aspects leading to women opting out of these professions (Fouad & Singh, 2011; Frehill, 2008;
Hewlett et al., 2008), this is one of few studies that use both qualitative and quantitative analysis to show that there is a relationship between the relational culture of engineering and the career commitment of women to the profession. These findings indicate that a manager can help to negate the deleterious effect of engineering’s male dominated culture on women’s retention by providing support and understanding.

While out-opting engineers interviewed in the first study viewed family and work as antagonistic commitments, persistent engineers saw them as competing but compatible goals. For many of the former they discussed a stark either/or choice and opted out of their engineering careers because they understood them to compete with personal life goals. But women who persisted in engineering, skillfully manipulated work environments or circumstances to accommodate both goals, often assuming new or different responsibilities, changing jobs altogether or finding new employers. The persistent engineers saw unrelenting opportunity in their professional futures, assured, despite decades in the field, that they would continue to find novelty in their work. The same level of optimism or preoccupation with novelty (fascination, for example, with new technologies or new product development or work that they had never before done) was not found in the out-opting group. Persistent engineers also described on-going challenges and the desire to learn continuously.

The persistent women engineers discussed being highly connected to their occupations and strongly engaged in their work. The link between work engagement and career persistence in engineering was supported by the quantitative analysis. Here work engagement was found to have the strongest impact on career commitment to engineering
and career commitment to engineering has been shown to be associated with persistence in the professions.

Kahn (1990), credited with first defining the term engagement in a work role, states that personal engagement is the degree to which people bring in their own selves while performing work tasks. While engaged at work, employees express themselves physically, cognitively, and emotionally while performing work roles.

Research on job engagement is relatively new (Saks, 2006) and most of the studies are focused on organizational benefits (Wildermuth & Pauken, 2008) and come mostly from practitioners and consulting firms (Saks, 2006). But in developing an empirical model for engagement Saks found that perceived supervisor support is an antecedent of employee engagement while Bakker and Demerouti (2008) theorized that supervisory coaching predicted engagement as did individual factors or personal resources.

These finding indicated that engaged managers are essential to retaining women in the engineering profession. Clawson and Haskins (2000) discuss how wise managers take the time to examine and assess their own engagement as well as their employees’ engagement. Reward systems and decision making processes are especially salient in an examination of workplace systems that could impact an employee’s engagement and retention in the profession.

As discussed previously, the ideal self is the manifestation of one’s dreams and aspirations and lead to one’s personal vision (Boyatzis & Akrivou, 2006). Dreams and aspirations are central to achieving one’s potential (Clawson & Haskins, 2000) and are the source of motivation (Boyatzis, 2008). Bakker and Demerouti (2008) argue that
positive self evaluations predict goal-setting, motivation, and other advantageous outcomes providing support for the recursive nature of the relationship between the real self and the ideal self especially in terms of discussing women’s persistence in an engineering career.

Higher levels of individual resourcefulness lead to congruence between goals and achievements (Bakker & Demerouti, 2008). Optimism and self-efficacy have been acknowledged as some of these personal resources and hope relates to goals and the identification of strategies to achieve these goals (Gallagher & Lopez, 2009).

For women with engineering degrees, an interesting relationship has been established between job engagement and career commitment in terms of the quantitative analysis. With the finding from the interviews that women who persisted in an engineering career described their reasons for persisting in terms of their challenging work assignments and engagement in the work affords opportunities for retention programs for women in engineering.

**Resonant Relationship**

Persistent women engineers described themselves as strikingly other-oriented in that the relational aspect of their core identity is strongly emphasized. The importance of work relationships with peers, superiors and subordinates is central to these women. They take pleasure in and are sustained by their interactions with and ability to support others.

O’Neill and Bilimoria (2005) and Mainiero & Sullivan (2005) discuss women’s careers as relational with women making career decisions considering the impact of these decisions on others. In in the narratives of persistent engineers we found ample evidence of consideration of others that was linked to expressions of career fulfillment.
Empirical results also support the role of resonant relationships for women in engineering careers. The role of the relationship between women and their immediate manager has been shown to impact career commitment to engineering.

Our finding that the interaction of age and children impacts a women’s commitment to engineering supports the Kaleidoscope career model (Mainiero & Sullivan, 2005) as to how women career decisions include their significant relationships. While career commitment overall is lower for women with more children the level does not change much with age. For women with fewer children, career commitment to engineering decreases with age.

**Gender Differences**

The work engagement finding, specifically that work engagement is more influential on a women’s commitment to engineering than for men is supported by the Kaleidoscope career model. KCM discusses women who strive to obtain great job challenge and personal fulfillment which in the case of engineering may help explain why women do not persist in careers. As discussed in several studies women are not always being given the opportunities for challenges with the scope of their career (Frehill, 2008; Hewlett et al., 2008).

The relationship with the first level manager was found to be more impactful for women and her commitment to engineering than for men. The US Bureau of Labor Statistics reports than 93% of engineering managers are men and we have no reason to believe that this statistic will change greatly in the future. The theory of gendered organizations helps us to understand the finding as discrimination within organizations as male managers continue to make decisions that propagate organizational differences due
to gender (Acker, 1990). While the “glass ceiling” metaphor had been used in the 1980’s to explain gender differences in obtaining equality in corporate leadership (Eagly & Carli, 2007) argue that times have changes. In today’s world, women face a series of many obstacles including subtle versus overt discrimination and the demands of family life. To counteract these obstacles Eagly & Carli (2007) recommend interventions within corporations that address the issues including increasing awareness of prejudice towards women professionals including the subjectivity of performance evaluations, use of open recruitment methods to fill leadership positions, and the establishment of family friendly human resource policies.

For men we found that there is no relationship between the number of children nor the interaction of age and children on career commitment to engineering, however there is an influence of age. We found that career commitment to engineering increases as a man ages which can also be explained by the Kaleidoscope career model as Mainiero & Sullivan (2005) posit that men’s careers are more likely to be linear and related to their own specific industry.
CHAPTER VI: CONCLUSIONS

Women’s persistence in the engineering profession can be explained as a complex system which includes non-linear behavior and discontinuities over multiple levels including individual, family, occupational and organizational. A model describing women’s persistence in an engineering career has been presented that is an adaptation of the intentional change theory (Boyatzis, 2008).

The findings from this study show that the reasons women persist in engineering are not the opposite of those reasons other researchers have identified as why women opt out. Other researchers have found that the cultural aspects of an engineering career cause women to leave the profession. Our findings validate previous research in that the environment of engineering impacts a woman’s persistence in the profession but we further demonstrate that individual characteristics as well as one’s family environment also are influential in persistence.

Summary of Contributions

1. The development and validation of a construct to measure the ideal self that supports the theory as proposed by Boyatzis & Akrivou (2006).

2. The utilization of the ideal self construct in a study that identifies factors for women persisting in engineering.

3. The development of a structural equation model that defines the factors relating to women persisting in the engineering profession.

4. Validation that the factors important to women’s persistence in engineering are different from their male colleagues.

5. The development of a theoretical model that integrates the findings from both qualitative and quantitative research to explain career persistence for women in engineering. The model has potential to explain career persistence in other male-dominated professions.
Study Limitations

Pertinent literature has been meticulously reviewed and well documented methods to present a sound theoretical model have been used, however several limitations to this study should be noted. The data used to develop the model was all self reported. A rigorous methodological approach of theory testing has been adopted that seems to confirm the adequacy of the measurement of the ideal self. However, no psychometric technique can adequately address the completeness or breadth of measurement. Therefore it is entirely possible that other dimensions of the ideal self exist but are not conceptualized in the present model.

Implications for Research

A theoretical model that integrates the findings from a mixed methods study has been developed that explains a woman’s persistence in an engineering career. This model provides rich insight into women in engineering and has potential for application in numerous research related undertakings.

First there is potential to explain persistence in other professions that are male-dominated. A study is recommended using a survey method to corroborate these findings for women in other STEM professions. The entire research area related to women’s careers particularly in understanding advancement as well as barriers may benefit from including the model and findings from the current study.

Next there are international implications for researchers. The woman in these studies all lived and worked within the United States. It is recommended that an international study be undertaken to compare these findings to women in other countries to determine if persistence for women in engineering is explained by the same factors as
within this study. International comparisons could aid in identifying societal differences that are important in career persistence. Additionally an international study would provide insight into factors associated with institutional support, such as child care, that may support persistence for women in engineering and other careers.

Another comparison study is recommended for those professions where women have obtained a higher share of those employed, for example physicians, lawyers, or news reporters. It would be interested to determine if both individual and contextual factors play a role in the persistence of women in these other professions as found here with women in engineering.

Additional opportunities for future research include the further development of the ideal self construct as well as continued development of the model for women’s persistence in engineering and other STEM or male dominated professions. It is recommended that researchers continue to explore reasons why women persist in a male-dominated profession and how individual factors such as self efficacy and adaptability are developed within these professions.

Researchers should continue to explore how individuals develop skills within a profession especially for STEM women. Studies should explore the relationships between the factors uncovered in this study.

Discerning how women engineers manage the alignment of personal and professional aspirations would be welcome contribution to the literature as would further inquiry about the role of factors constituting the ideal self in sustaining professional identity. We also recommend similar studies involving women in other STEM careers including science and technology.
The development of self efficacy and other individual factors within an engineering career has numerous opportunities for on-going work for researchers. Questions include: how do women develop self efficacy in engineering careers or in any career; does self efficacy develop within a professional domain in the same manner as for men; how does age and experience impact the development of an identity and what is the role of children and spouses in the development of personal resources.

The role of personal vision as conceptualized in this study as the ideal self provides rich opportunities as related to understanding the role of one’s career.

Especially in the developed world there is no question that men will pursue a career, the expectation is different for women. While societal expectation is usually that man will have a career and a family, there still exists significant conflict for women related to a career and a family. The data form this study shows that the conflict starts early in a girl’s life and so we recommend studies where researchers work with young girls to identify the forces related to this work-family conflict.

**Implications for Practice**

These findings provide considerable implications for retaining women in engineering and other STEM professions. These implications consider not only women engineers but include managers and educators of women engineers as well as organizations wishing to retain women engineers.

**Women Engineers**

Women in the engineering profession can use these findings to recognize how their own situation and skills may impact their retention an engineering career. Implications for women engineers include developing a personal vision, making a
conscious effort to build self efficacy and a core identity. Additionally women are encouraged to evaluate their own levels of hope and optimism. Recognizing the role of the manager and the organization can be helpful in determining the source of difficulties within a career.

A personal vision can be developed individually or with the help of a trained coach. For this study the ideal self test was developed and used as a measure of how well one could articulate a personal vision. The time frame for the vision is between 10 and 15 years in the future. Questions for developing this vision include: Where will you be in 10, 15 years? Who will be with you? What will you be doing? How important is your health? Your family? Your spiritual development? How much fun are you having?

In their book on leadership McKee, Boyatzis & Johnston (2008) provide a guided approach to developing a personal vision because as they say we become what we dream. Much like the Ideal Self Tests, narratives and exercises are used to help draw out one’s personal vision. Further McKee et al. (2008) discuss how a compelling and meaningful personal vision provides the optimism and energy to enact the vision.

Interventions may be effective in developing individual skills related to persistence in the profession. For example, numerous studies have proven that self efficacy is developed and can be improved by one or a combination of four mechanisms: performance accomplishments, vicarious experience, verbal persuasion and psychological states (Bandura, 1982).

Women are encouraged to assess their own level of self efficacy as it relates to their engineering career and also to other aspects of their lives. Further women should understand how they develop self efficacy and look for opportunities where they are in a
position to obtain the necessary feedback to continue to develop their self efficacy. As show in these studies a manager is influential in a woman’s career commitment to engineering and women are encouraged to find managers who provide the support necessary to succeed in engineering.

Women in engineering careers should assess their own skills and find opportunities to continuously improve. Society of Women Engineers and other professional organizations offer various opportunities for developing and improving individual skills. Further women engineers are encouraged to consider their work environment to ensure that opportunities for challenge and novelty continue.

Women are encouraged to be mindful of their circumstances as they choose careers, during the undergraduate process and within an engineering career. Mindfulness has been discussed in both practical and scholarly journals and it is important that women in engineering be mindful of their situation at both work and at home. Mindfulness, coming from Buddhist roots, is often defined as being actively attentive or deliberately keeping something in mind. Langer & Moldoveneau (2000) discuss mindfulness as the process of drawing novel distinctions leading to: greater understanding of one’s contextual situation, greater openness to new knowledge, the ability to perceive in new ways, and greater awareness of various perspectives when solving problems.

Educators

Opportunities for educators to use the concepts and findings from this study can be addressed at various levels including educators of young girls, high school students as well as at college and post-graduate level.
Educators in middle school and high school should focus on including girls in science and math related activities. Encouraging girls to participate in school wide challenges including Science Olympiad will aid in developing girls interests in STEM fields at an earlier age.

At an undergraduate level we recommend significant efforts be undertaken within engineering schools to inform and prepare women for a career in engineering beyond the basic degree. Educators should provide opportunities at orientation sessions to provide information on the various aspects of an engineering career. Throughout the four year process a focused and thorough plan for career success should be developed for each woman.

Based on this study the plan should include the development of individual skills such as self efficacy. Providing an opportunity to explore one’s ideal self and write a personal vision should be stressed as an important aspect of career success. Beyond the individual development, educators should focus on the dynamics women will face an engineering position.

It is also recommended that educators provide training to women as well as men engineering undergraduates of the systemic issues associated with the second-generation gender biases that exist in today’s organizations. Educators should provide opportunities that inform women entering an engineering career of the dynamics of the profession related to the male-dominated culture including reviewing the results of this study and those of other researchers. Professional skill development should be included within the undergraduate engineering curriculum.
As noted previously, vicarious experiences are shown to aid in the development of self efficacy. Educators could provide forums or seminars where women who currently work in an engineering role return to campus and discuss the engineering profession with the students. This could aid in developing the professional role confidence discussed by Cech et al. (2011). Establishing on-going mentoring programs with women in successful engineering careers can aid students in developing their own vision of work within an engineering career.

Internships where women are provided the opportunity to work during their undergraduate may also aid in the development of self efficacy related to the engineering profession.

**Parents**

Numerous streams of research discuss career choice especially for girls including psychology, child development, education and management. Since the 1980’s there has been significant research on non-traditional career choice especially related to the women and the STEM fields.

All conclude that the family is the most influential on career choices for both girls and boys. Beyond the immediate family, society in general including teachers, peers, and the media may play a role in career choice. Other factors specifically influencing career choices are abilities and interests, this notion of goal orientations, and one of my special interests is one’s self efficacy and confidence.

Parents should be made aware of their own influence on their daughter’s choices and we recommend that educators work with parents in developing programs specifically for girls focused on career choices. Encourage your daughter to pursue a passion. Let her
have a voice in making decisions. Identify the values most important to your family. Encourage her to solve issues on her own rather than fixing things for her. Get girls working together. Let your daughter know you love her because of who she is, not because of what she weighs or how she looks. Allow her to disagree with you and get angry. Make regular time to listen to your girl. Listen more than you talk. Acknowledge her struggles but keep a sense of perspective. Enjoy her!

**Managers of Women Engineers**

To reduce the influence of the cultural aspects of engineering and other STEM occupations, women entering these professions should be paired with managers who are personally engaged as a manager and have the ability to establish work systems that promote women’s engagement as an engineer. Managers should initiate conversations with employees specifically focused on aspects of job engagement as work systems can discourage and inhibit engagement.

Managers of women engineers are encouraged to consider challenging assignments for women engineers. It is recommended that these assignments provide novelty and continuous learning.

**Organizations**

This study supports the work of other researchers who suggest organizational changes necessary to retain women in engineering as well as other STEM professions (Bilimoria et al., 2008; Fouad & Singh, 2011; Hewlett, et al., 2008) (National Academies Committee on Science, Engineering, and Public Policy, 2007).

Organizations should recognize the compelling business case associated with increasing the gender diversity within all levels of the organizations including the number
of women in leadership (Catalyst, 2004; Ernst & Young, 2009; London School of Business, 2007; McKinsey & Company, 2010).

Ely et al. (2011) recommend development programs designed specifically for women in leadership as there are so-called second generation gender bias’ in today’s workplace that are powerful and invisible barriers to women’s success. Cultural beliefs and workplace structures, practices and patterns exist that can impede women’s progress by favoring men and impeding women’s ability to develop an engineering identity.

Organizations are urged to provide development opportunities for women engineers that are specifically designed to address retention. As proposed by Ely et al. (2011) these programs would allow the women to become aware of gender biases within their workplaces. Additionally the intent of the programs would be to allow for women to develop an identity as an engineer within their professional domain. Professional development has been found by (Fouad & Singh, 2011) as an important aspect of retaining women in the engineering profession.

The role of managers and colleagues has an important influence on women’s persistence in an engineering career and organizations wishing to retain women are encouraged to ensure that the support structure is in place. Employee networks may be important in developing support but informal networking opportunities such as attending conferences or projects can also aid in the development of support structures.

Organizations should recognize the importance of work engagement in retaining women engineers and as such should provide on-going opportunities for challenge, novelty, and learning.
As other researchers have suggested women’s careers are impacted by their family situations. Organizations wishing to retain women engineers should recognize the importance of families and that these women are most likely to have children. Providing flexibility and opportunities that allow for women and men to successfully integrate their work with their lives outside of work will lead to improved retention.
APPENDIX A
Details Supporting the Qualitative Study

Interview Protocol for Qualitative Study

1. Tell me about yourself and your career in engineering.
   • Degree/Year/School
   • Spouse/kids/other outside responsibilities
   • How long in engineering/technology career?
   • Which companies/how many/time at each?
   • Current position, organization and culture
   • Why engineering? (added after about 1/3 of interviews completed)

2. Thinking about the first 10 or so years of your career, tell me about your beliefs or your career expectations in the first years after graduating.
   • Did you believe you would have an on-going technical career?
   • Expectation on promotions?
   • Type of work environment?
   • Important - Co-workers? Mentors?
   • Have your beliefs changed over time?

3. Tell me about a time in your career where you were especially fulfilled in your work.
   • What were you working on?
   • Who were you working with?
   • What did you expect vs. what you got out of this work?
   • What did you think about yourself at that time?
   • Career choice and expectations?
   • Anyone else influence your choice?

4. Was there a time when things changed? When there were not so good?
   • When?
   • Why?
   • Organizational issues?
   • Occupational issues?
• Who do you seek career advice from?
  • Who helped in the decision making?
  • Did you express your concerns within your organization?

5. How do you explain your career longevity? Or why have you stayed?
   Or
   Why did you leave your engineering career?

6. During your time in engineering you must have seen many other women leave. Why
do you believe they have left?

7. What would you tell a young woman who is just starting an engineering career?
   Changed to:

   What do you believe the pros of an engineering career are?

   And what do you believe are the cons of engineering?
### TABLE A1
Summary of Respondents for Qualitative Study

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Additional Quotes from Qualitative Study

Quotes on how persistent women engineers were able to balance work and family.

“One of the things that I wanted to do was to get more of a research job because I wanted to be able to balance my work life and my home life. I think by switching companies and finding a company that allowed me, in the type of position I have, to balance the things that are important to me, it made it much easier for me to stay in this career.” (Technical Manager with two children)

“From the corporate engineering group to the (current job), one of the things that drove me was less traveling because we were traveling three, four days a week. In fact, at (my current job) I'll probably have to work longer hours, but even if I worked 7 to 5, at 5:00 pm I go home and I'm with my family, so that was a big plus. Even though you're working more hours, I'm still getting more time with my family.” (Chemical engineer with three children)

Quote on how a desired future state includes persistence in staying in an engineering career

“In ’83 there was a mini-oil crisis, and I lost my job. So I came back home ...to look for another job and I ended up entering an ad and the job turned out to be in Akron, Ohio. The job was (with X company)...they decided to close...so I lost my job... So about four weeks later, I got a call from a recruiter and that took me to (company Y)... And I spent 17 years (at company Y) doing development work, pilot work, scaling products from lab to production and production support work that went along with it. ...You learn the skills and figure out what you're good at and what you're not, because I ended up in manufacturing where everything is about your ability to communicate.” (Technical Manager)

Quotes on tipping points or wake up calls leading to their exit from engineering are vividly described in the following two narratives.

“I think you reflect upon really doing what you should be doing, and my dad passed away suddenly in May of 2005...what am I doing with my kids? What do I want to be and I really didn't feel like I was giving back enough because so much of your time is spent at work and not really concerned in serving the community... I realized I wasn't happy anymore.” (Chemical engineer now a grade school teacher)

“I was just getting really sick of it... but it felt my soul was being sucked out of me.... (Company X) is the most competitive environment I've ever, ever experienced... and there's a list of maybe 15 names, each one has a date next to it that goes back at least one name per year on this list - maybe two names in one year or something..."This is the list of the suicides in this company." ... “There's been one a year,” ...and I thought, “This is tough. It's really hard. ...The culture of the organization is just brutally ambitious, just the total brutality. ... I really had a difficult time figuring out how I fit into - how I was leaving a legacy, and that's really the answer (to why I left engineering).... I wanted to leave a legacy, and all I saw was stock prices going up and down, but because I was so detached from how what I did was affecting the world in any way, it just - that's why my soul hurt.” (Mechanical engineer now a college professor)

And then finding fulfillment in another career.

“...and every day, I see what I do at (college) and how it is helping someone... and every day, I go in, and I go in with that in my mind, and that's what I was looking for. That's what I personally needed, and I couldn't find in the corporate engineering world.” (Mechanical engineer now a college professor)
FIGURE A1
Self Efficacy and Confidence

SELF EFFICACY AND CONFIDENCE
Women who stayed in their engineering career are more likely
to express self efficacy and confidence.
Those who left are more likely to discuss self doubt.

Women Who Stayed

…my grandfather informed me my dad had started out as a
chemical engineer major and found it too difficult and
dropped out. So then I had to prove him wrong… It kind of
gave me the confidence, or at least the verification, that I
knew what I was talking about. … and all these
complicated systems, and I was able to demonstrate
knowledge and ability to present that well.
(Technical Manager with 13 years experience age 35)

(I) stand up in front … and say here’s what I think the issue
is, and here’s how I think we go about changing what we’re
doing basically, at the end of the day, come up with a
better way of lowest lifetime costs for this plant or this piece
of equipment. … So I basically approached him, told him I
was looking for some more opportunities, interested in
doing something closer to the customer, and basically, he
made a position in his group and hired me.
(Technical Manager with 28 years experience age 50)

I bought a pump, replaced one of the Sundyne pumps…
and I spent a lot of time researching it. They just put the
pump in last weekend and it’s working exactly as I thought it
would. It’s one thing to get a pump and have it work, but
everything that I figured out, what flow rates we need, what
pressures we need, what happens while we vapor lock,
why sometimes we trip the excess flow valve. … Oh, it
feels great.
(Process Engineer with 16 years experience age 38)

I purposeful progressively changed my voice to create more
of a louder voice, an aggressive voice with an aggressive
position. Not that I was being angry, but I was doing this
very purposely. And at the end, it’s like, “That’s what he
wanted.” Not that he knew to tell me that, or not that he
knew to change himself because I was a different type of
personality. He wanted somebody who could be as
aggressive and in-your-face as he was.
(Consultant with 21 years experience age 45)

…after a volleyball game - everybody went out for a
beverage, and there must have been, like, 20 people at
the table, and I just stood up and said, “Excuse me. Excuse
me. Everyone? Question. I have a degree in engineering
from Purdue University, and I need a job.” … Somebody
called me the next day. He was sitting at the table. He
called me the next day.
(Manufacturing Engineer with 19 years experience age 40)

Women Who Left

You know, when I graduated from (college), I had a tough
time finding a job. I really was low on confidence even
though I had this great engineering degree and all this stuff,
it was still tough for me to have the confidence to go and
interview.
(12 years in engineering career now a stay at home Mom
age 43)

I think I had very little confidence, and I kind of waited for
the other shoe to drop that somebody was gonna find out
that I really didn’t know what was going on, and so if I had a
boss who wasn’t confident in me, who treated me with no
respect, then I got into that completely.
(11 year engineering career now a college professor age
52)

…it was a tough year for me because it was - I had to learn
just on-the-job basically, and it was frustrating because I
didn’t know so much. And I think people expected me to
know things, and I didn’t. So it was kind of humbling
because you had to basically to acknowledge, “I don’t know
anything.”
(11 year engineering career now working in purchasing age
35)

I didn’t think I was qualified for, but since I had quality
engineering experience…they interviewed me…So hiring
me was great because they didn’t have to pay for a quality
manager … but I actually had more knowledge than I
realized for them.
(13 year engineering career now a stay at home Mom
age 35)

I wasn’t competent. My ego wasn’t being built, and it was
difficult. I just found it incredibly difficult. I felt worthless.
(10 year engineering career now a non profit director
age 48)
FIGURE A2
Other Orientation vs. Self Orientation

OTHER ORIENTATION VS. SELF ORIENTATION
Women who stayed discussed fulfilling times in their career in relation to helping others. Those who left were more likely to discuss fulfillment in relation to themselves.

Women Who Stayed

So I think working with the client areas, for me, is really fulfilling, particularly when you can see that you’re making a difference and that you’re really helping them to understand how their processes work, how they can improve it, and then you help them actually implement those processes, that you get to see those changes.
(Senior Engineer with 15 years experience age 37)

I would actually sit down with them to explain what we were trying to measure and what were our goals and what our targets and work with them to get there. Now, we had that potluck and the rah, rah, you know and when you call you do the rah, rah, cheer, cheer thing to keep people going.
(Senior Engineer with 28 years experience age 52)

So they had integrated our situation awareness with their targeting capability, and one of the things that they had noticed was there was a flight - there was a squadron of gunships that were flying missions into Afghanistan.... And my brother flies gunships and he was in Afghanistan and there’s only one active duty gunship squadron. ...So they re-vectored either my brother or somebody close to him. His - it was all his squadron.
(Consultant with 28 years experience age 50)

So just working with people, I think, and getting them ready to do that and then seeing them go out and be very successful is something that I kind of take great pride in actually.
(Technical Manager with 22 years experience age 44)

And it was just really fulfilling because you felt that at the end of the day, after you had all these meetings and you were able to come back and say, Okay, we discussed this. Let’s look at all the data. Here’s the best way to do it. It’ll solve the problem. Let’s talk about if this is the way we want to go, and get everybody to buy into it.
(Consulting Engineer with 21 years experience age 45)

Women Who Left

I was working hard. I believed you had to work hard to do good work. That was being recognized, and I was being rewarded. So that was a pattern that I was in, and I have an ego, so I also was getting that fed by being rewarded, and I needed that. I needed that in some way, shape, or form.
(10 years in engineering career now a director of a non-profit age 48)

So if I would suggest something, like, cut costs, change procedure, or do design better, you only have to talk to my boss who was the Vice President of the company, and if he found it reasonable and valuable, we would do it the next day.
(15 year engineering career now a homemaker age 52)

I think that’s the best - the most fulfilled, and it really is because I’ve got this ability to make an impact...Certainly, in the other jobs, there were the times when we’d have big meetings with lots of customers and stuff, and I’d be in front of that group. That was - I loved that. If I did that all day, I would never do anything else because that part was just so cool.
(11 year engineering career now a college professor age 52)

I just felt like I was learning so much and growing so much.
(8 year engineering career now a counselor age 40)

So the next time I came into work, one of my coworkers said, oh my gosh, she brought your report to the meeting and she said how wonderful it was. Then she came and told me I’m bringing this up to the plant manager and it’ll go to one of the manager meetings, they’ll hopefully listen to you and they’ll start doing some other things.
(14 year engineering career now a stay-at-home mom age 43)
RECOGNITION AND ADAPTATION TO CULTURE

Women who stayed have recognized the male-dominated culture and purposefully adapted to it to be successful.
Those who left discuss the culture but were passive in dealing with it.

**Women Who Stayed**

I can get the guys in the shop to do anything for me if I go to them and say, "I could really use your help." They'll help me because I'm some young girl. If I go in and tell them to do something, I'm not going to get what I want. I either use my womanly ways. I used what I thought would work in the situation to get what I wanted.
(technical manager with 24 years experience age 45)

So I figured out fairly early on that I had to do something that was not obvious to do that, but I wore sort of the severe suits. I mean, severe in terms of didn't call attention to myself. And I had long hair, and I would put that - I would pull that back so it wasn't like flying all over the place. And I would wear glasses, so I looked sort of studious.
(Consultant with 28 years experience age 50)

As a woman in engineering … I feel free to ask lots of questions. I don't walk in with the attitude that I have to know everything, and I think a lot of men who started as managers, feel that they have to come up with all the answers, or they're the big authority and they have to tell the people how to do things.
(Process Engineer with 16 years experience age 37)

And the other thing I'd advise a woman is it is a little bit of a boys' club. And it's not always, but - like the firm I'm at now is not, but some of the ones in the past you've got to figure out how to work in that environment and be okay.
(Consultant with 13 years experience age 35)

I took the exam and then I was told that I didn't get the job, but I had gotten the highest score. So, I petitioned the city and went in and sat - I can't remember what his title was, but I made him tell me why he thought I wasn't qualified for the job. And it ended up that they had to reverse it and give me the job. And I, of course, then had to prove that I was gonna be just as good as the guy that was, you know, had been kind of tabbed to take the job.
(Technical Manager with 30 years experience age 60)

**Women Who Left**

… It's mostly men - and a lot of older men - in there. But it was funny; I was thinking they totally viewed me as their granddaughter, there. ... you just assume catcalls, and people thinking you're stupid because you're a girl…
(13 years in engineering career now a stay at home Mom age 35)

… there was a competition with it and at the end when they were going to give the prize, they wouldn't give it to me. They pulled me aside and they said, “These guys will be mortified if you get this prize.” … They're like, “You did the best, but we can't give it to you.”
(12 year engineering career now a stay-at-home mom age 43)

I think you eventually get to lenses where you wonder is it male/female, but I think all of us, and I did as well, experience occasions along the way, where you are not included, and inclusion is an incredibly powerful thing.
(10 year engineering career now a director of a non-profit age 48)

All men; I was the only woman and I was, by far, the youngest person in the room… No matter what you think, they were just men in suits and it was intimidating.
(14 year engineering career now a stay at home mom age 42)

But I was not even in charge of anything. I was, let's say, average … work girl, you know. I was told to do this, to do that. They did not let me use my knowledge, brain, or they didn't want me to speak up. … Despite what anybody says in terms of equal opportunity for everyone, there is a clear discrimination for women in manufacturing in terms of giving them promotion, pay, and treatment. Like, they're not treated equally.
(15 year engineering career now a homemaker age 50)
FIGURE A4
Unrelenting Opportunity

UNRELENTING OPPORTUNITY
Women who stay believe that an engineering career will continue to provide unrelenting opportunities for novel, challenging, and interesting work.

they were giving me assignments that were brand new. You know, Greenfield, nobody had done before. … it was the carrot from the job. I always got to do something. And my whole career has been that. I mean the water supply to the hazardous waste site worked, I mean I just kept cutting edge stuff, brand new. So, that's-yeah, I think it's finding out what the carrot is for the stay, 'cause as I hear myself talk about it, I think it was the new stuff that kept me.
(technical manager with more than 30 years experience)

I have options to steer my way towards one thing or another towards something I enjoy more … I got into a large company that had a lot of opportunity for someone with an engineering background to a lot of different things. … I want to work on something that's important. I want to get satisfaction out of what I do. I want people to value me and want to include me in things that are important.
(technical manager with 24 years experience)

I also get to learn continuously. I've worked in so many different industries and businesses, everything from children's hospitals… utility companies, telecommunication companies. It's just been - it's really interesting to me to get to learn what's similar about all those different businesses and then what makes them different.
(project manager with 13 years experience)

…having had the opportunity to do a number of different things kind of keeps you from getting bored with it because I'm just having the growth, being able to come in every day, and I'd learn something every day.
(technical manager with 22 years experience)

...that it's always - it's going to be different and interesting.
(consultant with more than 30 years experience)

It's still fun. It's still rewarding and challenging to me.
(systems engineer with 15 years experience)

I like the type of work that I do right now because it changes all the time… I enjoy the challenges. I enjoy the people. I like the fact I can travel and see something new. By working with the government, it's opened up a completely different situation for me… I can't imagine anything else that would be this much fun on a regular basis.
(technical manager with 18 years experience)

And I'm big on life-long learning. If you're not being challenged in a job, if you're just putting time in then it's time to go someplace else. I mean, life's too short. … be with a team that you love, in a job that stimulates you intellectually, that gets your creative juices flowing. It's got to be something that gives you energy. …
(consultant with 28 years experience)

(Stay) …as long as the work is interesting and as long as things are happening. So far, it's definitely been that way.
(research director with 15 years experience)

…next year, I will be very busy with integrating that facility into our capital process… So think that'll be one of my big challenges next year.
(technical manager with 17 years experience)

You can do so many different things. You do not have to work in this field or that field or this field or that field. You can be an engineer in just about every field. Every field needs an engineer somehow, someway, whether it's medical or manufacturing or aeronautical or whatever. So there's variety. There's - it opens doors.
(manufacturing engineering with 19 years experience)
FIGURE A5
Alignment between Personal and Professional Aspirations

ALIGNMENT BETWEEN PERSONAL AND PROFESSIONAL ASPIRATIONS
Women who stayed discuss alignment between personal and professional aspirations. Those who left discuss tension between work related and personal goals.

Women Who Stayed

I'm one of these people that I won't quit. I really like what I do. There was just something about these industrial gas plants I just really like and enjoy. I don't know how to explain it. I just have a passion for the plants.
(Consultant with 28 years experience age 50)

I'm a hopeless geek. I can really - I love solving problems. I love working with users. My husband tells me that it's like I am so analytical about everything that he just wants to run from the room screaming sometimes. I love to solve problems; I actually have the toolset now, where the technology generally is easy for me. And I'm actually really, really good with people and facilitating communications among disparate groups.
(Consultant with 28 years experience age 50)

I feel needed. I feel like if I didn't show up to work - maybe not one day; maybe not a week, but if I was gone for a month, I would be missed. There are a lot of things that I can do, that I'm the only person who can do those things.
(Process Engineer with 16 years experience age 37)

I can feel like I did something that made a difference. Now, we can say that making XX that goes in paints and plastic is only so exciting, but it's something that I can look around and go, yeah, I impacted the world a little bit. So I think that's it. There's a very wide variety of things you can do with engineering. I chose to stay on the manufacturing side.
(Technical Manager with 17 years experience age 38)

I'm entirely fulfilled. And part of that is personality; it's this idea that, all right, let's find connections, and it's interesting because I work with some brilliant, brilliant people that never considered the idea of collaborating outside of the organization because it was never something they were allowed to do. So in a lot of ways, I feel that, all right, my role here is to break down barriers, and I do a lot of that.
(Research Director with 15 years experience age 42)

Women Who Left

And now I have a baby I was like I have to breast feed exclusively no formula, make my own baby food and everything. So I remember like missing work and thinking how could I possibly juggle. There's no way I could have juggled them.
(8 year engineering career now an office manager in family business age 43 years old)

I never saw myself working full time... So despite being pregnant and all the stuff that comes with that - maternity leave and everything - they hired me. At the time, I was hoping that I could possibly go part time... I worked so hard. I worked overtime every day. My goal was to make them want me part time - make them not want to lose me at all. I first broached the subject, and it came back with a probably not. I was just so upset because that was part of my whole master plan. So I sat down and I realized I had accomplished nothing because of the constant roadblocks.
(13 year engineering career now a stay-at-home mom age 35)

I was thinking (engineering) could be more creative than it turned out to be. I thought I could be a mechanical engineer and design cars or buildings. I thought it'd be much more creative than it was... I just came to a point where I had to decide do I want to keep doing this. If I'm not happy here, would I be happy doing it there? No, I really wasn't. I wanted a change.
(8 year engineering career now a counselor age 40)

There are certain things that kind of trigger it in life; I think you reflect upon really doing what you should be doing, and my dad passed away suddenly in May of 2005. What am I doing with my kids? ...what do I want to be, and I really didn't feel like I was giving back enough because so much of your time is spent at work and not really concerned in serving the community. ... I realized I wasn't happy anymore.
(17 year engineering career now a grade school teacher age 42)

And he holds it up, and there's a list of maybe 15 names, each one has a date next to it that goes back at least one name per year on this list - maybe two names in one year or something. I can't remember very well. And I said, “What's this a list of?” And he goes, “This is the list of the suicides in this company.” ... I wanted to leave a legacy, and all I saw was stock prices going up and down, but because I was so detached from how what I did was affecting the world in any way, it just - that's why my soul hurt. (Now) I've got this ability to make an impact.
(11 year engineering career now a college professor age 52)
APPENDIX B
Ideal Self as a Formative Construct

Summary of Pilot Study Data Analysis

The ideal self construct has been analyzed as a formative construct. Four different methods of analysis are detailed. Each model shows convergent and discriminate validity; however there are low loadings and low communality of one factor for the theoretically based model. Eliminating one item improves the loadings and the communality. The 5 factor model from the EFA shows the highest overall loadings across all 20 items and the highest communality measures.

A second order formative factor could also be considered and will be evaluated within the quantitative research study.

Item Development

The items developed for the ideal self construct came directly from the theory (Boyatzis & Akrivou, 2006). Pre-tests were conducted and feedback from those taking the pre-tests resulted in changes to the specific items. After three iterations of the pre-test, the ideal self construct included an optional written discovery statement and 20 items and is shown in Appendix 1.

Data Collection and Screening

A total of 112 surveys were completed in the pilot study for the Ideal Self construct. 16 of the surveys were completed by business students at a mid-western university and the other 96 were completed using SurveyMonkey, an on-line survey instrument. A link requesting participation in the survey was sent by email to four different groups associated with a non-profit institution in north east Ohio.
The data was analyzed for missing values and non-normality. (A separate report summarizes this work.) Missing values totaled about 1%. For analysis purposes we imputed the missing values using a mean value.

The data was analyzed as a reflective construct (see separate report) but discriminate validity could not be established. A second order construct may be an option within a larger study.

Using the three broad theoretical considerations outlined in (Coltman, Devinney, Midgley, & Venaik, 2008), the nature of the construct, the direction of causality and the characteristics of the indicators, it is concluded that the ideal self is a formative construct. The ideal self as the latent construct: is formed by its indicators, variation in the item measures causes variation in the construct and the items do not share a theme and are not interchangeable.

**Construct Evaluation**

PLS-Graph software was used to complete the factor analysis. Geffen and Straub (2005) state that convergent validity is established when the t-values of the outer Model Loadings are above 1.96. Discriminate validity is established when the square root of the AVE of each construct is greater than the correlation of this construct to all other constructs.

Sample size is a consideration in the development of a construct. For exploratory factor analysis a minimum of 5 to 10 cases per measure are recommended by Comrey & Lee (1992) and Gorsuch (1983), but MacCallum, Wildaman, Zhang and Hong (1999) found that communalities of 0.60 or greater were more likely to predict populations from
a sample size of under 100. Communalities of 0.50 and higher are suggested in samples of 100 to 200 to accurately reproduce the population loadings.

PLS-Graph software was used to complete the factor analysis. The first analysis was completed using the theoretical model where the 20 items formed 4 constructs. Additional analyses were completed to optimize the results and are summarized in Table B.1.

<table>
<thead>
<tr>
<th>TABLE B1</th>
<th>Ideal Self Measurement Model Summary (n=112)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td><strong>Items</strong></td>
</tr>
<tr>
<td>1</td>
<td>Theoretical</td>
</tr>
<tr>
<td>2</td>
<td>Theoretical Optimized</td>
</tr>
<tr>
<td>3</td>
<td>5 Factor from EFA</td>
</tr>
<tr>
<td>4</td>
<td>4 Factor from EFA</td>
</tr>
</tbody>
</table>

Each of these analysis yields results that may be acceptable in a larger model. More analysis will be completed with the data collected in the quantitative research study now underway on careers of people with engineering degrees.

Detailed analysis of these 4 measurement models follows.
**FIGURE B1**

Evaluation #1 Ideal Self

Theoretical Factors (4) using all 20 Items

---

**TABLE B2**

Evaluation #1 of Ideal Self

Measurement Model Statistics Formative with 4 Theoretical Factors

(n=112)

<table>
<thead>
<tr>
<th>Measure</th>
<th>CR</th>
<th>AVE</th>
<th>Feelings</th>
<th>Salience</th>
<th>Holistic</th>
<th>Mindfulness</th>
<th>AvCommun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feelings</td>
<td>0.885</td>
<td>0.658</td>
<td>0.811</td>
<td></td>
<td></td>
<td></td>
<td>0.6578</td>
</tr>
<tr>
<td>Salience</td>
<td>0.865</td>
<td>0.762</td>
<td>0.395</td>
<td>0.873</td>
<td></td>
<td></td>
<td>0.7619</td>
</tr>
<tr>
<td>Holistic</td>
<td>0.848</td>
<td>0.349</td>
<td>0.496</td>
<td>0.642</td>
<td>0.591</td>
<td></td>
<td>0.3489</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>0.860</td>
<td>0.673</td>
<td>0.759</td>
<td>0.341</td>
<td>0.528</td>
<td>0.820</td>
<td>0.6733</td>
</tr>
</tbody>
</table>

CR’s for each factor are high and loadings are above 0.6 for each item except for Q4=0.1831, Q3=0.5539, Q7=0.5259, Q14=0.5996.

Low communality on the holistic construct at 0.3489 but sample size is above 100.
Convergent validity is shown as all t-stats are above 1.96, the lowest is Q4=1.9682.

Discriminant validity as show in Table 1 as each correlation of one construct to another is lower than the square root of the AVE.

**Evaluation #2 – Theoretical Factors (4) using 19 Items Q4**

Due to low loading in evaluation #1 above and low communality of its construct, Q4 is deleted and data is reviewed. (Q4→ My vision includes my work in terms of my jobs and career.)
<table>
<thead>
<tr>
<th>Measure</th>
<th>CR</th>
<th>AVE</th>
<th>Feelings</th>
<th>Salience</th>
<th>Holistic</th>
<th>Mindfulness</th>
<th>AvCommun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feelings</td>
<td>0.885</td>
<td>0.658</td>
<td><strong>0.811</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.6578</td>
</tr>
<tr>
<td>Salience</td>
<td>0.865</td>
<td>0.762</td>
<td>0.395</td>
<td><strong>0.873</strong></td>
<td></td>
<td></td>
<td>0.7619</td>
</tr>
<tr>
<td>Holistic</td>
<td>0.856</td>
<td>0.399</td>
<td>0.475</td>
<td>0.575</td>
<td><strong>0.631</strong></td>
<td></td>
<td>0.3992</td>
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<tr>
<td>Mindfulness</td>
<td>0.845</td>
<td>0.578</td>
<td>0.745</td>
<td>0.463</td>
<td>0.596</td>
<td><strong>0.760</strong></td>
<td>0.5782</td>
</tr>
</tbody>
</table>

Here the loadings improve as all are above 0.60 except for Q3=0.5364, Q7=0.5641, Q12=0.5700. All items loading on Feelings, Salience are above 0.70.

Communality of Holistic factor goes up but could still be a problem to generalize results to population.

Convergent validity is shown as all t-stats are well above 1.96, with the lowest being Q16=7.7780.

Discriminate validity is shown in Table 2.

**Evaluation #3 – 5 Factor Ideal Self**

**FIGURE B3**
Evaluation #3 Ideal Self
5-Factor Model for Ideal Self
The 5 factor solution yields loadings that are all above 0.70 except for Q4=0.4578 and Q16=0.6411

**TABLE B4**

**Evaluation #4 Ideal Self**

**Measurement Model Statistics Formative 5 Factors from EFA, (n=112)**

<table>
<thead>
<tr>
<th>Measure</th>
<th>CR</th>
<th>AVE</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>F5</th>
<th>AvCommun</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>0.897</td>
<td>0.526</td>
<td>0.725</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5259</td>
</tr>
<tr>
<td>F2</td>
<td>0.861</td>
<td>0.608</td>
<td>0.445</td>
<td>0.760</td>
<td></td>
<td></td>
<td></td>
<td>0.6082</td>
</tr>
<tr>
<td>F3</td>
<td>0.847</td>
<td>0.581</td>
<td>0.270</td>
<td>0.527</td>
<td>0.762</td>
<td></td>
<td></td>
<td>0.5812</td>
</tr>
<tr>
<td>F4</td>
<td>0.822</td>
<td>0.698</td>
<td>0.458</td>
<td>0.362</td>
<td>0.371</td>
<td>0.835</td>
<td></td>
<td>0.6976</td>
</tr>
<tr>
<td>F5</td>
<td>0.852</td>
<td>0.743</td>
<td>0.369</td>
<td>0.561</td>
<td>0.561</td>
<td>0.351</td>
<td>0.862</td>
<td>0.7427</td>
</tr>
</tbody>
</table>

All communalities are above 0.50 and with the sample size of 112 the results are likely to accurately reproduce the population loadings.

Convergent validity is shown as all t-values are higher than 1.96, with Q4 lowest at 5.7660.

Discriminate validity is shown for all constructs as shown in Table 4

**Evaluation #4 – EFA Results with 4 Factor Ideal Self**
FIGURE B4
Evaluation #4 Ideal Self
4-Factor Model

TABLE B5
Evaluation #4 Ideal Self
Measurement Model Statistics Formative 4 Factors from EFA, (n=112)

<table>
<thead>
<tr>
<th>Measure</th>
<th>CR</th>
<th>AVE</th>
<th>F1</th>
<th>F2</th>
<th>F3</th>
<th>F4</th>
<th>AvCommun</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>0.896</td>
<td>0.523</td>
<td>0.723</td>
<td></td>
<td></td>
<td></td>
<td>0.5231</td>
</tr>
<tr>
<td>F2</td>
<td>0.877</td>
<td>0.472</td>
<td>0.406</td>
<td>0.687</td>
<td></td>
<td></td>
<td>0.4721</td>
</tr>
<tr>
<td>F3</td>
<td>0.824</td>
<td>0.701</td>
<td>0.346</td>
<td>0.456</td>
<td>0.837</td>
<td></td>
<td>0.7011</td>
</tr>
<tr>
<td>F4</td>
<td>0.843</td>
<td>0.729</td>
<td>0.427</td>
<td>0.545</td>
<td>0.458</td>
<td>0.854</td>
<td>0.7291</td>
</tr>
</tbody>
</table>

The communality for F2 is just below 0.50, there is discriminate validity and convergent validity.

Loadings are above 0.60 except for Q4=0.4674

Boot Strap, 300 samples, 112 cases per sample, T-stats all higher than Q4 which = 5.9758
Ideal Self Questionnaire (Boyatzis, Buse, & Taylor)

Describe, in as much detail as possible, your dreams of your ideal life for 10 to 15 years from now. The following categories may help stimulate your reflection.

- Your passion, calling, and sense of purpose

- Your legacy

- Your values and philosophy

- Your dreams, fantasies and aspirations

- How you feel about your future possibilities

- Other components or elements of your dream
Answer the questions below by circling the response to the right that best describes your response to the question as it concerns your image of your ideal life described previously.

<table>
<thead>
<tr>
<th>Strongly Disagree 1</th>
<th>Disagree 2</th>
<th>Somewhat Disagree 3</th>
<th>Neither Agree nor Disagree 4</th>
<th>Somewhat Agree 5</th>
<th>Agree 6</th>
<th>Strongly Agree 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel inspired by my vision of the future.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. My vision reflects many possibilities</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. My vision includes fun activities.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. My vision includes my work in terms of my jobs and career.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. My vision includes my family relationships.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I am excited about my vision.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. My vision includes leisurely activities.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I feel hopeful about my vision.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. My vision includes my physical health.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. My vision includes my values and philosophy.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I feel optimistic about my vision.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. My vision includes my contributions to others and the community.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. My vision includes relative priorities of things important to me.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. My vision includes my intimate/love relationships.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. My vision includes my spiritual health.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. I have a clear vision of my desired future.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>17. My vision includes my desired legacy in life.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>18. My vision of the future reflects the things most important to me.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. My passion, calling, and sense of purpose are clear to me.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. I see many possibilities in my future.</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C
Survey of Engineering Careers

Careers of People with Engineering Degrees
Qualtrics Survey

Dear Survey Participant:

Thank you for agreeing to participate in a research study conducted by Kathleen Buse, a doctoral candidate at Case Western Reserve University. The purpose of this research is to gain understanding of the careers of people with engineering degrees.

The amount of time required for your participation will be about 5 to 15 minutes. You are asked to complete all questions in the survey.

There are no risks associated with this research and your responses are completely anonymous. There will be no direct benefits of participation to either individuals or specific firms.

The records of this research will be kept private, in a secure password protected file and firewall protected from Internet access.

Your participation in this research study is voluntary. The researchers conducting this study are Dr. Richard Boyatzis and Kathleen Buse. If you have any questions, you may contact Dr. Boyatzis at richard.boyatzis@case.edu or Ms. Buse at kathleen.buse@case.edu. If the researchers cannot be reached, or if you would like to talk to someone other than the researcher(s) about concerns regarding this study or research participant rights, please contact Case Western Reserve University's Institutional Review Board at (216) 368-6925 or write: Case Western Reserve University; Institutional Review Board; 10900 Euclid Ave.; Cleveland, OH 44106-7230.
This is a study on the careers of people with degrees in engineering.

Please click on the button or buttons noting your field of engineering. You may choose more than one.

___ Aerospace Engineering
___ Biomedical Engineering
___ Chemical Engineering
___ Civil and/or Structural Engineering
___ Computer Engineering (any kind)
___ Electrical and/or Electronic Engineering
___ Environmental Engineering
___ Industrial Engineering
___ Materials and/or Macromolecular Engineering
___ Mechanical Engineering
___ Metallurgical Engineering
___ Nuclear Engineering
___ Petroleum Engineering

___ Other Engineering Degree(s) ___________________________________________

___ I do not have an engineering degree but I have worked as an engineer or technical manager. Please write in your degree

____________________________________________________________________

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

__________________________
__________________________
__________________________
What is the highest level of education you have completed?

___ Some College
___ 4-year College Degree
___ Master's Degree
___ Doctoral Degree
___ Professional Degree (JD, MD)

Please answer the questions below by clicking the response that most fits you.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all true</th>
<th>Hardly true</th>
<th>Moderately true</th>
<th>Exactly true</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can always manage to solve difficult problems if I try hard enough.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If someone opposes me, I can find the means and ways to get what I want.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am confident that I could deal efficiently with unexpected events.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thanks to my resourcefulness, I know how to handle unforeseen situations.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is easy for me to stick to my aims and accomplish my goals.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please answer the questions below by clicking the response that most fits you.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Not at all true</th>
<th>Hardly true</th>
<th>Moderately true</th>
<th>Exactly true</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can solve most problems if I invest the necessary effort.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can remain calm when facing difficulties because I can rely on my coping abilities.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I am in trouble, I can usually think of a solution.</td>
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<td></td>
<td></td>
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<tr>
<td>When I am confronted with a problem, I can usually find several solutions.</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>I can usually handle whatever comes my way.</td>
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<td></td>
</tr>
</tbody>
</table>
Please answer the questions below by clicking on the response that most fits you.

<table>
<thead>
<tr>
<th>Statements</th>
<th>I disagree a lot</th>
<th>I disagree a little</th>
<th>I neither agree or disagree</th>
<th>I agree a little</th>
<th>I agree a lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>In uncertain times, I usually expect the best.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It’s easy for me to relax.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If something can go right for me, it will.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I’m always optimistic about my future.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy my friends a lot.</td>
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<tr>
<td>It’s important for me to keep busy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I usually expect things to go my way.</td>
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<td></td>
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<td></td>
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<tr>
<td>I don’t get upset too easily.</td>
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<td></td>
</tr>
<tr>
<td>I usually count on good things happening to me.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, I expect more good things to happen to me than bad.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please answer the questions below by clicking the response that most fits you.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Definitely false</th>
<th>Mostly false</th>
<th>Somewhat false</th>
<th>Slightly false</th>
<th>Slightly true</th>
<th>Somewhat true</th>
<th>Mostly true</th>
<th>Definitely true</th>
</tr>
</thead>
<tbody>
<tr>
<td>If I should find myself in a jam, I could think of many ways to get out of it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the present time, I am energetically pursuing my goals.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are lots of ways around any problem that I am facing now.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right now I see myself as being pretty successful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can think of many ways to reach my current goals.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At this time, I am meeting the goals that I have set for myself.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please answer the questions below by clicking on the response that most suits you.

<table>
<thead>
<tr>
<th>The way I deal with my fears and anxieties.</th>
<th>Not important to who I am</th>
<th>Slightly important to my sense of who I am</th>
<th>Somewhat important to my sense of who I am</th>
<th>Very important to my sense of who I am</th>
<th>Extremely important to my sense of who I am</th>
</tr>
</thead>
<tbody>
<tr>
<td>My feelings of being a unique person, being distinct from others.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowing that I continue to be essentially the same inside even though life changes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My self-knowledge, my ideas about what kind of person I really am.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My personal self-evaluation, the private opinion I have of myself.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please choose the response that most fits your current situation.

_____ I am currently employed in an engineering role. Please insert your job title.

_______________________

_____ I am currently employed in a technical management or engineering management role.

Please insert your job title.________________________________________

_____ I am currently employed in a position that was a normal promotional move from my engineering career (but not in engineering or technical management). Please write your job title.______________

_____ I am employed in a role that has no relation to my engineering degree. Please insert job title.________________________________________

_____ I am not currently employed but am actively looking for a job.

_____ I am not currently employed and not actively looking for a job - but NOT because I am staying home with my children (see next question).

_____ 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.

_____ Other, please type in your current situation.________________________________________

How long have you worked as an engineer and/or in technical management?
Never worked in engineering.

___  less than 1 year to 5 years
___  6 to 10 years
___  11 to 15 years
___  16 to 20 years
___  21 to 25 years
___  26 to 30 years
___  30 to 35 years
___  36 to 40 years
___  More than 40 years

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

___ Yes
___ No
___ Yes, I left but I have returned.

Please choose the response that most fits you.

| Even if I could get a job that paid that same amount of money, I would probably NOT take a job other than engineering or technical management. |
|---|---|---|---|---|
| I disagree a lot | I disagree a little | I neither agree or disagree | I agree a little | I agree a lot |

| If I could do it all over again, I would choose to work in engineering. |
|---|---|---|---|---|
| I disagree a lot | I disagree a little | I neither agree or disagree | I agree a little | I agree a lot |

| I definitely want a career for myself in engineering or engineering/technical management. |
|---|---|---|---|---|
| I disagree a lot | I disagree a little | I neither agree or disagree | I agree a little | I agree a lot |

| I would recommend a career in engineering to others. |
|---|---|---|---|---|
| I disagree a lot | I disagree a little | I neither agree or disagree | I agree a little | I agree a lot |

| I am not disappointed that I ever entered the engineering profession. |
|---|---|---|---|---|
| I disagree a lot | I disagree a little | I neither agree or disagree | I agree a little | I agree a lot |
For the next questions please think about your current leader or manager.

If you are not currently working in an organization, please think about the last leader or manager for whom you worked and then respond to answer these questions.

Do you know where you stand with your leader... do you usually know how satisfied your leader is with what you do?

<table>
<thead>
<tr>
<th>Rarely</th>
<th>Occasionally</th>
<th>Sometimes</th>
<th>Fairly Often</th>
<th>Very Often</th>
</tr>
</thead>
</table>

How well does your leader understand your job problems and needs?

<table>
<thead>
<tr>
<th>Not a bit</th>
<th>A little</th>
<th>A fair amount</th>
<th>Quite a bit</th>
<th>A great deal</th>
</tr>
</thead>
</table>

How well does your leader recognize your potential?

<table>
<thead>
<tr>
<th>Not a bit</th>
<th>A little</th>
<th>A fair amount</th>
<th>Quite a bit</th>
<th>A great deal</th>
</tr>
</thead>
</table>

Regardless of how much formal authority he/she has built into his/her position, what are the chances that your leader would use his/her power to help you solve problems in your work?

<table>
<thead>
<tr>
<th>None</th>
<th>Small</th>
<th>Moderate</th>
<th>High</th>
<th>Very high</th>
</tr>
</thead>
</table>

Again regardless of the amount of formal authority your leader has, what are the chances that he/she would "bail you out" at his/her expense?

<table>
<thead>
<tr>
<th>None</th>
<th>Small</th>
<th>Moderate</th>
<th>High</th>
<th>Very high</th>
</tr>
</thead>
</table>

I have enough confidence in my leader that I would defend and justify his/her decision if he/she were not present to do so?

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neither agree nor disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>

170
How would you characterize your working relationship with your leader?

<table>
<thead>
<tr>
<th>Extremely ineffective</th>
<th>Worse than average</th>
<th>Average</th>
<th>Better than average</th>
<th>Extremely effective</th>
</tr>
</thead>
</table>

Please choose the response that most fits you.

If you are not currently working, please consider your last engineering/technical management position.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>A few times a year or less</th>
<th>Once a month or less</th>
<th>A few times a month</th>
<th>Once a Week</th>
<th>A few times a week</th>
<th>Everyday</th>
</tr>
</thead>
<tbody>
<tr>
<td>At my work, I feel bursting with energy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I find the work that I do full of meaning and purpose.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time flies when I am working.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>At my job, I feel strong and vigorous.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>I am enthusiastic about my job.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I am working, I forget everything else around me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My job inspires me.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>When I get up in the morning, I feel like going to work.</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I feel happy when I am working intensely.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please choose the response that most fits you.

If you are not currently working, please consider your last engineering/technical management position.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>A few times a year or less</th>
<th>Once a month or less</th>
<th>A few times a month</th>
<th>Once a Week</th>
<th>A few times a week</th>
<th>Everyday</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am proud of the work that I do.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am immersed in my work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can continue working for very long periods at a time.</td>
<td></td>
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<tr>
<td>To me, my job is challenging.</td>
<td></td>
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<tr>
<td>I get carried away when I am working.</td>
<td></td>
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<tr>
<td>At my job, I am very resilient, mentally.</td>
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<tr>
<td>It is difficult to detach myself from my job.</td>
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<tr>
<td>At my work I always persevere even when things do not go well.</td>
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</tbody>
</table>

To prepare to answer the next questions, please read the paragraph below. If you believe it would help you to type out your thoughts, please do so. This is the only optional question on the survey.

Dream of your ideal life as it will be in 10 to 15 years. The following categories may help stimulate your reflection:
- Your passion, calling, and sense of purpose
- Your legacy
- Your values and philosophy
- Your dreams, fantasies and aspirations
- How you feel about your future possibilities
- Other components or elements of your dream

Describe in as much detail as possible your dream of your ideal life (optional)

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

172
Answer the questions below by clicking on the response that best describes your response to the question as it concerns your image of your ideal life.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel inspired by my vision of the future.</td>
<td></td>
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<tr>
<td>My vision reflects many possibilities.</td>
<td></td>
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<tr>
<td>My vision includes fun activities.</td>
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<tr>
<td>My vision includes my work in terms of my jobs and career.</td>
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<tr>
<td>My vision includes my family relationships.</td>
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<tr>
<td>I am excited about my vision.</td>
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<tr>
<td>My vision includes leisurely activities.</td>
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<tr>
<td>I feel hopeful about my vision.</td>
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<tr>
<td>My vision includes my physical health.</td>
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<tr>
<td>My vision includes my values and philosophy.</td>
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</table>
### Answer the questions below by clicking on the response that best describes your response to the question as it concerns your image of your ideal life.

<table>
<thead>
<tr>
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<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel optimistic about my vision.</td>
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<tr>
<td>My vision includes my contributions to others and the community.</td>
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<tr>
<td>My vision includes relative priorities of things important to me.</td>
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<tr>
<td>My vision includes my intimate/love relationships.</td>
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<td></td>
</tr>
<tr>
<td>My vision includes my spiritual health.</td>
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<tr>
<td>I have a clear vision of my desired future.</td>
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<tr>
<td>My vision includes my desired legacy in life.</td>
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<tr>
<td>My vision of the future reflects the things most important to me.</td>
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<tr>
<td>My passion, calling, and sense of purpose are clear to me.</td>
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<td></td>
</tr>
<tr>
<td>I see many possibilities in my future.</td>
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</tr>
</tbody>
</table>
This is the last page!

We are collecting demographics to better analyze the results.

What is your gender?

___ male
___ female

What is your current marital status?

<table>
<thead>
<tr>
<th>Single, never married</th>
<th>Married without children</th>
<th>Married with children</th>
<th>Divorced</th>
<th>Separated</th>
<th>Widowed</th>
<th>Living w/ partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

How many children do you have (including step children)?

___ 0
___ 1
___ 2
___ 3
___ 4 or more

What is your age range in years?

___ 20 to 25
___ 26 to 30
___ 31 to 35
___ 36 to 40
___ 41 to 45
___ 46 to 50
___ 51 to 55
___ 6 to 60
___ 61 to 65
___ 66 to 70
___ 70 to 75
___ Over 75

Thank you so much for completing our survey!
We thank you for your time spent taking this survey.
Your response has been recorded.
APPENDIX D
Descriptive Statistics and Measurement Model Supporting Data

Examples of the work done to understand the sample are included in this appendix. While most of the data collected for each question there was some level of skewness or kurtosis however no action was taken.

Included here are the descriptive statistics for one of the constructs – career commitment.

**TABLE D1**
Descriptive Statistics for Career Commitment

<table>
<thead>
<tr>
<th>Descriptive Statistics for Career Commitment (5 Items)</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Statistic</td>
<td>Std. Error</td>
</tr>
<tr>
<td>CC1: Please choose the response that most fits you.-Even if I could get a job that paid that same amount of money, I would probably NOT take a job other than engineering or technical management.</td>
<td>495</td>
<td>1</td>
<td>5</td>
<td>2.96</td>
<td>1.458</td>
<td>.028</td>
<td>.110</td>
</tr>
<tr>
<td>CC2: Please choose the response that most fits you.-If I could do it all over again, I would choose to work in engineering.</td>
<td>495</td>
<td>1</td>
<td>5</td>
<td>3.86</td>
<td>1.260</td>
<td>-.847</td>
<td>.110</td>
</tr>
<tr>
<td>CC3: Please choose the response that most fits you.-I definitely want a career for myself in engineering or engineering/technical management.</td>
<td>495</td>
<td>1</td>
<td>5</td>
<td>3.63</td>
<td>1.217</td>
<td>-.581</td>
<td>.110</td>
</tr>
<tr>
<td>CC4: Please choose the response that most fits you.-I would recommend a career in engineering to others.</td>
<td>495</td>
<td>1</td>
<td>5</td>
<td>4.30</td>
<td>.930</td>
<td>-1.351</td>
<td>.110</td>
</tr>
<tr>
<td>CC5: Please choose the response that most fits you.-I am not disappointed that I ever entered the engineering profession.</td>
<td>495</td>
<td>1</td>
<td>5</td>
<td>4.33</td>
<td>1.071</td>
<td>-1.649</td>
<td>.110</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>495</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIGURE D1
Histogram and boxplot for CC1

Histogram

Please choose the response that most fits you:
- Even if I could get a job that paid that same amount of money, I would probably NOT take a job other than engineering or technical management.

Boxplot

Please choose the response that most fits you:
- Even if I could get a job that paid that same amount of money, I would probably NOT take a job other than engineering or technical management.
FIGURE D2
Histogram and boxplot for CC2

Please choose the response that most fits you. If I could do it all over again, I would choose to work in engineering.
FIGURE D3
Histogram and boxplot for CC3

Please choose the response that most fits you:
1. I definitely want a career for myself in engineering or engineering/technical management.

Histogram

Boxplot

Please choose the response that most fits you:
1. I definitely want a career for myself in engineering or engineering/technical management.
FIGURE D4
Histogram and boxplot for CC4

Histogram

Please choose the response that most fits you. I would recommend a career in engineering to others.

Boxplot

Please choose the response that most fits you. I would recommend a career in engineering to others.
FIGURE D5
Histogram and boxplot for CC5

Please choose the response that most fits you: I am not disappointed that I ever entered the engineering profession.
TABLE D2
Exploratory Factor Analysis, initial Pattern Matrix using SPSS

This section includes some of the work completed to establish the measurement model.

<table>
<thead>
<tr>
<th>KMO and Bartlett's Test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</td>
<td>.930</td>
</tr>
<tr>
<td>Approx. Chi-Square</td>
<td>17339.456</td>
</tr>
<tr>
<td>Bartlett's Test of Sphericity</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>1770</td>
</tr>
<tr>
<td>Sig.</td>
<td>.000</td>
</tr>
</tbody>
</table>

TABLE D3
Total Variance Explained

| Factor | Initial Eigenvalues | Extraction Sums of Squared Loadings | Rotation Sums of Squared Loadings<sup>a</sup> |  |
|--------|---------------------|-------------------------------------|------------------------------------------|  |
|        | Total % of Variance Cumulative % | Total % of Variance Cumulative % | Total |  |
| 2 | 5.324 8.873 33.748 | 4.891 8.152 32.415 | 6.365 |  |
| 4 | 2.870 4.783 45.195 | 2.395 3.991 42.442 | 6.061 |  |
| 5 | 2.535 4.225 49.420 | 2.143 3.571 46.013 | 9.095 |  |
| 6 | 2.132 3.554 52.974 | 1.586 2.644 48.657 | 3.149 |  |
| 7 | 1.568 2.613 55.587 | 1.135 1.891 50.548 | 2.713 |  |
| 8 | 1.417 2.361 57.948 | .891 1.484 52.033 | 5.221 |  |
| 9 | 1.164 1.940 59.888 | .730 1.217 53.250 | 3.153 |  |
| 10 | 1.100 1.833 61.722 | .594 .989 54.239 | 3.304 |  |

Extraction Method: Principal Axis Factoring.
<sup>a</sup> When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.
Highlighted items have been deleted to improve Cronbach’s alpha.

**TABLE D4**

*Pattern Matrix for Reflective Factors*

<table>
<thead>
<tr>
<th>Pattern Matrix&lt;sup&gt;a&lt;/sup&gt;</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>3</td>
<td>4</td>
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Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

** Deleted due to confusing questions
REFERENCES


We are IT. Retrieved March 2009 from http://itcs.lakelandcc.edu/we_are_it/index.htm