PROFILES OF PERSISTENCE:

A QUALITATIVE STUDY

OF

UNDERGRADUATE WOMEN IN ENGINEERING

by

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(ABSTRACT)

This study was designed to investigate a phenomenon, persistence of undergraduate women in their engineering majors, from a qualitative paradigm. Guided by the tenets of feminist and inclusive research, the assumption was made that all women, whether they persist or not in their engineering majors, have strengths and insights into their own personal experiences. The experiences of African American women, Asian women, Caucasian women, Hispanic women, women from rural geographical areas, and non-persisters were investigated. A developmental life-span and social learning perspective called for an examination of factors relevant to engineering major choice and persistence from early childhood to the present time, including family background and individual factors, environmental factors and experiences with the engineering culture, and social factors relevant to major choice and persistence. Twenty-eight (28) persisters and 8 non-persisters participated in the study which was conducted at a large land-grant university in the southeastern United States in the fall of 1996.

The following questions guided the study: (1) What experiences have been influential in undergraduate women's selection of engineering as a major? (2) How does the culture and climate of engineering education influence the experiences of these undergraduate women? (3) How do individual, educational, social, and environmental characteristics and strategies contribute to undergraduate women's persistence in their engineering majors? (4) Which of these characteristics and strategies differentiate between female persisters and non-persisters, in other words, what are the differences between academically successful undergraduate women who leave their engineering majors and those who remain in them? (5) How do characteristics and strategies of persistence and non-persistence compare for special populations?

Qualitative interviewing through in-depth individual interviews and small group interviews was the method of data collection; participants were recruited through a purposive sampling frame as well as through volunteering and snowball sampling. Criteria for inclusion in the persisters group were junior or senior level academic standing and academic eligibility. Grounded theory methodology was the primary tool of analysis.

The findings clearly demonstrated two major groups of persisters and non-persisters. One group of persisters made early decisions and stayed the course through academic preparation and hands-on experiences. A second group of persisters made later decisions based on encouragement and the structure of opportunity for women and minorities in engineering. One group of non-persisters left engineering for majors that provided a better person-environment fit. A second group of non-persisters, many of whom were pressured to major in engineering although they lacked

hands-on experience, left their engineering majors for a variety of different reasons including intimidation, isolation, lowered confidence in their abilities, and personal problems. Perceptions and experiences with the institution itself and perceptions of the culture of engineering education varied depending on the career decision making process, group membership, and individual factors such as personality. Therefore, persistence and non-persistence were found to be a function of a complex interaction of individual, environmental, and social factors.

DEDICATION

In memory of
Catena L. Parker
May 19, 1973 - September 1990
and all the other young women
who, for many reasons, never had the
opportunity to realize their potential.

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CHAPTER 1

INTRODUCTION TO THE STUDY

"The main difference between people who succeed
and people who fail is how they handle adversity.
Success will depend primarily on determination to persist"
(Landis, 1991, p.13).

In the last two-and-a half decades, a "gender gap" in America's schools has sparked school-reform efforts all across the country. Beginning with Title IX legislation in 1972, legislators mandated equal educational opportunities in academic and athletic programs for boys and girls (AAUW, 1992). Over ten years later in 1983, the United States Department of Education published A Nation at Risk adding even further commitment toward gender and sex equity in school systems all across the country (AAUW, 1992). However, after almost two decades of legal support, a problem still persisted in 1990. That year, researchers who had spent six months visiting twenty-five rural school districts in twenty-one states found Title IX violations in terms of sex segregation in higher level mathematics and science classes (Schmuck & Schmuck, 1992).

Mathematics and science, in particular, are academic areas in need of further reform despite legislative efforts to provide gender equity in those academic programs. In 1991 President Bush and the Department of Education presented America 2000, now Goals 2000 legislation, as a plan to move U.S. students to first place in the world in science and mathematics acheivement (AAUW, 1992). "Despite a narrowing of the 'gender gaps' in verbal and mathematical performance, girls are [still] not doing as well as boys in our nation's schools. The physical sciences are one critical area in which girls continue to trail behind boys. More discouraging still, even girls who take the same mathematics and science courses as boys and perform equally well on tests are much less apt to pursue scientific or technological occupations than are their male classmates" (AAUW, 1992, p. 25). "The millions of dollars in public and private funds devoted to producing gender equity in science and engineering have added to the expectation of a general trend toward less rigid gender roles. Somehow we cannot produce the desired result" (Barber, 1995).

1.1. Background of the Problem

Within mathematics and science fields, engineering has one of the largest participation rates, yet engineering trails behind nearly every other profession in participation of women (Daniels, 1996). Although there has been a sizable increase in the percentage of women obtaining engineering degrees over the past 20 years, equality between men and women has not been reached. Particularly disturbing is the fact that the percentage has leveled off over the past five to eight years (Brush, 1992; McIlwee & Robinson, 1992). Statistics indicate that, compared to men, women are less likely to enter and to persist in undergraduate engineering programs and less likely to complete a graduate degree; ultimately they are poorly represented among the practicing profession (Henes et al., 1995). Few studies have been directed at explaining the twofold problem of the underrepresentation and attrition of women in engineering.

1.1.1. Underrepresentation

The percentage of women enrolled in engineering curricula was almost negligible for the first seven decades of this century, rose in the 1970's and early 1980's, and then leveled off with the actual number enrolled declining after 1986 (Brush, 1991; Johnson, 1992; McIlwee & Robinson, 1992). The rise in the number of women enrolled in engineering during the 1970's and 1980's was actually attributable to increases in the percentage of total degrees that went to women, not to changes in their field preferences (Berryman, 1983).

The underrepresentation of women in engineering occurs at all stages of the "educational pipeline," from enrolling in engineering programs, to completing engineering programs, to aspiring to graduate degrees in engineering programs (Berryman, 1985). While we have more girls taking math and science in the United States, the numbers and percentages of girls interested in careers in math and science is increasing minimally, if at all. In fact, during the senior year of high school and the first year of college, female students drop out of the math/science pipeline because they choose not to pursue scientific careers (Oakes, 1990). National statistics revealed that only 2.9 percent of all women entering college in 1994 planned to major in engineering (National Research Council, 1994). Four out of 10 male college students, compared to 2 out of every 10 female college students, are electing a science or engineering major (Barber, 1995). In 1992, women accounted for only 15.0 percent of the B.S. degrees, 14.8 percent of the M.S. degrees, and 9.7 percent of the Ph.D. degrees in engineering (Morgan, 1992). Women college graduates today are still only two-thirds as likely as men to have obtained their degree in science or engineering (Barber, 1995).

Several organizations have documented the underrepresentation of women in science and engineering in the United States (Council on Research and Technology, 1989; National Science Board, 1989; National Science Foundation, 1992a, 1992b). This underrepresentation of women and minorities in engineering indicates future serious shortages of engineers and scientists (Levin & Wyckoff, 1991, National Research Council, 1984; National Science Foundation, 1987). Statistical reports have documented this underrepresentation which persists despite the fact that women and minorities are an increasingly important source of talent for maintaining world leadership in these areas (Dix, 1986).

1.1.2. Attrition

A nontraditional choice of major does not guarantee completion of a degree in that major. The attrition rate of women and men in engineering has purportedly been as high as 50-70 percent in some engineering programs (Hayden & Halloway, 1985; Levin & Wyckoff, 1991). The average retention rates for Caucasians in engineering schools are approximately 50 percent, and for minorities, only about 30 percent (Landis, 1991). Thus, the attrition rate for minorities is estimated at 70 percent (Morning & Fleming, 1994).

The dropout rate in engineering, very much higher for women than men, indicated that experiences in undergraduate programs may be situational or institutional (Shaer et al., 1991). In fact combining the fields of science, mathematics and engineering, female engineering students fare worse than male students. For example, 44.4 percent of females (compared with 54.2 percent of males) intending to major in one of these fields actually received a degree in them. Of female freshmen enrolling in engineering programs in 1985, 35.6 percent dropped out of engineering before completing their sophomore year compared with approximately 16 percent of male freshmen engineering majors (Engineering Manpower Commission, 1987). Although few published studies are available to explain the differential attrition rates among men and women in engineering, many studies have been aimed at the general college population. One particularly illuminating study was Arnold's (1987) Illinois Valedictorian Project described by Widnall (1988). A group of 80 students (46 women and 34 men) who had graduated in 1981 at the top of their high school classes was tracked through college. The group continued its high academic performance, with the women earning a final GPA of 3.6 and the men 3.5 for their college years. In spite of their performance, the women suffered a significant loss of self-esteem by the end of their senior year and underestimated their intelligence relative to their peers (Arnold, 1987).

Most attrition in engineering education occurs in the lower divisions (Henes et al., 1995). Two recent studies underscored women's dissatisfaction with almost every facet of the freshman engineering experience (Hegg, 1995; Van Aken, 1995). Women engineering students reported both subtle and blatant sexual harassment and disrespectful treatment by both first year engineering faculty and male engineering students. Even though attrition rates become similar for men and women in the final years of undergraduate work, women do not go on to graduate school in the same proportion at which they graduate (Henes et al., 1995). In recent years, women obtained 14.5 percent of the bachelor degrees in engineering, yet only 6.8 percent of the doctorates (Wadsworth & LeBold, 1993). Such differential attrition occurs to a varying extent in all the major specialities of engineering (Wadsworth & LeBold, 1993).

Some writers have attempted to explain women's attrition from engineering. Schaer et.al. (1991) identified six areas which function as barriers to the successful compeltion of an engineering degree: personal and background variables, such as family support or social status; financial concerns; career awareness and maturity; sex stereotyped views that few women can manage a career in engineering; personality factors related to locus of control, responsibility, and self-esteem; and abilities in math and science. A second study identified environmental barriers to persistence in engineering. A survey conducted at the University of California-Davis indicated five major reasons why women leave or become discouraged with engineering; isolation; not seeing the relevance of highly theoretical basic courses; negative experiences in laboratory courses; the "chilly" classroom climate; and lack of role models and mentors (Henes et al., 1995).

1.2. Statement of the Problem

Women's underrepresentation, or failure to choose, and attrition, or failure to persist, in engineering and other non-traditional curricula, results in their continuing plight with occupational segregation and wage discrimination. Girls who fail to pursue higher level mathematics and science in high school limit their future occupational opportunities. The subjects women study in school can make a difference in the fight against occupational segregation and wage discrimination. Wage differentials favoring men are considerably less - or disappear altogether - for women in their early thirities who have earned eight or more mathematics credits in college (Adelman, 1991). "To study college-level mathematics, however, students must have taken high school courses and believe that mathematics is for them, not only for others" (AAUW, 1992, p.8). Only then do occupational opportunities become equitable and are women free to choose occupations traditionally male-dominated - those often offering more status and rewards in society.

Occupational segregation and wage discrimination can affect women throughout their lives. Women are heavily concentrated in a narrow range of occupations traditionally considered appropriate for them and earn about two-thirds the salary of men employed in comparable occupations. Occupational segregation among minority women is even more extreme. Forty-one percent of African-American women working in service occupations are employed as maids, welfare service aides, cleaners, or nurse's aides. For Hispanic women, job segregation has meant disproportionate employment in low-level factory jobs in some of the industries hardest hit by the current downturn in the economy (Escutia & Prieto, 1988).

Sixty percent of all working women hold clerical, service, or professional positions; however, more than sixty percent of the women holding professional positions are concentrated in female-intensive fields such as school teaching and nursing (Taeuber, 1991). Indeed, most women continue to work in four career categories: social work, nursing, teaching, and office work, including secretarial and clerical positions. These stereotypically "feminine" occupations pay less and have less status than do comparable "masculine" occupations (Foss & Slaney, 1986). The gender gap in the engineering profession is dramatic: although women make up roughly 50 percent of the general population and 44 percent of the United States work force, as of 1988 they represented only 4 percent of the practicing engineers (Morgan, 1992).

Women in nontraditional fields can increase their earnings by 35 percent over their counterparts in female-dominated occupations; however, fewer than one in ten working women is employed in nontraditional occupations (Dougherty, 1990). Unfortunately, female scientists and engineers are not spared the effects of wage discrimination. In 1989 women scientists and engineers with twenty years experience were paid 85 percent of what their male colleagues employed for the same length of time were receiving (Barber, 1995).

1.3. Purpose of the Study

Given the grim statistics presented in Sections 1.1 and 1.2, one might question why and how women choose engineering, and specifically, why and how they persist despite biases, obstacles, and barriers to their career development as future engineers. "The devaluation of any work known to have been done by women, the exclusion of women from men's informational networks, the obstacles put in the path of women's attempts to obtain safe and reliable mentors (and, later to be perceived as such mentors themselves) - these and other disciminatory tactics give us increased appreciation for women who persisted" (Harding, 1991, p. 29).

Research on persistence in engineering has been limited, especially with samples of female engineering students; many studies have utilized samples of male and female freshmen with expressed interests in science and engineering. [The distinction between projected and actual career choice is important because there is evidence that projected choice in early adulthood is a poor predictor of future careers especially for women who eventually select nontraditional occupations (Nieva & Gutek, 1981).] The few studies which do address persistence have been quantitative studies based on such indices as mathematics and science ability, grade point average, and Scholastic Achievement Test (SAT) scores. Though predicitive of persistence, these indices do not tell the whole story.

The purpose of this study was to develop profiles of women who persist in engineering (see the definition of terms in Section 1.7). A strong line of feminist research and thinking, including the work of Jane Roland Martin, Jean Baker Miller, Carol Gilligan, Nel Noddings, and Mary Belenky and her colleages, addresses the strengths of girls and women. Likewise, inclusive research focuses on the competencies and strengths of underrepresented groups rather than the deficits, thus facilitating new ways of thinking about ethnic minorities. Qualitative data contributed further to our understanding of the career choice processes of women in a male-dominated, non-traditional occupation, their experiences in that environment, and their strengths and ways of persisting. Qualitative methodology included both individual in-depth interviews and small focus group interviews which resembled small group conversations. The data were collected in the fall of 1996 at a large land-grant institution in the Southeastern United States. Participants included 36 current and former undergraduate women engineering students, including African American women, Asian women, Caucasian women, Hispanic women, and women from rural geographical areas.

1.4. Rationale for the Study

Previous research on the career development of women, including women in nontraditional fields such as science and engineering, has contributed greatly to our understanding of the multitude of factors relevant to both traditional and nontraditional career choice. Studies show that gender role socialization influences both men and women in their occupational choices, often restricting both to gender-traditional occupations (AAUW, 1992; Auster & Seiferth, 1979; Betz & Fitzgerald, 1987; Dillard & Campbell, 1981; Fitzgerald & Crites, 1980; Haring & Beyard-Taylor (1984); Wesley & Wesley, 1977). Studies also document the importance of parental influence, especially a father's influence for women (Dick & Rallis, 1991; O'Connell, Betz & Kurth, 1989). A national survey by the Cooper Union of women studying engineering as well as those in engineering practice revealed that 75 percent of those women had fathers or brothers who were engineers (Hamlin, 1995). The father often provides an engineering or technical role model, thus offering his daughter learning experiences, opportunities, and encouragement to pursue engineering as a profession.

Factors relevant to nontraditional occupational choice and persistence can be grouped into three primary categories:

- family background variables, such as socioeconomic status and parental education (Ethington, 1988; Hannah & Kahn, 1989; Ware, Steckler & Leserman, 1985);
- individual or psychological variables, such as mathematics and science ability and achievement (Ethington & Wolfle, 1984, 1986a; Eccles & Jacobs, 1986; Hyde et al., 1990; Singer & Stake, 1986); dimensions of personality (AAUW, 1990; Baker, 1987; Chusmir, 1983; Cooper & Robinson, 1989a; Gill et al., 1987; Jagacinski, 1987a); and self-efficacy (Betz & Hackett, 1981, 1983; Lent, Brown & Larkin, 1984, 1986).
- environmental or sociological variables, such as role models and mentors (Fitzgerald & Silverman, 1989); the structure of opportunity (Chusmir, 1983; Fitzgerald & Silverman, 1989; Stringer & Duncan, 1985); educational climate in the schools (Reyes & Fennema, 1982; Sadker & Sadker, 1986; Sadker, Sadker & Klein, 1991); and counseling and mentoring (Cosgrove, Blaisdell & Anderson, 1994a; Evans, 1993; Levin, Wyckoff & Hussey, 1994; McDaniels & Gysbers, 1992).

What are the factors relevant to women (apart from men), their choice of engineering as a major, and ultimately, their persistence in that major? Research documents the importance of the following in persistence: (1) traditional quantitative variables, such as grade point average and math and science ability (Levin & Wyckoff, 1987, 1988, 1990a, 1990b); (2) personality variables (Brown & Cross, 1992, 1993); (3) environmental variables, such as classroom climate (Blaisdell, 1995; Hall & Sandler, 1982, 1984; Seymour, 1995) and engineering education (O'Neal, 1994; Wankat, 1993); (4) self-efficacy (Betz & Hackett, 1983; Lent, Brown & Larkin, 1984, 1986; and (5) support systems such as Women in Engineering Programs (Brainard et al., 1993) and counseling and advising (Anderson, 1995; Panitz, 1995). The rationale for this study is to consider all these variables in concert with women's strengths in an attempt to learn how they persist, and ultimately to learn how to combat the underrepresentation and attrition of women in engineering.

1.5. Questions Guiding the Study

The study was guided by the following questions:

(1) What experiences have been influential in undergraduate women's selection of engineering as a major? For example, what are the aspects of home environments, educational experiences, and counseling and guidance services which foster non-traditional choice of major?

(2) How does the culture and climate of engineering education at the university level influence the experiences, both positive and negative, of women in engineering majors?

(3) How do individual, educational, social, and environmental characteristics and strategies contribute to women's persistence in their engineering majors?

(4) Which of these characteristics and strategies, if any, differentiate between female persisters and non-persisters, that is, what are the differences between academically successful women who leave their engineering majors and those who remain in their engineering majors?

(5) Are factors of persistence and non-persistence similar for women of different groups, that is, African American women, Asian women, Caucasian women, Hispanic women, women from rural geographical areas, and non-persisters?

1.6. Significance of the Study

Why conduct a qualitative study of women's persistence in engineering majors? Women's profiles of persistence, that is, their strengths and ways of persisting in engineering majors, can be utilized in the planning and implementation of a developmental career counseling model focusing on building such personal strengths. Findings provide insight into non-traditional major choice and implications for school and college counselors who are committed to broadening girls' and women's future options. "By ignoring the strengths and contributions as well as the educational needs of girls [and women], the current debate is short-changing not only our daughters but our sons as well" (AAUW, 1992, p.4).

In general, research should contribute to knowledge, be useful and meaningful to the relevant policy arenas, and be useful to practitioners (Marshall & Rossman, 1989). This study was useful in these three broad areas:

1.6.1. Contribution to Knowledge

The findings from this study have increased our understanding of (1) the choice of major process for women in undergraduate engineering through a developmental perspective, and (2) their ways of persisting in that choice. A more proactive model aimed at identifying and encouraging talented young women and minorities in realizing their potential and developing the skills necessary for persistence in engineering majors will ultimately increase their numbers in the field. In fact, Berryman (1985) proposed the need for early interventions in order to increase women's share of the initial mathematical/scientific talent pool. This study proposes that the actual persisters inform educators about those factors which have helped them to persist despite the odds.

1.6.2. Relevance to Public Policy

Educational policy makers may use these findings to actively support and encourage both male and female students in their pursuit of individual values and goals and the realization of each individual's potential. It is also hoped that knowledge gleaned from this study will reinforce the importance of legislation aimed at educational equity for both genders and for students from all geographical areas and educational systems.

1.6.3. Usefulness to Practitioners

Identifying profiles of persisters and non-persisters will have implications for parents, teachers and counselors in public schools, and faculty and program administrators in colleges of engineering at major public universities. While Minority Engineering Programs (MEPs) and other retention programs are beneficial to retaining those women and minorities who have selected engineering as a career choice, this strategy is necessarily reactive. More useful strategies might be guiding girls and adolescents in the development of more positive self-concepts, ensuring equitable educational and other learning opportunities for girls from all socioeconomic levels and family backgrounds, developing outstanding mathematics and science programs which link theory to practice, and alleviating gender bias and chilly environments in mathematics, science, and engineering programs in the public school systems and institutions of higher education.

1.7. Definition of Terms

Non-traditional occupations are those employing thirty percent or less women (United States Women's Bureau, 1975). In this study, the focus is on engineering, a non-traditional major and occupation for women. The College of Engineering at this research institution in the Southeastern United States has an enrollment of approximately 17 percent women in its programs.

Persistence refers to a behavioral tendency to persevere or persist and suggests an admirable striving against opposition (Reber, 1985). As an operational definition, persistence was defined as having completed a minimum of two years of study in engineering in good academic standing. Non-persistence was defined as having dropped out of engineering sometime during the first two years of study.

A profile analysis is a profile of a person in the sense of a sketch or general representation of the personality traits and characteristics displayed, relative to a set of norms for the population as a whole. The analysis may take the form of a literal profile, in which the data are presented in graphic form, or it may be a more general metaphoric profile in the sense of a general overview of the individual's characteristics or traits presented in summary form (Reber, 1985). This study utilized the metaphoric profile form.

Rural geographical areas refer to those rural and small town communities in the state in which public school funding levels and average SAT and achievement test scores lag behind most suburban and urban areas in the state (Felder at al., 1994). Rural areas in this study were located in communities in the South Central and Southwest portions of the state.

Culture refers to a "learned body of tradition that governs what one needs to know, think, and feel in order to meet the standards of membership" (Goodenough, 1970). Kunda (1992) presented a study of the engineering culture in a high-tech corporation. This study focused on the engineering culture at a Southeastern land-grant institution with an all-male, military history. An institution with such a history and with a higher average percentage of men than women enrolled in its engineering programs created a negative climate for women engineering students (Hegg, 1995).

1.8 Assumptions

Assumptions underlying this study were as follows:

- women and minority women are talented in engineering in the same proportion as males in engineering, that is, all students admitted are qualified to study engineering by virtue of admissions criteria, including high school academic records, SAT and other achievement scores, and any other relevant criteria used in the admissions process.

- the study of engineering, and likewise the engineering climate and culture, can create obstacles and barriers to the career development of Caucasian male students as well as women and minority engineering students.
- the climate and culture of engineering may have more of a negative influence on women and minority engineering students than on Caucasian male engineering students.
- the rates of persistence and non-persistence are similar across all engineering disciplines.
- persistence is inherently advantageous for women and minority women engineering students.

1.9. Limitations

Several limitations are inherent in this type of methodology. In some instances, data relied on participants' long-term recall, a methodology that has questionable reliability (Blasidell, 1995). In all likelihood, some students were not able to accurately recall their processes of choice of major and the influences on that choice. Furthermore, participants may not have been consciously aware of those psychological attributes which led to persistence in engineering majors. Finally, people often have widely varying perceptions of the same phenomenon. What is perceived one way by one individual is often perceived another way by another individual.

This study emphasized the experiences of women in engineering at one university, thus there was no attempt to generalize the findings to other populations of engineering students. Ultimately, this study provides guidelines for researchers who desire to study their own population of female engineering students qualitatively.

1.10. Theoretical Framework

Career development theories relevant to women provided an eclectic theoretical framework for the study, for example, Krumboltz & Mitchell's (1979) social learning theory and Hackett & Betz's (1981, 1983) self-efficacy theory applied to the process of career development; Super's (1963) theory of self-concept; Gottfredson's (1981) occupational aspirations model; Astin's (1984) sociopsychological model of career choice and behavior; Forrest & Mikolaitis's (1986) relational identity model; and Farmer's (1985) and Fassinger's (1985, 1987) multidimensional models. Theories of college persistence (Cabrera et al., 1992) also provided a theoretical framework.

1.11. Overview of the Chapters

Following this introduction, the specific components of the study are presented in Chapters 2 through 5. Chapter 2 provides a review of the literature. Chapter 3 contains the methodology and procedures utilized in the study. A presentation of the textual data and analysis of findings are presented in Chapter 4. The study's summary, conclusions, and recommendations for additional research are contained in Chapter 5.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

A review of related literature was conducted to provide a general framework of background information relevant to the study of women and persistence of non-persistence in engineering, including women's career development, women's non-traditional occupational choice, and women's persistence in engineering. Section 1 presents an overview of theories of career development particularly relevant to women. An overview of factors relevant to women's non-traditional occupational choice is presented in Section 2. Section 3 presents an overview of literature related to persistence in engineering.

2.1. Women and Career Development

Theories of career development have their roots in the work of Frank Parsons whose landmark book Choosing A Vocation was published in 1909 following his death. Parsons proposed the "matching model" of vocational choice based primarily on a logical match between a man's interests and the requirements of an occupation. While relevant in its time and still used extensively by career counselors today, the matching model may not be an adequate framework for career counseling with women (Betz and Fitzgerald, 1987). Although, logically, the matching or trait-factor model of career development would predict that intellectual capabilities of all youth, both male and female, would lead to high educational and occupational achievement, many young girls and women fail to realize their potential. Why do gifted young women, in particular, fail to utilize their intellectual abilities and talents in the pursuit of majors and occupations? Why are young girls and women often socialized to pursue the same roles regardless of their individual capabilities and talents? Two decade ago, Bem and Bem (1976) referred to this phenomenon as the "homogenization of the American woman," that is, a woman's life roles and vocational choices are predictable, not on the basis of her characteristics as an individual, but on the basis of her gender. Such homogenization results in losses to both individuals and to society when women's talents are so poorly utilized.

The nature of women's labor force participation continues to differ greatly from men. Women restrict their occupational choices more than men. Women also underutilize their abilities and talents and are less likely to advance to higher levels in their occupational fields. Women are underrepresented in a variety of fields and professions and, as a group, enter lower-paying, lower-status occupations, keeping themselves economically disadvantaged and burdened with multiple role demands (Betz and Fitzgerald, 1987). In contrast to men, women's intellectual capacities and talents are often not reflected in their educational and occupational achievements; women's career aspirations and choices are frequently far lower in level than are the aspirations of males with comparable levels of ability (Fitzgerald and Crites, 1980). In other words, despite similar intellectual ability, women compared to men are employed primarily in traditionally female occupations, and they are clearly overrepresented in lower-level, lower-status, and lower-paying occupations (Betz and Fitzgerald, 1987).

Brooks (1984) and Betz and Fitzgerald (1987) made the claim that no adequate explanations of the vocational behavior of women exist. Career development theories have been especially criticized because they inadequately explain the vocational behavior of special groups, particularly women and racial and ethnic minorities (Brooks, 1984). Brooks (1984) stated, "existing theories were formulated primarily to explain the career development of men, and since women's career development is different from men's, the existing theories are inadequate" (p. 355).

Women's labor force participation has been paralleled by a growing concern with the processes of career development relevant to women as well as practical efforts designed to facilitate those processes. About three decades ago, career development theorists began to acknowledge women's differences and the importance of trying to explain their life patterns. Super (1957) proposed seven career patterns and Zytowski (1969) proposed nine postulates, both with the intention of characterizing women's occupational participation patterns. In a longitudinal study of male and female adolescents, Gribbons & Lohnes (1968) discovered the existence of four early emerging persistent differential career processes (DCPs) rather than a single developmental process. Hansen and Rapoza (1978) contributed a comprehensive text on career development and counseling of women while Betz and Fitzgerald (1987) reviewed and integrated research on the career development of women and provided recommendations for future research. Basically there have been three approaches to efforts to develop theory that more adequately explains women's career development: (1) to apply a theory from one realm to another, for example, Hackett and Betz' (1981) application of self-efficacy theory to vocational behavior; (2) to create a new comprehensive theory that is applicable to men as well as women, for example, Gottfredson's (1981, 1983) occupational aspirations model, and Astin's (1984) sociopsychological model; and (3) to suggest ways in which additional concepts can be incorporated into existing theories, for example, Forrest and Mikolaitis' (1986) relational identity model (Brown, Brooks, and Associates, 1990, pp. 365-366).

To complicate the process of career development, women's career decisions are often delayed relative to those of men because women have two major decisions to consider (Betz and Fitzgerald, 1987). Often even before women decide what occupation to pursue, they must decide whether or not and to what degree they wish to make outside employment a focus on their lives. Women are more likely to experience conflict between work and family roles (Fitzgerald and Crites, 1980; Betz and Fitzgerald, 1987). Studies suggest that career planning is built into women's socialization as "contingency training," which involves strategies to delay career decisions until the decisions of marriage and parenthood have been made or until it becomes apparent that they may not occur (Angrist and Almquist, 1975). Though most women are now pursuing employment outside the home, the assumption that a woman is still primarily responsible for maintenance of a home and family, as well as a career, creates obstacles in the form of role overload and role conflict (Russo and Denmark, 1984). Morgan (1992) replicated a study done in 1964. The most popular reason given for women not entering science and engineering was the same in 1992 as it was in 1964; the difficulty of managing demanding professional work with home and child-rearing responsibilities. In fact, men most often responded that a job in engineering is too demanding for women to combine with family responsibilities (Morgan, 1992). Thus, understanding the processes of career choice and the demands of role overload and role conflict and how they are managed across the life span is of central importance in understanding women's career adjustment (Betz and Fitzgerald, 1987).

Although there is no comprehensive theory of women's career development, approaches to the classification of multiple influential factors in that development are important steps toward further understanding of women's career development (Betz and Fitzgerald, 1987). Several theories of career development are useful in explaining women's career development, occupational choice, and barriers to those occupational choices, including Krumboltz' (1979) social learning theory; Hackett and Betz' (1981) self-efficacy theory; developmental models including Gottfredson's (1981, 1983) occupational aspirations model and Super's (1980) life-span, life-space approach; and Astin's (1984) sociopsychological model. Drawing on the work of Chodorow

(1974, 1978) and Gilligan (1977, 1979, 1982), Forest and Mikolaitis (1986) developed a relational identity model that provides a useful framework for understanding non-persistence in engineering. The theory of person-environment fit (Holland, 1985) is also relevant to non-persistence in engineering. Farmer's (1985) and Fassinger's (1985, 1987) multidimensional models are also noteworthy. These theories or models are discussed in the following subsections.

2.1.1. Social Learning Theory

In an attempt to bridge the gap between what we already know about the process of career choice and women's career development, increased attention has been given to social learning theory and the role of a multitude of factors in the process of career choice (Mitchell and Krumboltz, 1984). Social learning theory is a comprehensive theory of career development that attempts to explain how educational and occupational preferences and skills are acquired and how selection of courses, occupations, and fields of work are made. It identifies the "interactions of genetic factors, environmental conditions, learning experiences, cognitive and emotional responses and performance skills that produce movement along one career path or another" (Krumboltz, 1979, p. 19). Both internal (personal) and external (environmental) influencers shape the nature and number of those options and the way in which individuals respond to them. These influencers may act as constraints or facilitators.

Krumboltz posits four categories of influencers: (1) genetic endowment and special abilities; (2) environmental conditions and events; (3) learning experiences; and (4) task approach skills. Both race and gender may limit or encourage certain educational and occupational preferences and skills. In the choice of engineering as an occupational path, intelligence in general, and mathematics and science ability in particular, are forms of special abilities relevant to that choice. Although some individuals are born with greater or lesser predispositions to profit from some learning experiences, some variance is also due to environmental conditions and events. The young woman raised in rural Southwest Virginia will have fewer opportunities to participate in vicarious learning experiences related to mathematics, science and engineering, for example, space and computer camps, than the young woman raised in suburban Northern Virginia. "The underlying environmental, economic, social and cultural events and conditions impinge upon the individual's learning experiences" (Krumboltz, 1979, p. 33). The educational system, including per pupil expenditures, school organization and administration, and teacher training and personality are primary influencers on the learning experiences available to individuals in those systems.

Educational and occupational decision making is also influenced by an individual's past learning experiences. Observational learning experiences are often very relevant to a nontraditional occupational choice and occur when an individual learns by observing real or fictitious models (Krumboltz, 1979). These learning experiences produce not only preferences (emotional reactions of liking or disliking) for various activities but cognitive and performance skills as well (Krumboltz, 1979). A successful performance or positive feedback from other people increases the probability that certain types of activities will be repeated and therefore that certain types of skills will be developed to a greater extent (Krumboltz, 1979). Therefore, it is the "sequential cumulative effects of numerous learning experiences affected by various environmental circumstances and the individual's cognitive and emotional reactions to these learning experiences and circumstances that cause a person to make a decision to enroll in a certain educational program or become employed in a particular occupation. School enrollment or employment is not a simple function of preference, choice, or interest but is influenced by complex environmental factors, many of which are beyond the control of any single individual" (Krumboltz, 1979, p. 37).

Social learning theory directs attention to those characteristics and experiences that differentiate girls from boys as well as to the differences found among girls and boys of various racial, ethnic, socioeconomic, and cultural groups (Krumboltz, 1979). In addition to one's learning experiences and socialization processes, social learning theory considers the role of socioeconomic status, gender, race, ethnicity, and culture in explaining an individual's occupational choice. Socioeconomic status is perhaps the best predictor of both grades and test scores in school (AAUW, 1992). For example, very few low-socioeconomic status students score in the advanced reading or in the advanced math category while very few high-socioeconomic status fall below the basic skills level in reading or math (AAUW, 1992). The data confirm what has been known for many years - socioeconomic status, more than any other variable, predicts education outcomes (Weis, Farrar and Petrie, 1989). These authors found that when student populations were matched by socioeconomic status, blacks and Hispanics were less likely than white to drop out of school and were more likely to go on to college (Weis et al., 1989).

Within both low- and high-socioeconomic groups, there are gender differences. Among high-socioeconomic eighth graders, girls are no more likely than boys to be in advanced reading, and they are less likely to be in advanced math. Thus, there is a "marked bipolarity in the relative achievement of eighth-grade girls; those of low socioeconomic status are more likely to do better than similar boys, while those at high socioeconomic status are only as likely and often less likely to do as well as boys" (AAUW, 1992, p. 57). Among high socioeconomic students, boys clearly do better than girls in high school. Studies have shown that "women engineers are typically from families of high socioeconomic standing" (Hannah and Kahn, 1989).

Parental level of education and occupational attainment are the best predictors of socioeconomic status with higher levels of education leading to greater occupational attainment. Female engineers' fathers are typically employed in engineering (Fitzpatrick and Silverman, 1989). If their fathers are not engineers, they are still likely to be well educated (Greenfield, Holloway and Remus, 1982). In act, both parents are more likely to have college degrees and be employed in professional positions than the parents of women employed in traditional occupations and male engineers (Jagacinski, 1987a). On the other hand, while chances are good that her mother works, her mother is less likely to work than the mother of a girl who will pursue a traditionally feminine career (O'Connell, Betz and Kurth, 1989). Although the eldest child is often associated with the characteristics of being ambitious and goal-directed, birth order does not appear to affect a girl's chances of becoming a scientist or engineer, nor does it matter what gender her siblings are (Fitzpatrick and Silverman, 1989).

While dropping out is minimal among students of high socioeconomic status (AAUW, 1992, p. 58), the picture is much bleaker for students of low socioeconomic status. "Children who feel that they will be consigned to low-caste jobs because of their race or caste status have little motivation to excel in school" (Ogbu, 1978). Racial and ethnic minorities are more likely to attend poorer schools with fewer resources (AAUW, 1992, p. 60). Research on black students in desegregated schools indicates that black girls do not do as well as boys in this environment, often feeling excluded and socially isolated (Smith, 1991). Jonathan Kozol's (1991) recent book, <u>Savage Inequalities</u>, points to a fact: "there is something terribly wrong with the way we finance education in this country. Educational excellence and equity can never be achieved until we devote substantial financial resources to poor children." Cycles of poverty and low socioeconomic status are being perpetuated in schools all across the country.

2.1.2. Self-Efficacy Theory

Self-efficacy theory is concerned with one's beliefs that a given task or behavior can be successfully performed; that is, self-efficacy is concerned with one's beliefs about his or her own capabilities (Bandura, 1977). Self-efficacy expectations vary on three dimensions: (1) level, (2) strength, and (3) generality (Bandura, 1986). While self-efficacy refers to beliefs about the ability to perform a behavior, outcome expectations refer to the individual's beliefs about the consequences of performance (Bandura, 1986). Another variable that influences whether behavior will be initiated are incentives (Bandura, 1986). In regard to the development and modification of efficacy beliefs, Bandura (1986) identified four sources of information: (1) performance accomplishments, (2) vicarious experiences, (3) verbal persuasion or encouragement from others, and (4) physiological or emotional arousal, for example, anxiety.

Performance accomplishments have been shown to have the most powerful influence on self-efficacy (Maddux and Stanley, 1986). Vicarious learning appears to be the second most powerful influencer on self-efficacy and is influenced by the perceived similarity between the model and the observer, the number and variety of models, and the perceived power of the models (Maddux and Stanley, 1986). Encouragement and support, the third most powerful influencer, are influenced by the perceived expertness, trustworthiness and attractiveness of the source (Maddux and Stanley, 1986). Perceived self-efficacy causes an individual to approach that particular task or behavior with anxiety, and this emotional arousal may perpetuate a sense of self-inefficacy (Bandura, 1986). The degree to which self-efficacy is affected by emotional arousal depends on the individual's appraisal of the source of arousal, the level of arousal, and the circumstances under which the arousal is elicited, and the personal experiences of how arousal affects the individual's performance. It is perceived self-inefficacy for coping with these aversive events that leads to fearful expectations and avoidance behavior, for example, math anxiety (Bandura, 1986).

Hackett and Betz (1981) were the first researchers to apply self-efficacy theory to the process of women's career development. They proposed that differential sex-role socialization prevents women from gaining equal access to information from which self-efficacy expectations are acquired. In particular, differential sex-role socialization prevents women from gaining access to the four sources of information through which self-efficacy beliefs are acquired (Hackett and Betz, 1981). For example, regarding performance accomplishments, girls are less likely than boys to gain the experiences that will enable them to develop abilities related to male-dominated occupational areas. Boys have also been found to receive more encouragement for career pursuits than girls and women do (Hackett and Betz, 1981). Women, compared to men, possess lower and weaker career-related efficacy expectations, and these differences help explain women's vocational behavior (for example, a restricted range of options and underutilization of abilities (Hackett and Betz, 1981). If individuals "lack expectations of personal efficacy in one or more career-related behavioral domains, behaviors critical to effective and satisfying choices, plans, and achievements are less likely to be initiated and, even if initiated, less likely to be sustained when obstacles or negative experiences are encountered" (Hackett and Betz, 1981, p. 329).

Other studies have extended Hackett and Betz' (1981) early work of applying self-efficacy theory to the career choice process. Campbell and Hackett (1985) and Hackett and Campbell (1985) (as cited in Betz and Hackett, 1986) found that performance accomplishments (success) led to an increase in self-efficacy, while failure resulted in a decrease in level and strength of self-efficacy. Performance also influenced ability ratings, interest, and attributions (whether success was attributed to luck or a lack of ability).

Several studies on the topic were published in 1987. Lent and Hackett (1987) found that self-efficacy beliefs are predictive of important indices of career-entry behavior, such as college major choices and academic performance in certain fields. Because career self-efficacy and other measures of self-esteem and career indecision were not significantly correlated, their work provided support for the idea that self-efficacy is a unique construct (Lent and Hackett, 1987). Hackett and Campbell (1987) found that college students' self-efficacy ratings and task interest decreased as a result of failing a task. Women in a "success" condition were more likely than men to attribute their performance to luck while women in the "failure" condition were more likely than men to attribute their performance to a lack of ability (Hackett and Campbell, 1987). These authors concluded that a lack of past performance accomplishments may be more detrimental to women's self-efficacy than men's (Hackett and Campbell, 1987). Lent, Brown and Larkin (1987) found that self-efficacy was a more useful predictor of perceived options than Holland's (1985) theory of person-environment congruence.

Bandura (1986) posited that perceived efficacy and self-evaluative mechanisms foster the growth of intrinsic interests, with people exhibiting enduring interest in activities that engage their feelings of personal efficacy and satisfaction. Women's limited access to sources of self-efficacy restrict their entry into traditionally male-dominated careers such as science and engineering (Hackett and Betz, 1981). How does a woman develop an interest in nontraditional occupations? Self-efficacy expectations are considered an important cognitive determinant of whether individuals will attempt such a behavior. The literature relevant to self-efficacy and nontraditional occupational choice is presented in Section 2.2.8.

2.1.3. Developmental Models

The normal development processes and the accompanying tasks associated with those processes over the life span provide insight into the development of interests, abilities, values, self-concept, and other aspects of personality. "Self-concepts, such as self-efficacy, self-esteem, and role self-concepts, being combinations of traits ascribed to oneself" influence every aspect of individuals' lives, including occupational aspirations and choice (Super et al., 1963). "The process of career development is essentially that of developing and implementing occupational self-concepts" (1990).

Extending Super's work, Hansen (1978) and Gottfredson (1978) discussed career development frameworks for facilitating women's growth. Providing a vehicle through which counselors can work with teachers in creating curriculum experiences to facilitate female growth, Hansen (1978) provided a conceptual framework of sequential, developmental experiences for girls and boys from kindergarten through senior high. Gottfredson's developmental model of occupational aspirations explains "how the well-documented differences in aspirations by social group (race, class, and gender) develop" (Gottfredson, 1983, p. 204). Occupational aspirations are circumscribed according to elements of the self concept that are vocationally relevant, that is, gender, social class, intelligence, interests, values, and abilities (Brooks, 1990). In other words, Gottfredson suggested that people assess the suitability of occupations according to their self-concepts. She suggests that occupations that are perceived to be inappropriate for one's sex are first eliminated at about the age of 6-8 years; thus occupations become gender stereotyped early in one's development (Gottfredson, 1981). Once these options are rejected, they usually will not be reconsidered except in unusual circumstances. Therefore, vocational choice, especially for women, often involves a compromise process which eliminates alternatives from further consideration (Brooks, 1990). Holt (1989) investigated the compromise process using undergraduate social work and engineering majors. Results showed that Realistic types (engineering majors) were more concerned with prestige level than interests while Social types (social work majors) were more concerned with interests than with prestige level, suggesting that the compromise process is a function of Holland types (Holt, 1989). Betz and Fitzgerald (1987) criticized the deterministic assumptions of Gottfredson's model on the grounds that it does not account for the increasing numbers of women entering some nontraditional fields. Perhaps it best accounts for those qualified and talented young women who never enter those fields.

2.1.4. Sociopsychological Model

Astin's need-based sociopsychological model contains four constructs: motivation, expectations, sex-role socialization, and structure of opportunity (Astin, 1984). Her model attends to both psychological variables (personal characteristics) as well as the cultural-environmental variables (social forces) and the interaction of the two in shaping human behavior, including occupational choice (Astin, 1984).

Roe's (1956) theory included the important of early childhood experiences as well as the concept of needs. Likewise, Astin (1984) proposed that all humans, both male and female, are motivated by three primary needs: survival, pleasure, and contribution (Astin, 1984). All three needs are relevant to occupational choice. However, women differ from men in their expectations of what kind of work will satisfy those needs due to the sex-role socialization process and the structure of opportunity (Brooks, 1990). "The interactive relationship between sex-role socialization and the structure of opportunity is what accounts for the changes in women's aspirations and choices in recent years" (Brooks, 1990, p. 380). Likewise, the structure of opportunity (Astin, 1984) is affected by one's subculture and culture and the rate of return for different occupations.

2.1.5. Relational Identity Model

Influenced by the work of Chodorow (1974, 1978), Gilligan (1977, 1979, 1982), and Lyons (1983), Forrest and Mikolaitis (1986) developed a model which relates women's occupational choice to their sense of identity gained primarily in terms of their connection to and relationship to others (Brooks, 1990). "The relational models have provided a means of understanding and affirming basic human needs for connection and attachment throughout the life span" (Blustein and Noumair, 1996). For example, a woman's desire for a "connected self" may alleviate an occupational choice, such as engineering, which more clearly emphasizes a "separate self" identity (Brooks, 1990).

2.1.6. Person-Environment Fit

"Holland (1985) adopted some aspects of Erikson's (1968) identity construct in his notions of identity for both the individual and the environment" (Blustein and Noumair, 1996, p. 74). In the person-environment fit theory developed by Dawis and Lofquist (1984) and Lofquist and Dawis (1991), a person's self-concept or self-image represents his or her perception of personality, including psychological needs, values and abilities, and ability to satisfy those needs within the environment (Blustein and Noumair, 1996). Hegg (1995) found that many young women left engineering because they felt their perceptions of personality did not fit into the environment in engineering. Science and engineering fields are perceived to be masculine environments. They are occupied mostly by men and are characterized by traits such as competitive and analytical, traditionally viewed as masculine (Leder, 1986). Among college students in Britain, engineering, followed by physics, chemistry, and mathematics, were rated as the most masculine (Archer and Freedman (1989). Taylor and Whetstone (1983) examined the educational goals and personal characteristics (values and attitudes) of academically successful and unsuccessful men and women engineering students. Their work confirmed the college-fit theory: If the values, goals, and attitudes of a student correspond to those of an institution, the student is likely to remain at the institution (Taylor and Whetstone, 1983).

2.1.7. Multidimensional Models

Farmer's (1985) social learning-oriented model proposes that the career motivation of adolescents develops through three interacting influences: background variables, personal psychological variables, and environmental variables (Brooks, 1990). Fassinger's (1985, 1987) covariance structural model is based on Betz and Fitzgerald's (1987) comprehensive review of the research relevant to women's vocational behavior (Brooks, 1990). In addition to the variables proposed by Farmer, Fassinger hypothesizes that ability, instrumentality, feminist orientation, and family orientation influence both career and mathematics orientation (Brooks, 1990).

2.2. Women in Non-traditional Fields

When the homemaking versus career orientation approach to women's career development decreased in usefulness in the early 1970s, the major approach to describing the nature of women's career choices involved the classification of preferences or choices according to the degree to which they were traditional versus nontraditional for women (Betz and Fitzgerald, 1987). Although there is some disagreement in the literature as to the definition of a "non-traditional" occupation, those occupational fields with less than 30 percent women or men are defined as nontraditional for women or men, respectively. Those with 30 to 69 percent women or men are considered gender-neutral, and those with 70 or more percent women or men are traditional for the gender. Ethington (1988) stated that studies concerning the underrepresentation of women in non-traditional fields have gone in two directions: (1) identifying factors involved with a woman's choice between a quantitative or a qualitative field, and (2) making comparisons between women and men in quantitative fields. This study provides another direction: studying differences between female persisters and non-persisters in a nontraditional field, specifically engineering. Literature related to the topic of nontraditional occupational choice will be discussed under the following subsections: gender role socialization; influences on non-traditional occupational choice; innate gender differences; educational climate in public schools; role models and mentors; dimensions of personality, including masculinity/instrumentality, femininity/expressiveness, and locus of control; mathematics achievement; and self-efficacy.

2.2.1. Gender Role Socialization

The influence of gender role socialization is paramount to an individual's sense of identity and eventual occupational choice. Gender refers to "different sets of expectations and limitations imposed by society on girls and boys simply because they are female or male" (AAUW, 1992, p. 5). Society holds different expectations for girls and boys. These expectations in turn generate different patterns of behavior toward children, depending on their sex (AAUW, 1992, p. 16). Differential treatment of boys and girls from birth, by their parents and others, has been confirmed by an abundance of studies (Letarte, 1992). The Center for Research on Women (1992) has published a bibliography of research on the topic and its influence on girls in U.S. Public Schools from kindergarten through grade 12. One conclusion of such research is that different socialization experiences of males and females result in a more complex pattern of career development for women (Fitzgerald and Crites, 1980).

The mechanisms by which children learn sex role stereotypes, or normative expectations for the sexes, and develop sex-typed characteristics include reinforcement and punishment, modeling, and the adoption of rules, schemas, or generalizations based on observations of others or as they are taught by others (Hyde and Rosenberg, 1980). These mechanisms operate through the influences of parents, teachers, and the media (Williams, 1983).

2.2.1.1. Parental Influence

Gender role socialization processes begin in the home through such mechanisms as parental attitudes and beliefs, patterns of interaction, expectations of appropriate and inappropriate behavior, choice of toys, philosophies on child-rearing, and assignment of tasks and chores. While some studies have demonstrated changes over the years, other studies demonstrate differential treatment of boys and girls. Lytton and Romney (1991) conducted a meta-analysis of 172 studies in an attempt to resolve the conflict between previous narrative reviews on whether parents make systematic differences in their rearing of boys and girls. Most effect sizes were found to be nonsignificant and small. In North American studies, the only socialization area of nineteen to display a significant effect for both parents was encouragement of sex-typed activities. Williams, Goodman, and Green (1985) studied differences between tomboys and non-tomboys and their parents in a longitudinal study. Analyses of parental factors in gender role socialization indicated little difference between the two groups in parent child contact during the first five years of the children's lives (Williams et al., 1985). Tomboys were more likely to choose their fathers as the favored parent, and they were more likely to model their fathers (Williams et al., 1985). Fathers from both groups had similar masculinity ratings; however, mothers of tomboys were more likely to have been tomboys themselves and to accept tomboyish behavior on the part of their daughters (Williams et al. 1985). (Idle et al., 1993) examined the interaction and gender role socialization for 20 parent-child dyads in intact families. The play patterns of parents and children were not typically gender stereotyped. The results suggested a change in parents' perceptions about what is acceptable gender-typing behavior, possibly reflecting a realization that some toys are more socially acceptable than others (Idle et al., 1993). However, in a study published only a year earlier, the authors found that the perceived attitudes of mothers and fathers had significantly different influences for male and female Agriculture students on the students' own attitudes. The mothers of these students were all found to be predominantly traditional (Donelan, 1992).

Parental choice of toys is often based on gender role stereotypes (Solomon, 1982). Likewise, boys and girls grow up having different play experiences. Preschool boys handle more tools, throw more balls, construct more Lego bridges, build more block towers, and tinker more with simple mechanical objects than do girls (Kahle, 1990). As they grow, girls and boys also have different science experiences. Girls are more apt to be exposed to biology-related activities and less apt to engage in mechanical and electrical activities (Kahle, 1990). Thus, "if girls are not specifically encouraged to participate in these 'boy' activities, they do not receive a full and balanced set of educational experiences" (AAUW, 1992, p. 28). Gender differences in science-related activities may be reinforced in schools if children are allowed always to select science topics based on familiarity or interest. Gender differences continue through ages thirteen and seventeen and is paralleled by an increasingly negative view of science, science classes, and science careers on the part of girls (Zimmer and Bennett, 1987).

Tasks and chores are often assigned according to what parents perceive as gender appropriate, with boys more often assigned outdoor tasks and girls more often assigned inside tasks (Rosenwasser, 1982). Parental expectations also differ for their children, depending on their sex. Expectations such as hard working, intelligent, honest, ambitious, aggressive, independent, and successful have been reported for males while expectations such as good mother, good wife, kind, loving, and attractive have been reported for females (Hoffman, 1977). These parental expectations may influence the occupations and roles children select for themselves (Rosenwasser, 1982).

2.2.1.2. Influence of the Schools

The subtle messages children receive from a variety of societal influences impacts both gender role development and the development of the self-concept. In addition to the family, schools are a strong socializing force in the development of the individual (Gibson, 1989). Teachers enter the classroom with their own socially influenced expectations of sex-appropriate behaviors and careers for girls and for boys. Like other members of society, teachers are the product of a socialization process that generally expects girls to be passive and dependent and expects boys to be assertive and competitive (Sadker, Sadker and Donald, 1989). The books and materials used by teachers can also have an influence on gender role socialization. Fifteen preschool teachers in four classrooms at a university-affiliated child care facility were found to use books in which male characters appeared 1.8 times as frequently as female characters, with females comprising only 22 percent of the sample (Patt and McBride, 1993). Masculine pronouns were used as generics 3.4 times as frequently as feminine pronouns (Patt and McBride, 1993). The authors concluded that the effect of books' use of predominantly masculine characters and language can be detrimental to girls' gender role socialization (Patt and McBride, 1993).

2.2.1.3. Developmental Factors

A young woman's occupational choice may be influenced by the process of adolescent development. Rogers and Gilligan reported "young girls show striking capacities for self-confidence, courage and resistance to harmful norms of feminine behavior as well as a detailed and complex knowledge of the human social world. Up until the age of eleven or twelve, girls are quite clear and candid about what they think and feel and know" (1988, pp. 42-43). In early adolescence the relative flexibility surrounding appropriate behavior for each gender observed among eight-to-ten year olds lessens and more rigid adherence to gender roles becomes the norm (Simmons and Blyth, 1987). "As girls mature and enter mid-adolescence, their voices become more tentative and conflicted. Their responses reveal a sometimes debilitating tension between caring for themselves and caring for others, between their understanding of the world and their awareness that it is not appropriate to speak or act on this understanding" (AAUW, 1992, p. 20). Studies report significant declines in girls' self-esteem and self-confidence as they move from childhood to early adolescence with sharp differences in self-esteem among girls from different racial and ethnic groups (AAUW, 1991; Harter, 1990; Gilligan, Lyons and Hammer, 1990; Simmons and Blyth, 1987). Thus, young women in high school confront even more directly the conflicting expectations for women in our society (Bush and Simmons, 1987). Recent research traces depression in twelfth grade to changes experienced earlier in adolescence and to the coping strategies individuals develop to deal with stressful events (Peterson, Sarigiani and Kennedy, 1991).

2.2.1.4. Influence on Career Choice

Through gender role socialization, children learn that men and women have different abilities, interests, and aptitudes that are suitable for different occupations based on their gender (Wesley and Wesley, 1977). This process begins early in children's lives. Riley (1981) investigated the effect of gender role socialization on occupational preferences of 540 kindergarten children. Males perceived a significantly wider range of vocational options than females (Riley, 1981). The author concluded that current gender role socialization fails to recognize the realities of the expanding participation of women in the paid labor force. In other words, the socialization process perpetuates rigid gender roles that constrain or limit occupational choice to those traditionally considered sex-appropriate (Auster and Seiferth, 1979; Dillard and Campbell, 1981). For example, men prefer practical, physical, or managerial occupations while women prefer supportive, clerical, and socially-oriented occupations (Kendall and Miller, 1983). Haring and Beyard-Taylor (1984) cite gender role socialization and poor self-concept, particularly concerning math and science abilities, as barriers for females entering non-traditional occupations.

Through gender role socialization processes, children learn to assume the appropriate life roles assigned to their gender. Role induction occurs through the socialization of the child into the acquisition of "sex-appropriate" preferences and skills (Leach and Davies, 1990). Thus society defines what is appropriate for boys and girls, men and women. One's occupational interests, therefore, result from the experiences one gains through the socialization process. Holland (1975) proposed that occupational aspirations of men and women differ because of their life histories.

2.2.2. Influences on Non-traditional Occupational Choice

Several authors have discussed the phenomenon of women and men clustering into different occupations, based on the traditional-nontraditional dichotomy (Betz and Fitzgerald, 1987; Chusmir, 1983; Eccles, 1987). There are some fields which are clearly still dominated by men and the majority of these are technical fields (Betz and Fitzgerald, 1987). One major impetus of the research concerning the underrepresentation of women in nontraditional fields has been to identify the factors involved with a woman's choice between a quantitative or a qualitative field. When considering some of the crucial decisions and factors affecting women's choice and pursuit of a scientific major, six major themes emerged from quantitative data: confidence, personal contact and teamwork, the bigger picture, career plans, understandings about scientific research, and the issue of women in science (Cunningham, 1996).

Differences have been found when comparing women who select nontraditional college majors with those who select traditional college majors. In one study, fathers of the nontraditional students had significantly more education than the fathers of the traditional students (O'Connell, Betz and Kurth, 1989). Surprisingly, only 60 percent of the mothers of nontraditional women worked while 71 percent of the mothers of the traditional women worked (O'Connell, Betz and Kurth, 1989). High socioeconomic status females chose male-dominated fields more than low socioeconomic status females (Hannah and Kahn, 1989). The researchers, however, did not control for the occupations of parents.

Murrell, Frieze and Frost (1991) found that women who planned careers in male-dominated occupations had higher career and educational aspirations. Ethington (1988) found that women who took more science courses in high school, who had higher self-ratings for math and science abilities and who had higher indices of family background not only enhanced the likelihood of choosing a quantitative field, but especially enhanced the likelihood of choosing engineering or the physical sciences. Women enrolled in nontraditional programs have demonstrated greater academic success and more egalitarian sex role attitudes than women in traditional programs (Chatterjee and McCarrey, 1989). Those choosing female-dominated occupations had more traditional attitudes regardless of race (Murrell, Frieze and Frost, 1991).

Racial differences have been found when comparing African-American and Caucasian women who choose nontraditional college majors (Murrell, Frieze and Frost, 1991). Black women who planned careers in male-dominated professions showed higher levels of aspiration, planned more education than was necessary for the desired occupations, and perceived less conflict in combining the roles of career and family than white women (Murrell, Frieze and Frost, 1991). Ellerman and Johnston (1988) found that undergraduate seniors in nontraditional fields are significantly less committed to a future home and family than women entering traditional fields. Furthermore, nontraditional students are significantly more likely to believe that women have a right to compete for jobs traditionally held by men and are less likely to believe the husband should be the breadwinner (O'Connell, Betz and Kurth, 1989). For example, women pursuing nontraditional majors have been compared with women pursuing nursing degrees (O'Connell, Betz and Kurth, 1989). The nontraditional majors were more committed to full-time work than those in nursing (O'Connell, Betz and Kurth, 1989).

Morgan (1992) hypothesized that women at the college age perceive nontraditional fields to be incompatible with having a family. Indeed, women in nontraditional programs expect more difficulties than women in traditional programs (Chatterjee and McCarrey, 1989). Nontraditional careers are seen as more difficult, but not more important, than comparable traditional occupations. For example, Eccles' (1986) survey found that success at nursing was seen as more important than success at engineering, leading the author to conclude that females may be selecting traditionally female occupations because they are positively attracted to them, not because they are avoiding nontraditional occupations. On the other hand, more college senior women expected traditionally feminine occupations than actually preferred them (Burroughs, Turner and Turner, 1984).

Factors involved in choosing a major in science and engineering are both similar and different for men and women (Ware, Steckler and Leserman, 1985). Parents and teachers were perceived to be influences on career choice more often for both male and females students choosing majors in engineering and science than for those not choosing such majors (Dick and Rallis, 1991). Studies also demonstrate gender differences for the factors influencing the decision to enter science or engineering. A lack of interest was a factor for women not choosing careers in engineering or science (Dick and Rallis, 1991). For women, having highly educated parents, extremely high Scholastic Achievement Test (SAT) Mathematics scores, a strong desire for control, prestige and influence, and a desire for positive interaction with others are primary influencers on nontraditional occupational choice (Ware, Steckler and Leserman, 1985). For men, high grades in science courses their freshman year and being certain about the choice of major the summer before college are primary influencers (Ware, Steckler and Leserman, 1985). More men (49 percent) than women (31 percent) reported that the availability of jobs and salary were important influences in their choice of occupation, more often than did traditional majors (Chusmir, 1983; Fitzgeral and Silverman, 1989; Stringer and Duncan, 1985). Male-dominated fields such as science and engineering tend to pay more, and are more prestigious, than female-dominated fields (Foss and Slaney, 1986).

High school girls, even those with exceptional academic preparation in math and science, are choosing math/science careers in disproportionately low numbers (Mullis et al., 1990). Unfortunately, due to a combination of factors including limited exposure and opportunities and lack of encouragement from role models and mentors, many qualified and talented young women do not consider a nontraditional career choice such as engineering. Sax (1992) explored the relationship between men's and women's background characteristics, their college experiences, and their persistence toward careers in science. While 20.6 percent of male college students aspire toward careers in the hard sciences, only 6.4 percent of women shared these goals. At the end of their freshman year, significantly less women than men who had been interested in science entering college actually declared a major in scientific areas, even though they were equally prepared for a scientific major by way of aptitude and academic backgrounds in math and science (Ware, Steckler and Leserman, 1985). Women in engineering programs cite a number of issues that are problematic to them and may be deterring other women from entering engineering (Jagacinski, LeBold and Salvendy, 1988).

2.2.3. Gender Differences

Studies concerning the underrepresentation of women in nontraditional fields have also been concerned with comparisons between men and women in quantitative fields (Ethington, 1988).

Although mathematics and science achievement are often linked to innate abilities more than achievement in any other discipline (Reis and Callahan, 1989), innate differences between men and women fail to explain the underrepresentation of women in science and engineering (Jacklin, 1991).

One area of research concerning gender differences has been that of differences in mathematics ability. Studies prior to 1973 showed greater gender differences in mathematics ability (Hyde, Fennema and Lamon, 1990). Benbow and Stanley (1980) published a number of influential studies which supported the idea that males held genetically superior math skills, but these authors had no biological data on which to base their claims and their methods of data analysis exaggerated gender differences (Jacklin, 1991). Today there are many methodologically rigorous studies supporting the idea that genetic differences between men and women are small or nonexistent (Blaisdell, 1995). Any sex difference in mathematics ability is very small, and sex differences in math ability have actually decreased over the years (Friedman, 1989). Studies conducted after 1973 have demonstrated insignificant gender differences in mathematics ability, and gender differences in math ability have actually decreased over the years (Friedman, 1989). Studies conducted after 1973 on gender differences in mathematics ability support the idea that differences are environmentally determined (Eccles and Jacobs, 1986).

There is some support for innate spatial abilities (Nash, 1979; Sadker, Sadker and Klein, 1991). However, boys more often engage in play activity that tends to exercise their spatial-visual skills, whereas girls tend to exercise their verbal skills (Nash, 1979; Sadker, Sadker and Klein, 1991). Cross-cultural research indicates that child-rearing practices and social gender roles also affect gender differences in spatial ability (Nash, 1979). Like gender differences in mathematics ability, gender differences for spatial abilities are also decreasing over time (Linn and Hyde, 1989).

Ware, Steckler and Leserman (1985) found that, among men and women expressing interests in science, both groups were equally prepared for a scientific major by way of aptitude and academic backgrounds in science and math. In fact, women who majored in engineering reported taking five years of high school mathematics while men took only four years (Rowe, 1992). Taking more advanced mathematics courses in high school increased the likelihood of majoring in engineering in college (Rowe, 1992).

Greenfield, Holloway and Remus (1982) studied differences in academic persistence, academic characteristics, family background, career information, and personal characteristics among freshmen engineering students at a major university. In a national survey of the parents of women engineers, Jagacinski (1987b) found that the parents of women engineers were more likely to have college degrees and be employed in professional positions than the parents of male engineers. For the women, direct recruitment efforts played an important role in the decision to go into engineering. Family and friends played an important role in the men's decisions to major in engineering. Additionally, for the women, the opportunity to help others and participate in challenging work were tied and ranked first as opportunities provided by engineering (Greenfield, Holloway and Remus, 1982).

Gender differences have been found when comparing career paths in engineering. Once a woman has entered engineering, she may have interests in marketing and sales positions, while men may give priority to construction and field engineering (Greenfield, Holloway and Remus, 1982). Women who choose engineering often think of their choice as both an opportunity to help others and do challenging work (Greenfield, Holloway and Remus, 1982). Unfortunately, women engineers do not fare as well as men in their professional careers. A gender difference favoring men was found for supervisory responsibility and salary among the latter three cohorts (6-10, 11-15, and 16-20 years out of college) with the gap between men and women increasing over time

(Jagacinski, 1987b). Men with 16-20 years experience and all four cohorts of women endorsed the opinion that there are better opportunities for men than women in engineering (Jagacinski, 1987b). Whether by personal preference or the nature of the profession, women engineers were also less likely to be married and were more likely to be childless than male engineers (Jagacinski, 1987b).

2.2.4. Educational Climate in Public Schools

Boys and girls are educated differently and these differences significantly contribute to the underrepresentation of women in science and engineering. The educational system is a major source of sex bias and sex role stereotyping (Betz and Fitzgerald, 1987). For example, Reyes and Fennema (1982) found that teachers interacted more with boys even when the girls indicated similar levels of confidence in their mathematics ability. Additionally, the more precise, the more valuable, and the more evaluative the teacher comments, the more likely they were to be directed at male students (Sadker and Sadker, 1985). The fact that teachers' attention is often focused on boys and boys' groups adds to classroom inequities (Sadker and Sadker, 1986).

Illustrations in textbooks used from preschool through post-secondary education are often biased (Patt and McBride, 1993). Examples of textbooks with illustrations of women are still far outnumbered by those with illustrations of men (Bazler, 1993; Sadker, Sadker and Klein, 1991). Women scientists are rarely portrayed in popular magazines and when they are they tend to be either subordinate assistants or super scientists (LaFollette, 1988). On the other hand, when students read about a female involved in a "masculine" activity, both boys and girls are more likely to think that females could and should participate in that activity (LaFollette, 1988).

David and Myra Sadker have been the leading researchers in the area of bias in the public school classroom. In the early 1980s, they observed elementary and secondary level classrooms. Almost 50 percent of those classrooms were segregated by sex (Sadker and Sadker, 1986). Since children tend to self-select into same-sex peer groups, this can have detrimental effects for girls in math and science (Sadker and Sadker, 1986). Girls' groups tend to stress different values than boys groups (for example, being popular, cute and sweet versus being strong, a good student and a good athlete) (Sadker and Sadker, 1986). Sherman (1983) found that 29 percent of girls in grades 8 through 11 admitted to "playing dumb" while 76 percent of girls perceived that other girls played dumb. Peer groups tend to dissuade girls from taking advanced math courses (Sadker, Sadker and Klein, 1991).

Studies have demonstrated gender differences in the classroom that affect math and science persistence for girls. Teachers were found to give detailed instructions to boys, while they simply did things for girls, resulting in "learned helplessness" (Sadker, Sadker and Klein, 1991). Studies of science and math classrooms have revealed that teachers interact more often with male students, and this difference increases from the seventh to the eighth grade (Sadker, Sadker and Klein, 1991). Teachers have a tendency to give longer wait-time for answers to male students (Sadker, Sadker and Klein, 1991). Girls also become less assertive over time. They are especially less assertive in science classrooms and have fewer experiences with the instruments, materials, and techniques of science, leading to a disadvantaged science education (Sadker, Sadker and Klein, 1991). Girls are also less likely to have access to equipment such as microscopes, telescopes, and computers at home (Brown, 1995).

The educational climate in science and engineering classrooms in general may not be conducive to women's success in those fields. Over 86 percent of the undergraduate women in science and engineering in one study said the competitive atmosphere in their classes is one reason for the underrepresentation of women (Evans, 1993). The effects of a "chilly" classroom climate at the post-secondary level and its effect on women's persistence in engineering will be discussed in Section 2.3.8.

2.2.5. Role Models and Mentors

Career "modeling and mentoring" is essential for girls and women of all ages and races and at every developmental stage of the life span (McDaniels and Gysbers, 1992). McDaniels and Gysbers (1992) reiterate the importance of addressing the special needs of and providing models and mentors for African-American women.

Parental role models can be a positive influence for girls in the six to twenty-four age range (Auster and Auster, 1981; Lavine, 1982; Lunnenberg, 1982). However, Brown (1995) stated that girls are less likely to receive encouragement from their parents to do well in science. In fact, parents and significant others have actually discouraged young women from studying engineering (Morgan, 1992).

Two other groups of individuals should play a significant modeling and mentoring role in young girls' and women's lives: teachers and counselors. In high school young women with nontraditional goals receive less encouragement to pursue these goals despite having higher than average SAT scores (Lauria et al., 1983). One study found differences in levels of encouragement by race and gender, with Euro-American and Mexican-Amerian men receiving more encouragement than Euro-American or Mexican-American women (Hackett, Betz, Casas, and Rocha-Singh, 1992). McNamara and Scherrei (1982) identified reinforcers of an orientation toward science and math. High school counseling, role models, and exposure to related research were instrumental in a nontraditional occupational choice.

Students require guidance from their high school teachers and counselors to plan their academic careers (Levin, Wyckoff and Hussey, 1994). More often than not, guidance is not readily available. Sixty percent of undergraduate women and 57 percent of graduate women enrolled in a college of engineering and applied science felt a lack of encouragement in high school was responsible for the underrepresentation of women in science and engineering (Cosgrove, Blaisdell and Anderson, 1994). Another study found more staggering results. Evans (1993) found that 83 percent of female respondents felt a lack of encouragement from both teachers and counselors in high school. Perhaps women are not encouraged to pursue science and engineering because the majority of science teachers in high school are male. For example, only one-quarter of all high school physics teachers are women, and many of them complain they are being forced to teach a subject for which they are ill-prepared and don't really like anyway (Brush, 1991).

Gender discrimination has also been cited as a factor in the underrepresentation of women in science and engineering (Cosgrove, Blaisdell and Anderson, 1994). A survey conducted by Evans (1993) revealed that 86.5 percent of the respondents had experienced discriminatory attitudes toward women on the part of teachers and others. On the other hand, the "technique of exposing subjects to the performances of competent females may be an effective method or changing biased attitudes about gender roles" (Haemmerlie and Montgomery, 1991, p. 193).

A lack of contact with women in science and engineering has been cited as a factor in the underrepresentation of women in science and engineering (Cosgrove, Blaisdell and Anderson, 1994; Evans, 1993). For example, a recent study by Ginario (1995) found that women comprised only four percent of engineering professors and about nine percent of the professors in physical sciences. Only 0.3 percent of women engineering professors and 4.4 percent of women physical science professors are full professors (Ginario, 1995). It appears that actual contact with role models may not provide a sufficient incentive to pursue science and engineering. Lanier and Byrne (1981) found a significant positive correlation between women perceived to be attractive and those perceived to be professional. Attractiveness was also positively related to the selection of masculine courses and with professional status (Lanier and Byrne, 1991).

2.2.6. Dimensions of Personality

Research on the personalities of engineering students and engineers have provided insight along a number of personality dimensions. For example, engineers have been described along the dimensions of instrumentality-expressiveness (Chusmir, 1983; Gill, Stockard, Johnson and Williams, 1987; Jagacinski, 1987a; Metzler-Brennan, 1985), masculinity-femininity (Baker, 1987; Cooper and Robinson, 1989a; Letarte, 1992; Long, 1989; Signorella and Jamison, 1986), and internal vs. external locus of control (AAUW, 1990; Felder et al., 1994; Leder, 1990). Chodorow (1978) maintained that these characteristics probably emerge when a child develops a sense of gender identity which begins to emerge around 18 months of age (Condry, 1984). Since women in nontraditional majors typically have been found to have more egalitarian sex role attitudes (Chatterjee and McCarrey, 1989), personality development cannot be considered apart from gender role socialization.

Women who have pursued nontraditional fields have reported higher levels of instrumental characteristics, while those in traditional fields have reported expressive characteristics (Chusmir, 1983; Letarte, 1992). Instrumental characteristics include being goal-directed, task-oriented, and independent, while expressive characteristics include being concerned with interpersonal relationships, understanding and dealing with emotions, and having the ability to keep others content (Gill, Stockard, Johnson and Williams, 1987). Expressive and instrumental characteristics have been found to remain stable from the first through the twelfth grade, and to affect one's occupational choice (Metzler-Brennan, 1985).

Instrumentality has been associated with a thinking orientation while expressiveness has been associated with a feeling orientation (Jung, 1921). Several authors have extended Jung's work by studying personality type. Certain types are disproportionately represented in certain academic environments (Provost & Anchors, 1987). Furthermore, among the personality type INTJ (introverted intuition supported by thinking), Myers & Myers (1980) found a concentration of research scientists and design engineers. Among samples of male and female high school students, college preparatory and other than college preparatory, the same authors found gender differences in the feeling vs. thinking dimension of personality type. Both female samples were 68 percent feeling types. The nonpreparatory males were 41 percent feeling while the college preparatory males were 38 percent feeling (Myers & Myers, 1980).

An endorsement of masculine characteristics has characterized women planning careers in mathematics. Hamilton, Hamilton and Franks (1995) investigated gender role socialization among 107 gifted and talented high school seniors. Although no significant gender differences were found, students in general endorsed either androgynous or masculine sex role characteristics (Hamilton, Hamilton and Franks, 1995). However, the women did not label themselves as masculine, a conclusion that contradicts Baker's (1987) finding that females preferring science and other nontraditional careers have a masculine perception of themselves (Letarte, 1992). In fact, women and men in science and engineering differed in their gender-oriented childhood play experiences, with women scoring higher on the feminine and androgynous scales, and lower on the masculine scale than men (Cooper and Robinson, 1989a). Hacker (1981) conducted in-depth interviews with both engineering and humanities faculty. Engineers reported more distance in childhood from experiences and qualities generally gender-linked with females, for example, intimacy, sensuality, one's body, and social complexity. Childhood masculine interests and activities have also discriminated career women from homemakers (Lewis and Gerrard, 1985). Adult scores of masculinity are more strongly associated with childhood masculine interests and activities than adult femininity is with childhood feminine interests and activities (Lewis and Gerrard, 1985).

In the workplace, men and women scoring high in instrumentality have reported greater levels of supervisory and technical responsibility, salary, involvement in professional activities, and satisfaction (Jacacinski, 1987a). Women scoring high on masculinity scales tend to employ problem-solving rather than emotion-focused coping and have been found to have higher self-confidence ratings than the low-masculine women in traditional occupations (Long, 1989). In addition, women who scored high on masculinity scales also tended to have better spatial and mathematical performance than other women (Signorella and Jamison, 1986). On a social hierarchy continuum, male engineers gave more prestige to scientific abstraction and least to feminine qualities (Hacker, 1981).

Felder et al. (1994) examined gender differences in students' academic performance, persistence in chemical engineering, and attitudes toward their education and themselves. Women attributed poor performance to their lack of ability (internal locus of control) while men usually attributed it to lack of hard work or being treated unfairly (external locus of control). In a study by Ethington and Wolfle (1988), locus of control did not have a direct impact on the selection of a field of study, but it did have a positive indirect effect, mediated by course-taking patterns. The women in the sample indicating more internal orientations were more likely to persist in the study of quantitative areas. Locus of control also has positive direct and indirect effects on high school grades, science achievement, and mathematics achievement.

Math performance provides another example related to the internal vs. external locus of control dimension. Females and males often abandon math and science for different reasons. Males who drop out of math and science tend to do so because of a lack of competence - they cannot do the work; many females who drop out do so even though they can do the work (AAUW, 1990). Girls often interpret their problems with math as personal failures (AAUW, 1990). Thus, males are more apt than females to attribute their success to ability, while females are more apt to attribute their failure to a lack of ability (Leder, 1990).

Osborn and Harris (1975) characterized the assertive individual as one who feels confident in interpersonal relationships, can express feelings and emotions spontaneously, and is highly regarded by others. Nevill and Schlecker (1988) suggest a high level of assertiveness is an important factor in considering a nontraditional occupation. They suggested increasing the level of assertiveness, perhaps through training with role playing of specific job-related scenarios, as an effective method of increasing the perceived career options of women (Nevill and Schlecker, 1988). The fact that women in nontraditional majors believe women have a right to compete for jobs traditionally held by men (O'Connell, Betz and Kurth, 1989) is characteristic of an assertive personality. Unfortunately, evidence suggests that girls become less assertive over time, volunteering answers less often, and having fewer experiences with instruments, materials, and techniques of science (Sadker, Sadker and Klein, 1991).

2.2.7. Mathematics Achievement

Mathematics is a subject area in which girls have traditionally not fared as well as boys. For one reason, girls in high school take fewer math and science courses than boys (Fennema, 1984). Ulik (1994) studied one school district and found that only 36.6 percent of the students in honors calculus were female while 62 percent of the students in honors English were female. The author concluded that girls are self-selecting out of the math courses that would prepare them for college-level science and engineering programs.

Even males and females of equality ability and socioeconomic status, with similar attitudes toward math, do not take the same number of math courses (Brush, 1985). Research shows that several factors play into girls' failure to participate in math courses: exposure to math (Ethington and Wolfle, 1984, 1986a; Sherman, 1983), perceptions of the value of math (Brush, 1985; Eccles, Wigfield, Harold and Blumenfield, 1993; Eccles and Jacobs, 1986), math anxiety (Brush, 1985; Cooper and Robinson, 1989b; Eccles and Jacobs, 1986; Liabre and Suarez, 1985), mathematics self-efficacy (Betz and Hackett, 1983; Hackett, 1985; Hackett and Betz, 1989; Hackett, Betz, O'Halloran and Romac, 1993; Lent, Lopez and Bieschke, 1991), and parental attitudes and influence (Eccles and Jacobs, 1985; Jacobs and Eccles, 1985). These factors, in turn, are responsible for women's underrepresentation in the fields of mathematics, science, and engineering.

Exposure to math has been found to be the most important predictor of mathematics achievement (Ethington and Wolfle, 1984). In another study published two years later, the same authors found mathematics ability and exposure to math were the most influential indicators of math achievement (Ethington and Wolfle, 1986a). The first study utilized a sample of high school sophomores and seniors while the second study utilized a sample of high school sophomores only. In addition to exposure to math, spatial visualization ability, grades and gender, in that order, were important predictors of math achievement (Ethington and Wolfle, 1984). Father's education was correlated with spatial visualization and grades, both of which were correlated with math achievement (Ethington and Wolfle, 1984).

Boys have been found to value math more than girls do and to perceive both math and science both to be more relevant in their adult lives (Eccles, Wigfield, Harold and Blumenfield, 1993). Something appears to be happening about the time students enter middle school wherein the value of math appears to be related to both perceived difficulty and to level of anxiety. Brush (1985) conducted a longitudinal study of two groups of students by following sixth graders into the ninth grade and ninth graders into the twelfth grade. Female students reported that math was more difficult than did male students and females rated themselves as more anxious in quantitative situations than males, even though math ability was approximately equal (Brush, 1985).

On the other hand, girls' math performance is slightly better than males in some areas (Hyde et al., 1990). Girls outperformed boys in computation during elementary and middle school, while boys outperformed girls in problem solving during high school and college (Hyde et al., 1990). However, once in high school, the girls found math less useful than did boys (Brush, 1985). In fact, girls and women, more often than boys and men, stereotype math as a male domain (Liabre and Suarez, 1985). Masculine-biased terms and examples may explain this perception. Nash (1979) found that using typically feminine terms and examples in math and logic problems increased correct responses for girls and decreased correct responses for boys.

Eccles and Jacobs (1986) conducted a path analysis to determine predictors of math achievement and participation. A student's performance in math was found to have an indirect effect on the student's attitudes toward math (Eccles and Jacobs, 1986). In particular, boys' estimates about the value of math were related to their past performance in math, and their teachers' and parents' estimates of their math ability (Eccles and Jacobs, 1986). Girls' estimates of the value of math were not related to any of these measures, leading the authors to speculate the social and attitudinal factors appear to have much stronger direct effects on girls' belief about the value of math and plans for math participation (Eccles and Jacobs, 1986). Women's career goals are significantly related to their ratings of the value of math (Eccles, 1986). Women whose goals are engineering, math, computer science, chemistry, physics, biology, pharmacy, or medicine value and enjoy math more than women whose career goals are clinical psychology, law, social science, education, humanities, or social work (Eccles, 1986).

Math anxiety plays a tremendous role in math course participation and achievement. Women have reported significantly high levels of math anxiety (Liabre and Suarez, 1985; Eccles and Jacobs, 1986). Math anxiety has been found to be directly influenced by social factors, especially the mother's belief about the difficulty of math for her children (Eccles and Jacobs, 1986). In fact, math anxiety and parent's gender-stereotyped beliefs may account for and perpetuate the sex differences in achievement and enrollment in math courses (Eccles and Jacobs, 1986). There appears to be a cycle in which an inadequate background in math leads to anxiety about math, which leads to math avoidance (Cooper and Robinson, 1989b). This phenomenon is unfortunate, since a woman's choice to participate in math-related occupations is correlated with scholastic ability and math background (Singer and Stake, 1986). Even among freshmen enrolled in engineering, computer science, physics and math at a technologically-oriented university, math anxiety was found to have a significant affect on mathematical performance (Cooper and Robinson, 1989b). However, the authors found no gender differences in their study. The study only surveyed those students self-selected on the basis of math ability and lack of math anxiety.

Parental influence plays a significant role in math achievement and career selection, particularly when that selection is engineering (Blaisdell, 1995). Girls who took three years versus two years of college preparatory math had more positive attitudes toward math, had better educated parents who were employed at higher occupational levels, and reported being closer to their parents and more influenced by them (Sherman, 1983). A study conducted in Britain by Haworth, Povey and Clift (1986) found that engineering and technical women differed from the traditional women not only in their subject choices and curriculum opportunities in school, but also in their perceptions of the attitudes of their parents toward their careers. Unfortunately, media reports about women's math inferiority, such as those which followed Benbow and Stanley's (1980) study, affect parents' beliefs about how well their daughters can do math (Jacobs and Eccles, 1985).

In summary, past success in math, parent and teacher encouragement, and lowered anxiety lead to more positive attitudes about math, greater persistence in math education, and greater math achievement. These components, coupled with vicarious learning make up the sources necessary to build self-efficacy, including mathematics self-efficacy (Blaisdell, 1995), a topic which is discussed in the next section.

2.2.8. Self-efficacy's Relationship to Non-traditional Fields

The research on self-efficacy as it relates to women in nontraditional fields is abundant. Betz and Hackett, the first researchers to apply self-efficacy to career choice, utilized a questionnaire that included six measures of self-efficacy. They found that women's self-efficacy for five of ten traditionally male occupations was lower and weaker than men's (Betz and Hackett, 1981). Additionally, only 30 percent of females felt they could successfully complete engineering educational requirements (Betz and Hackett, 1981). Furthermore, nontraditional interests and nontraditional self-efficacy were positively related to the range of nontraditional career options considered by both females and males, but self-efficacy for traditional occupations was negatively related to the extent of consideration of nontraditional options (Betz and Hackett, 1981).

Clement (1887) studied current and prospective students in England and found that men were less willing than women to study nontraditional occupations. Men's lesser willingness than women to consider sex-atypical occupations was due to their anticipated lack of enjoyment of the occupations, rather than to lack of confidence in their ability to do the work (Clement, 1987). Females displayed lower self-efficacy than the males for all but one (manager) of the traditionally male occupations. Generally individuals reported higher self-efficacy for same-gender dominated occupations than for cross-gender dominated occupations (Hannah and Kahn, 1989). Research suggests that, or many women, the perceived outcome expectations of becoming a scientist or engineer are not desirable (Blaisdell, 1995).

In addition to gender differences, differences in self-efficacy also relate to age, particularly for women. Blackman (1986) found that younger women (median age = 25.7) were more likely to enroll in college-level math courses than older women (median age = 36.8). Clement (1987) found a significant negative correlation between age and self-efficacy for females. Older females had lower self-efficacy for male-dominated occupations and higher self-efficacy for female-dominated occupations than younger females (age range - 17-36) (Clement, 1987).

Lent, Brown and Larkin (1984, 1986) extended the earlier work of Betz and Hackett. Among college students enrolled in a career/educational planning course for undergraduates considering science and engineering majors, there were no gender differences found regarding the relationship between self-efficacy and degree of persistence. However, subjects reporting high self-efficacy for educational requirements generally achieved higher grades and persisted longer in technical and scientific majors over the following year than those with low self-efficacy (Lent, Brown and Larkin, 1984). Self-efficacy scores were significantly correlated with Math SAT and high school ranks (Lent, Brown and Larkin, 1984). The authors concluded that men and women in science and technical majors may have had more similar efficacy-building experiences than the general population of women and men used in Betz and Hackett's study. Logically, a lack of self-efficacy building experiences helps to explain the underrepresentation and attrition of women in science and engineering.

Several studies have examined the relationship of interests and self-efficacy on occupational career choice and persistence. Post-Kammer and Smith (1986) studied the topic utilizing different samples of students. Interest played a major role in the consideration of both traditionally male and female occupations; however interest appeared to be a function of gender differences. The same authors utilized a sample of economically disadvantaged students between the ages of 16-24 (Post-Kammer and Smith, 1986). They found that females had extremely low self-efficacy for engineering and drafting courses (Post-Kammer and Smith, 1986). Furthermore, both interests and self-efficacy were significant predictors of math- and nonmath-related occupational considerations for women, but only interests were predictive for men (Post-Kammer and Smith, 1986).

Although vocational interest was not a significant predictor of persistence in a career field, both self-efficacy and interest added unique variance in predicting occupational consideration (Lent, Brown and Larkin, 1986). Technical and scientific self-efficacy was predictive of grades in technical courses, persistence in a technical major and range of career options considered (Lent, Brown and Larkin, 1986). Comparing male-dominated with female-dominated occupations. Rotbert, Brown and Ware (1987) found that self-efficacy was a significant predictor of range of options for male-dominated but not for female-dominated occupations.

Self-efficacy and its relationship to mathematics achievement has also been a topic of research. Betz and Hackett (1983) developed a measure for mathematics self-efficacy and administered the measure, along with a measure of math anxiety and sex role orientation, to undergraduates enrolled in Introductory Psychology courses. Students reporting stronger mathematics self-efficacy expectations were more likely to select science-based college majors than were students reporting weaker mathematics self-efficacy expectations (Betz and Hackett, 1983). Lent, Lopez and Bieschke (1991) found that women had lower mathematics self-efficacy and Math ACT scores than men. They concluded that the "effects of gender on self-efficacy are mediated by differential efficacy-building experiences for the two sexes, particularly differences in past performances" (p. 427). In other words, if women and men of similar ability had similar past performance accomplishments, there would be relatively little difference in their self-efficacy ratings. Performance on an assigned verbal or math task not only increased self-efficacy and interest but also generalized to self-efficacy and interest for an irrelevant task as well as to global ratings of math and verbal ability (Hackett, Betz, O'Halloran and Romac, 1993).

Mathematics self-efficacy was negatively correlated with math anxiety and positively correlated with degree of reported masculinity (Betz and Hackett, 1993). Hackett (1985) utilized self-report inventories to study the effect of various measures on mathematics self-efficacy. Path analysis methodology revealed that gender, gender role socialization, high school math preparation, and past math achievement influence mathematics self-efficacy (Hackett, 1985). In turn, mathematics self-efficacy was a significant predictor of math-relatedness of college major career choice more significantly than gender, years of high school math, ACT math scores, or math anxiety (Hackett, 1985). Gender did prove to be a significant variable in a later study by Hackett and Betz (1989). The authors found a tendency for men to be overconfident and for women to be underconfident in their self-ratings of math ability, thus both groups inaccurately estimated their math ability (Hackett and Betz, 1989). Women have also been found to have lower chemistry self-efficacy than men (Kerns, 1981) (in Lent and Hackett, 1987). These differences in math and science self-efficacy affect one's choice of a college major.

Several studies conducted within the last decade have extended the earlier research in this area. Nevill and Steckler (1988) found strong self-efficacy expectations and assertiveness were related to a willingness to engage in nontraditional career-related activities. Mathieu, Sowa and Niles (1993) found that junior and senior level college women who preferred nontraditional occupations demonstrated higher career decision self-efficacy than women preferring traditional occupations. Another form of self-efficacy, academic milestones self-efficacy or confidence in one's ability to negotiate major hurdles in an engineering program, was the strongest predictor of performance (Hackett, Betz, Casas and Rocha-Singh, 1992). Interests, positive outcome expectations, and faculty encouragement were positively related to academic milestones self-efficacy whereas the number of stressors and faculty discouragement were negatively related to this variable (Hackett, Betz, Casas and Rocha-Singh, 1992). Higher levels of faculty encouragement and lesser levels of strain were also positively correlated with successful performance (Hackett, Betz, Casas and Rocha-Singh, 1992). Women reported significantly lower positive outcome expectations than men, which has interesting implications for women's persistence in engineering programs (Hackett, Betz, Casas and Rocha-Singh, 1992). Women in nontraditional careers have higher self-efficacy for working with things, while women in traditional careers have higher self-efficacy for working with people (Whiton, 1993). The perception that engineering is more thing-related than people-related may affect women's pursuit of engineering degrees.

In summary, women's limited access to the sources of self-efficacy restricts their entry into traditionally male-dominated occupations such as science and engineering. This conclusion is logical since women who select careers in science and engineering apparently have roughly equal levels of self-efficacy as men. This further supports the idea that only those women with high self-efficacy choose science and engineering occupations. The theory of self-efficacy is very useful in the area of nontraditional career choice; that is, it has direct implications for interventions that would increase the number of women in science and engineering.

2.3. Persistence in Engineering

Two primary theoretical models explain the phenomenon of persistence in higher education: the attrition model theorizes that dropping out of college (non-persistence) is a result of student and school-environment interaction while the integration model compares student attrition to employee turnover, as an effect of student behavior of choice (Cabrera et al., 1992). Both models are similar in all respects except in the effect of external factors or of social and psychological factors. A landmark study on college persistence found that the major difference between those who persisted and those who left the university was a connection with a faculty member (Tinto, 1987). Cabrera et al. (1992) claim that a convergent model is most effective for understanding why students stay in college. The literature on persistence in engineering demonstrates the need for a comprehensive, convergent theoretical model of persistence which considers the role of a multitude of factors on persistence.

Another theory attempts to explain women's persistence in nontraditional fields of study. Rosabeth Moss Kanter's theory of tokenism states that women's persistence in undergraduate majors is proportionate to the gender balance in those majors and so the few women in science and engineering have the least persistence (Rogers and Menaghan, 1991). Surprisingly, data revealed that the strongest gender discrimination and pressure to quit occurs when the genders are balanced rather than when only a few women are involved (Rogers and Menaghan, 1991). The greater number is more threatening to a male-dominated field (Rogers and Menaghan, 1991). Their research points to the additional effect of political factors on women's persistence in engineering.

Studies about engineering students and their success and attrition in college are numerous and diverse. One set of research efforts has focused on the differences between academically successful and unsuccessful engineering students (Castaneda and Winer, 1985). A second set of studies has focused on academic prediction and attempts to distinguish potentially successful students from those who will leave the field of engineering. An analysis of academic prediction studies indicates that the best method for differentiating successful from unsuccessful students involves multiple predictors such as grade point average, SAT or ACT results, interest inventories, and personal interviews (Castaneda and Winer, 1985). James Levin and John Wyckoff at the Pennsylvania State University have conducted several quantitative studies to differentiate persisters from nonpersisters along a variety of intellective and nonintellective variables.

2.3.1. Quantitative Findings

Levin and Wyckoff published several studies in the late 1980s and early 1990s. Levin and Wyckoff (1987) identified predictors of persistence and success in undergraduate engineering. Two models predicted academic achievement: the first predicted a student's cumulative GPA while the second predicted engineering GPA, which isolated specific engineering foundation courses in mathematics, physics, and chemistry (Levin and Wyckoff, 1987). The other two models predicted the probability of students' persisting successfully in engineering versus other enrollment status outcomes. Levin and Wyckoff (1988) analyzed five intellective and nine non-intellective variables to develop mathematical models to predict freshman success and persistence. Levin and Wyckoff (1990a, b) analyzed pre-enrollment, freshmen, and sophomore variables in order to predict persistence and success in an engineering college at the end of the sophomore year. For the pre-enrollment model, the variables that best predicted persistence were high school grade point average, algebra score, gender, non-science points, chemistry score, and reason for engineering choice (Levin and Wyckoff, 1990a, b). For the freshman year model, best predictors included grades in Physics I, Calculus I, and Chemistry I (Levin and Wyckoff, 1990a, b). In the sophomore year model, the variables of grades in Calculus II, Physics II, and Physics I were the best predictors (Levin and Wyckoff, 1990a, b).

Richardson and Attinasi (1982) developed demographic and academic profiles in order to calculate persistence rates for a population of 3,166 freshman, and by gender and ethnicity. Additional demographic variables were residency status and age (Richardson and Attinasi, 1982). The academic variables included major, composite ACT score, rank in high school graduating class, first semester grade point average, last semester of attendance, and cumulative earned hours (Richardson and Attinasi, 1982). Graduates and persisters were on the average slightly younger and also had higher average high school ranks, ACT composite scores, and first semester GPAs (Richardson and Attinasi, 1982). Among the important indicators of persistence were previous academic performance and first semester GPA (Richardson and Attinasi, 1982).

Corlett and Schendel (1987) studied the relationship of traditional and non-traditional variables to grades achieved by university students in five different majors (business, liberal arts, education, nursing, and engineering). Traditional variables were the college major; freshman writing class grade; California Aptitude Test (CAT) scores in reading, language arts, and reference; gender; and race (Corlett and Schendel, 1987). Non-traditional variables were high school attended; employment; community/church activities; athletics; citizenship; preferred language; parental education; and high school activities (Corlett and Schendel, 1987). Traditional variables were better as predictors of academic achievement among the study group, at least for GPA, a short term measure (Corlett and Schendel, 1987). The authors concluded that nontraditional variables may prove more effective for academic achievement in long-term prediction of academic achievement and/or persistence (Corlett and Schendel, 1987).

2.3.2. Differences Between Persisters and Non-persisters

Several studies have demonstrated very little difference between persisters and non-persisters on various measures. Yanico and Hardin (1981) studied persistence in home economics and engineering. Although the authors hypothesized that persistence in either major would be related to sex roles, with feminine-typed subjects more likely to leave engineering and masculine-typed subjects more likely to leave home economics, their findings did not support this hypothesis (Yanico and Hardin, 1981). Subjects who persisted in the two majors were not found to differ significantly from subjects who changed majors or dropped out on either sex roles or on freshman ratings of their satisfaction with and certainty of college major (Yanico and Hardin, 1981). Persisters in engineering had higher college SAT math scores than changers or dropouts (Yanico and Hardin, 1981). Subjects who changed majors from home economics tended to go into less traditional fields than home economics while nearly all of the subjects who changed from engineering chose another non-traditional or male-dominated field (Yanico and Hardin, 1981). This finding has implications for the theory of congruence (person-environment fit). Since engineering non-persisters changed to other non-traditional majors, one might hypothesis that the nature of engineering education or the educational climate in engineering is more hostile or chilly than that found in other non-traditional majors.

Hayden and Holloway (1985) identified factors which distinguish persisters, dropouts, and transfer students in engineering. They also determined a discriminate function which predicted persistence of an incoming engineering student. Factors influencing non-persistence included student expectations, academic style, and faculty support (Hayden and Holloway, 1985). Gardner and Broadus (1990) found that “mathematics was the basic culprit undermining student academic progress” in engineering. They examined students’ mathematical-mechanical abilities, psychological-motivational aspects, support services, and perceptions of the world of engineering work (Gardner and Broadus, 1990). Students leaving the program had less commitment to engineering and inconclusive career goals compared to persisters (Gardner and Broadus, 1990). Likewise, Brewton and Hurst (1984) found that students in a well-defined study program, such as engineering, tended to have higher GPAs and higher persistence rates, while those who were unsure of their goals usually dropped out and had lower GPAs. Financial aid appeared to be a prominent factor in persistence in that those students who experienced financial difficulties often failed to persist (Brewton and Hurst, 1984).

2.3.3. Gender Differences in Persistence

When women were compared to men, several studies demonstrated differences in rates of persistence. Discriminate analysis has been used to classify students on the basis of SAT scores, sex, and high school mathematics and science background (Campbell and McCabe, 1982). Sex differences were noted such that males were more persistent in the scientific and engineering majors than were females (Campbell and McCabe, 1982). Sax (1992) explored the relationship between men's and women's background characteristics, their college experiences, and their persistence toward careers in science. Men were higher in persistence rates than women in the biological, physical, and engineering sciences (Sax, 1992). Positive associations for persistence in the hard sciences included GPA, math self-rating, and parental careers, and negative associations including raising a family, self-rating in popularity, and parents' income (Sax, 1992). Women's nonpersistence may be related more to social factors than academic factors. Levin and Wyckoff did find this to be true. Due to differences in the social environment, men were more persistent in pursuing engineering than women (Levin and Wyckoff, 1994).

Several studies have failed to demonstrate gender differences in persistence. Lauria et al. (1983) found no significant differences in grade point averages, persistence in original major, or persistence at the university among women in their study. Jackson et al. (1993) also found few differences between men's and women's persistence in engineering. The best overall predictor of persistence was grade point average (Jackson et al., 1993). Schoenberger (1988) questioned whether the patterns of persistence, internal transfer, or withdrawal differed by gender. The patterns for men were almost identical while the patterns for women differed (Schoenberger, 1988). For mathematics and physics there were no significant main effects for gender. There were significant main effects for persistence on mathematics and physics measures (Schoenberger, 1988). Physics appeared to be a more critical filter for both male and female students in engineering and physical science (Schoenberger, 1988).

2.3.4. Racial Differences in Persistence

Schaer et al. (1990) investigated gender and racial differences in achievement and enjoyment of academic subjects, and persistence among freshman engineering students. Black males reported significantly more persistence than white males, though the reverse was true for females (Schaer et al., 1990). Wood and Schaer (1991) investigated race and gender effects on persistence among a sample of middle school students in a rural Southeastern community. Children's attitudes toward persistence, life goals and sex-stereotypes were hypothesized to be potential barriers to their pursuit of engineering careers. Again, results indicated that males had higher scores on persistence than females, and black males had higher scores than white males (Wood and Schaer, 1991). The freshmen males held more sex-stereotyped opinions against women in engineering than did the eighth grade males (Wood and Schaer, 1991).

High ability minority students persist in science, mathematics, and engineering fields to an unusually high degree (Hilton et al., 1989). Asian Americans fare very well in both persistence and progression, compared to other ethnic groups (1988). In fact, Asian American students are more likely to stay in the same college, with engineering being the number one choice, than other racial/ethnic groups (Peng, 1985). The concentration of Asian Americans in engineering and science is most noticeable at the doctorate level (Peng, 1988).

2.3.5. Personality Profiles of Persisters

The personality profiles of incoming engineering freshmen were studied to find out if they had any similarity to persisters in engineering (Brown and Cross, 1992, 1993). The study also aimed to determine the relationship of personality variables to persistence (Brown and Cross, 1993). Personality differences did suggest that personality may be important in persistence and can help in developing better retention and instructional techniques (Brown and Cross, 1993). While personality differences played a vital role in persistence, racial differences were not decisive (Brown and Cross, 1993).

Results of an earlier study also suggested that those who persisted in physical science, engineering, or other curricular were significantly discriminable from one another on the basis of freshman personality data, and these personality variables showed reasonable predictive stability when applied to a cross-validation sample (Scott and Sedlacek, 1975). For example, physical scientists appeared to be markedly differentiated from engineers or others along an introspection-intellectual versus social-conventional dimension (Scott and Sedlacek, 1975).

A Statistical Analysis System (SAS) multiple regression procedure found Factor G of the test (conscientious, conforming, moralistic, staid, rule-bound) to be a significant predictor of success (Shaughnessy et al., 1993). Factor G was determined to be a measure of persistence and perseverance (Shaughnessy et al., 1993).

2.3.6. Environmental Factors

Students who do not persist do so because of a combination of individual and environmental variables (Hilton et al., 1989). Benton (1985) compared teachers with five other occupational groups, including engineers. Three occupations were considered to be in the organizational/social realm (teaching, nursing, and social work) and three were in the technological realm (computer science, engineering, and accounting) (Benton, 1985). Individual characteristics were found to be most significant in differentiating between groups of persisters and dropouts in social service occupations, while external variables were most significant in determining turnover for the technical professions (Benton, 1985). Seymour (1995) found that people who switched from science to nonscience majors at four-year colleges and universities left for the same reasons that persisters were discontented with their educational experience. She examined criticisms of the structure of science, mathematics, and engineering education, and the resulting loss of women and minorities (Seymour, 1995).

A large proportion of those who switch from science, math, and engineering majors acknowledge difficulties that arise from structural and cultural sources rather than from personal inadequacy (Seymour, 1992), for example, college classroom experiences and expectations (Bonsangue and Drew, 1995) and perceptions of the college environment (Young and McAnulty, 1981). Differences between engineering persisters and non-persisters were more often related to environmental than individual variables, and both groups criticized their environments (Hegg, 1995). Women persisters have learned to be more heavily involved in study groups, finding a source of both academic and social support (Collins et al., 1996). Successful students have more frequently described specific learning strategies (Sondgeroth and Stough, 1992), effective use of situational resources (Seymour, 1993), and employment of various strategies to tolerate difficulties (Seymour, 1993). Female persisters have also proven their academic ability and appear to be no more intimidated by the rigor of the program than are their male counterparts (Collins et al., 1996). Female students also appear more likely to take the initiative to approach faculty and place a high value on such interactions (Collins et al., 1996). Female students clearly react positively to meeting with faculty and developing rapport (Collins et al., 1996). On the other hand, low achievers have referred to poor teaching in response to factors which have hindered their achievement (though close to half of the successful students also mentioned poor teaching) (Sondgeroth and Stough, 1992). As a group, both persisters and non-persisters usually sound alienated, discouraged, and/or overwhelmed by program difficulty, and both persisters and non-persisters have characterized the system as hostile (Sondgeroth and Stough, 1992).

2.3.7. Self-efficacy's Role in Persistence

Self-efficacy is presumed to have a powerful influence on the initiation and persistence of a behavior (Maddux and Stanley, 1986). Several studies have examined the role of self-efficacy in persistence in scientific and technical majors. Lent, Brown and Larkin (1984) examined the relation of self-efficacy beliefs as measured by indices constructed using procedures of N. E. Betz and G. Hackett. Self-efficacy measures tested subjects' perceived ability to fulfill the education requirements and job duties of a variety of technical and/or scientific occupations (Lent et al., 1984). Results showed that subjects who reported high self-efficacy for educational requirements achieved higher grades and persisted longer in technical and/or scientific majors over the following year than those with low self-efficacy (Lent et al., 1984).

Lent, Brown and Larkin published two additional studies related to the role of self-efficacy beliefs on persistence in scientific and technical majors. Hierarchical regression analyses indicated that self-efficacy contributed significant unique variance to the prediction of grades, persistence, and range of perceived career options in technical and scientific majors (Lent et al., 1986). The same authors compared the effects of self-efficacy, interest congruence, and consequence thinking on career and academic behavior (Lent et al., 1987). Results of multiple regression analyses indicated that self-efficacy was the most useful of the three in predicting grades and persistence in technical and scientific majors (Lent et al., 1987). Both self-efficacy and congruence contributed to the prediction of the range of perceived options, and congruence alone offered significant incremental variance in explaining career indecision (Lent et al., 1987).

Results of one study revealed positive and statistically significant relationships between self-efficacy beliefs and academic performance and persistence outcomes (Multon, Brown and Lent, 1991). Brown et al. (1988) also explored the moderating effects of academic self-efficacy beliefs on the relationship of scholastic aptitude to academic performance (grade point average) and academic persistence. The academic performance and persistence of low aptitude students was facilitated by high self-efficacy beliefs, but the performance and persistence of high aptitude students was unaffected by their self-efficacy beliefs (Brown et al., 1988).

2.3.8. Educational Climate at the Post-secondary Level

A number of factors, academic, social, and cultural, impact college students in their pursuit of degrees. The academic factors include the classroom climate. A number of recent studies document how college classroom climates impact young women as they try to achieve their potential in engineering, math or science. Young men and women are educated differently and these differences significantly contribute to the underrepresetnation of women in science and engineering (Blaisdell, 1995). "Male and female students sitting side by side often have very difference experiences in the same classroom. Faculty members, both male and female, often treat male and females students differently in the classroom in ways that are so subtle that often no one even notices. For example, women are more likely to be interrupted, not called upon as often, and receive less praise, less criticism, less help and less attention from professors. Moreover the competitive nature of the traditional classroom may have a different impact on women. Male students may also create a hostile environment for their female classmates, and environment that may be tolerated by faculty members. Add to this the lack of female faculty and the absence of women from the curriculum, and it becomes clear that the classroom is often chilly for women students, dampening their classroom participation, their ambitions, and their self-esteem" (Sandler, 1996).

Hall and Sandler (1982, 1984) and Sandler and Hall (1986) provided a highly cited series of papers, produced by the Project on the Status and Education of Women of the Association of American Colleges, on the impact of a possibly hostile environment for women students. These authors cite an overwhelmingly "chilly climate" for women students, particularly those in science, mathematics and engineering programs. Indeed, persistence and success may be more related to college classroom experiences and expectations than to pre-college preparation (Bonsangue and Drew, 1995). The competitive atmosphere in technical classes (Evans, 1993) as well as gender discrimination (Cosgrove, Blaisdell and Anderson; Evans, 1993) are deterrants. Women may feel they are not taken seriously in the classroom, laboratory, and workplace (Gardner and Broadus, 1990). The classroom climate and sink-or-swim instructional style often inherent in engineering education contributes to the attrition of women from quantitative majors (Gainen, 1995).

The Association of American Colleges reports spurned several studies — both quantitative and qualitative — to test the "chilly climate" hypothesis (Brady, 1995; Constantinople et al., 1988; Crawford and MacLeod, 1990; Heller et al., 1985). These authors found little support of a chilly climate for women college students. However, Yaeger (1995) admonished that the authors did not focus on highly male-skewed programs such as those generally found in engineering. Collins et al. (1996) did focus on a population of engineering students in their survey of classroom climate. Two factors were identified in their study: negative treatment and gender neutrality, both of which are measures of a "chilly climate" for women in engineering education programs. They found that 20 to 25 percent, and up to 40 percent at the freshman level, of the women were less inclined to agree that faculty are equally supportive of men and women students (Collins et al., 1996). They noted that the "climate and experiential results in this report exclude engineering dropouts and transfers (especially among upper division students) — that is, those students who likely experienced more negative program aspects as opposed to the 'persisters' whose data are reported" (Collins et al., 1996).

A classroom climate survey was administered to a random sample of 4,000 engineering students on the campuses of the seven universities in the SUCCEED (Southeastern University and College Coalition for Engineering Education). Results indicate that a "chilly climate" exists in colleges of engineering on these seven campuses (Hirschfeld, 1996a). Through assessing climate activities, such as female student and faculty experiences, institutions can identify obstacles (for example, lack of support, gender discrimination, poor teaching methods) that affect progression in academic programs (Seymour and Hewitt, 1994). Great interest has been shown in funding climate programs, researching classroom factors, and evaluating climate activities, and disseminating materials on issues related to the college classroom for women students majoring in engineering.

2.3.9. Engineering Education

"The origins of engineering education in military organizations has led to educating engineers through 'ordeal' — learning how to deal with difficulty and failure, to go beyond what one thought was possible. One learns discipline by striving, and failing, and striving again, and finally succeeding" (O'Neal, 1994). Persistence is an appropriate term for the phenomenon of succeeding under these circumstances. The "ordeal" in engineering education has three primary parts: (1) students are asked to do homework and quiz problems that are often beyond their ability, (2) they receive grades that are generally below their expectations, and (3) they must spend an inordinate amount of time on their studies (O'Neal, 1994). The ordeals in engineering education may be inappropriate, discouraging, and counterproductive for female students. Women in engineering curricula often report negative experiences (Agogino and Linn, 1992; Hegg, 1995; Van Aken, 1995). Even women who persist in technical curricula through graduation showed marked declines in self confidence and career aspirations (Arnold, L., 1987; Holland and Eisenhart, 1990).

Many engineering courses stress theory (engineering science) over applications (engineering practice). This emphasis invariably places some students at a distinct disadvantage relative to others (Felder and Silverman, 1988). It may particularly work to the detriment of women, more of whom lack the hands-on experiences that might clarify the abstract theoretical material (Robinson and Reilly, 1993). Most engineering courses require individual work and grades are assigned on a competitive basis, whereas women tend to be more comfortable in an environment that stresses cooperation and collaboration (Tobias, 1990).

Several authors have recommended collaborative learning techniques in engineering classrooms and laboratories as a means of increasing retention rates among female engineering students (Landis, 1995; Wankat, 1993). A study was initiated in the Fall of 1992 at Virginia Tech, funded through SUCCEED, to investigate the effects of voluntary collaborative learning or group study among freshman engineering students (Gregg et al., 1996). Preliminary results showed satisfaction with these innovative methods.

2.3.10. Support Programs

Two primary sources of support programs for women in engineering include Women in Engineering Programs and programs in counseling and advising which are discussed in Sections 2.3.10.1 and 2.3.10.2 respectively. The goals of such programs are generally twofold: (1) to increase the representation of women in engineering, and (2) to increase the retention rates of those young women who select engineering as a major.

2.3.10.1. Women in Engineering Programs

For the past several decades, intervention programs for women and for minorities in engineering and science have mushroomed. Most programs have focused primarily on helping individuals develop the skills necessary to "survive and thrive in the academy" (Lazarus, 1996). Now, after decades of experience, many groups are calling for institutional change. WIE Programs in the United States are similar to those offered by WIE Programs in Australia and fall into three broad categories: (1) recruitment programs in schools and communities; (2) retention programs focusing on support for women in engineering courses; and (3) educational development programs for teaching staff in engineering faculties (Lewis, 1996).

Women in Engineering (WIE) programs are having an impact on increasing the retention rate of women in engineering and, in turn, the number of women receiving degrees in engineering. Thirty-one institutions were identified from the Women in Engineering Directory of College/University Programs as having formal WIE programs (Wadsworth, 1991). Brainard et al. (1993) conducted a national evaluation of existing WIE Programs in order to (1) identify the conditions for successful WIE Programs, and (2) develop criteria to be used in evaluating WIE Programs. Six prerequisite conditions, or indicators, of a successful WIE Program were identified: (1) percent of undergraduate degrees awarded to women; (2) the size of the annual WIE budget; (3) fundraising assistance for the program; (4) fundraising responsibility of the director; (5) use of evaluation; and (6) major discipline of the director of the WIE Program. The authors concluded that "commitment from the Dean, a designated full-time director, a WIE budget, faculty and student involvement, and program evaluation were critical components of a successful WIE Program" (Brainard et al., 1993).

The most common target groups for WIE Programs are shown in Table 2.1 below. Girls in middle school and high school and undergraduate students at the post-secondary level received 89 percent of the responses.

Table 2.1. Women in Engineering Programs Target Groups
(Brainard et al., 1993).

Target Groups	% of Respondents
Kindergarten - 6th Grade	31%
7th - 12th Grade	89%
Undergraduate	89%
Graduate	58%
Re-entry	27%
Community College	23%
Single Parents	15%
Faculty	15%

The most commonly offered WIE Program services are listed in Table 2.2. Thirty-five percent of the survey respondents believed that counseling and mentoring were the two most important services provided to those target groups listed in 2.1.

Table 2.2. Women in Engineering Programs Services Offered
(Brainard et al., 1993).

WIE Program Services	% Offering Service
Counseling/Advising	84%
Seminars	72%
Support Group Meetings	68%
Scholarships/Fellowships	68%

One of the indicators of a successful WIE Program included a full-time director. Table 2.3 lists the type of degree held by the directors of the 31 WIE Programs identified in the Brainard et al. (1993) evaluative study.

Table 2.3. Women in Engineering Program Directors' Degrees
(Brainard et al., 1993).

Degree	% of Directors
Bachelor of Science or Art	27%
Master of Science or Art	35%
Ph.D., Ed.D., or Sc.D.	38%

The highest percentage of directors' degrees were in education, social sciences, or the humanities (61 percent) while 39 percent were in engineering or science (Brainard et al., 1993). Findings revealed that institutions with directors who had majors in engineering or the hard sciences tended to have a lower percentage of women receiving degrees in engineering ($p < 0.036$) while institutions with directors who majors were in education or the humanities had a higher percentage of women receiving degrees in engineering (although no percentage was stated) (Brainard et. al., 1993).

Based on the six prerequisite conditions used to identify successful WIE Programs, the following programs were identified as programs of excellence:

Table 2.4. WIE Programs of Excellence (Brainard et al., 1993).
Note: The Douglass College Program is recognized as a prototype of programs for women in science; programs for women in engineering are limited at this time.

WIE Program	Academic Level Served
Cornell University	University (undergraduate)
Purdue University	Pre-College and University (undergraduate)
Douglass College (Rutgers University)	Pre-College and University (undergraduate)
Stevens Institute of Technology	Pre-College
University of Dayton, Ohio	Pre-College
University of Washington	University (undergraduate and graduate)

Although the programs offered by these WIE Programs of excellence and other commendable programs nationwide are too numerous to mention, the following are current examples of WIE programs at the elementary, middle, secondary, and post-secondary levels:

Elementary Level

- The Colorado State University (CSU) Society of Women Engineers assisted the Beattie Elementary Girls in Math and Science Club with a snow sled design contest. The program was designed to encourage interaction between the elementary school-age girls and the college-age engineering students and to show the girls how fun and interesting engineering can be (James, 1996).
- The Arizona State University Women in Applied Science and Engineering (WISE) Program developed and implemented three, week-long residential camps for the Arizona Cactus-Pine Girl Scout Council. The camps were designed to expose the girls to engineering (Middleton, 1996).

Middle School Level

• Drexel WIE initiated GOES (Girls' Opportunities in Engineering and Science), an "outreach effort which seeks to remedy the detrimental effects of women's underrepresentation in engineering by creating an engineering workshop that literally GOES to middle and junior high schools" (Wheatley, 1996).

• A partnership between Hewlett-Packard and Northern Colorado school districts was formed to promote systemic change in math and science teaching methods. Hewlett-Packard devotes the time of a woman engineer one day a week to train and mentor teachers in encouraging young women in math, science and technology (Herbener, 1996).

High School Level

• Project 1999 was designed to encourage underrepresented female minorities and Anglo female students to study and eventually practice in the engineering profession. The commitment of a manufacturing company as a sponsor and involvement of parents are features of the program (Hellman, 1996).

• The Penn State New Kensington Campus offers an annual, two-day summer program targeted at ninth through eleventh grade females from local high schools (Begolly, 1996).

Community College Level

• Thomas Nelson Community College in partnership with six industries developed two programs geared to the average achiever. The goal of these programs is to instill an interest in math and science and to provide instruction and support services for non-traditional careers (Remsberg, 1996).

Post-Secondary Level

• At the University of Iowa, science, engineering, and math students are teaching their disciplines to young children in the local community through service learning projects (Ocif, 1996).

• The University of Michigan provides a supportive contiguous living arrangement with programmatic efforts including mentoring programs, undergraduate research opportunities, and study groups (Davis, 1996).

• Virginia Tech has instituted voluntary gender clustering in introductory engineering classes to create sections containing a greater number of women in order to facilitate the establishment of study groups with gender peers (Hirschfeld, 1996).

• ENGR 194, a one-credit elective course for first-year female students is a major component of the retention activities for female engineering students at Purdue University (Daniels, 1996).

Other efforts include support systems through mentoring programs (Heising, 1996, Mikawoz, 1996); orientation programs (McCubbrey, 1996); restructured curriculums (Laughlin, 1996); community service learning projects (Athreya, 1996, Vest, 1996); workshops to acquaint high school math and science teachers with the basic concepts of engineering (Cathcart, 1996), new applications, technology, and research (Williams, 1996), and innovative teaching methods (Cathcart, 1996, Margle, 1996); programs to develop self-esteem and confidence (Teasdale, 1996); Careers in Science and Engineering speakers' series (Blaisdell, 1996); and job search and survival skills seminars (Heising, 1996).

2.3.10.2. Counseling and Mentoring

"Probably the most neglected area in engineering education is advising, and certainly this is the area where students show the least satisfaction" (Panitz, 1995, p. 19). Academic advising has traditionally been low on the priority list of engineering schools (Panitz, 1995, p. 19). The increased number of women and minorities in a population previously dominated by white male students brings with it new advising concerns (Anderson, 1995). Basic to understanding and anticipating the advising and counseling needs of these students is a knowledge of the bases on which women decide to embark on a career in engineering (Anderson, 1995). Those women who entered the study of engineering based nearly without question on the recommendation and encouragement of an advisor or high school guidance counselor, encountered the most difficulty and the greatest discouragement in pursuing their programs (Anderson, 1995). This group clearly had the most critical need for career counseling and academic advising (Anderson, 1995).

Differences between males and females can play a role in the design of academic counseling and recruitment. Tannen (1990) purports that men communicate facts and try to maintain independence during conversations, while women search for rapport and connections. Studies have also found differences in what male and female students want from their advisors (Panitz, 1995). Anderson (1995) found that a lack of evidence of personal concern from faculty or administrators contributed significantly to women's sense of isolation and marginal status as engineering students. Thirty percent of the women in her study felt that their professors and advisors did not care about them (Anderson, 1995).

More women than men reported that direct recruitment efforts to enter science and engineering were important (Greenfield, Holloway and Remus, 1982). Eagan (1994) found that contact with women engineers and networking are the two most important means of recruiting and retaining women engineering students. Research indicates that advising can also influence student retention (Panitz, 1995). About 30 percent of the students who switch out of engineering cite "inadequate advising or help with academic difficulties" as one of the reasons for nonpersistence in engineering (Panitz, 1995, p. 19).

Panitz (1995) identified guidelines for effective advising. These guidelines included (1) up-to-date information on the curriculum and university policies and procedures; (2) listening and communication skills; (3) counseling skills; (4) knowledge of referral sources; (5) the ability to accurately assess the student's ability to persist; (6) the ability to provide career information and guidance; and (7) willingness to go the extra step by providing such services as a personal touch, computer-assisted advising, group advising, and the formation of networks.

Prior research on the role of counseling and mentoring in women's selection of engineering as an occupational choice, as well as their persistence in that choice, has been sparse. This study seeks to ascertain how advising and counseling from middle school through secondary school on to post-secondary school has influenced persistence and nonpersistence in engineering for the sample of students in this study.

Summary

This chapter has summarized the literature relevant to the topic: women and career development, women in nontraditional fields, and persistence in engineering. Section 2.1 presented the literature relevant to women and career development conducted over the past thirty years, including theories and frameworks of career development relevant to women. Section 2.2 presented the literature relevant to non-traditional major and occupational choice, including family, individual, and environmental factors relevant to non-traditional choice. Section 2.3 presented the literature on persistence, also including family, individual, and environmental factors relevant to college persistence, in general, and, in particular, persistence in engineering majors.

CHAPTER 3

METHODOLOGY

The purpose of this study was to develop profiles of women who persist in engineering by addressing the strengths of the young women who participated in the study. In addition to their ways of persisting, this study also contributed further to an understanding of (1) the process of nontraditional major choice and (2) women's experiences in the culture and climate of engineering education. A qualitative approach provided the most appropriate framework for the study of women's stories of persistence in engineering and best answered the questions as outlined in Chapter 1. This chapter discusses the qualititatve research design and data collection procedures.

3.1. Type of Research

Qualitative research methods allow researchers to be more spontaneous and flexible in exploring phenomena in their natural environment (Rudestam & Newton, 1992). Qualitative methods are especially useful in the "generation of categories for understanding human phenomena and the investigation of the interpretation and meaning that people give to events they experience" (Rudestam & Newton, 1992). Therefore, the qualitative researcher seeks a psychologically rich, in-depth understanding of an individual or a phenomenon. Kuh & Andreas (1991) have promoted the use of qualitative methods to explore student issues and concerns.

Qualitative methods share three fundamental assumptions:

(1) a holistic view which seeks to understand phenomena in their entirety in order to develop a complete understanding of a person, program, or situation;

(2) an inductive approach in which the researcher does not impose much of an organizing structure or make assumptions about the interrelationships among the data prior to making the observations; and

(3) naturalistic inquiry, a discovery-oriented approach in the natural environment (Rudestam & Newton, 1992).

3.2. Description of the Conceptual Framework

A conceptual framework explains either graphically or in narrative form the key factors, constructs, or variables to be studied and the presumed relationships among them (Miles & Huberman, 1994). Conceptual frameworks are the "current version of the researcher's map of the territory being investigated" (Miles & Huberman, 1994, pp. 32-33). This means that the framework may change as the study evolves. Figure 3.1 provides a conceptual framework utilizing a causal network. A causal network is a graph displaying the independent and dependent variables in a naturalistic study. Such a graph uses arrows to represent the direction of influence (causality) and makes specific notations regarding the meaning of the connections between the arrows linking the variables in the analysis (Miles & Huberman, 1994). This chart may serve as the basis for a conceptual framework or the development of a "grounded" theory (Rudestam & Newton, 1992; Glaser & Strauss, 1967). Miles & Huberman (1994) suggest that the use of a wide variety of displays, presenting one's conceptual framework, context of analysis, and results, greatly facilitates the analysis of qualitative data.

3.3. Design Considerations

Lincoln & Guba (1985) outline a broad series of ten design considerations that describe what must be considered, in advance, in order to prepare a naturalistic study. The first three

CONCEPTUAL FRAMEWORK

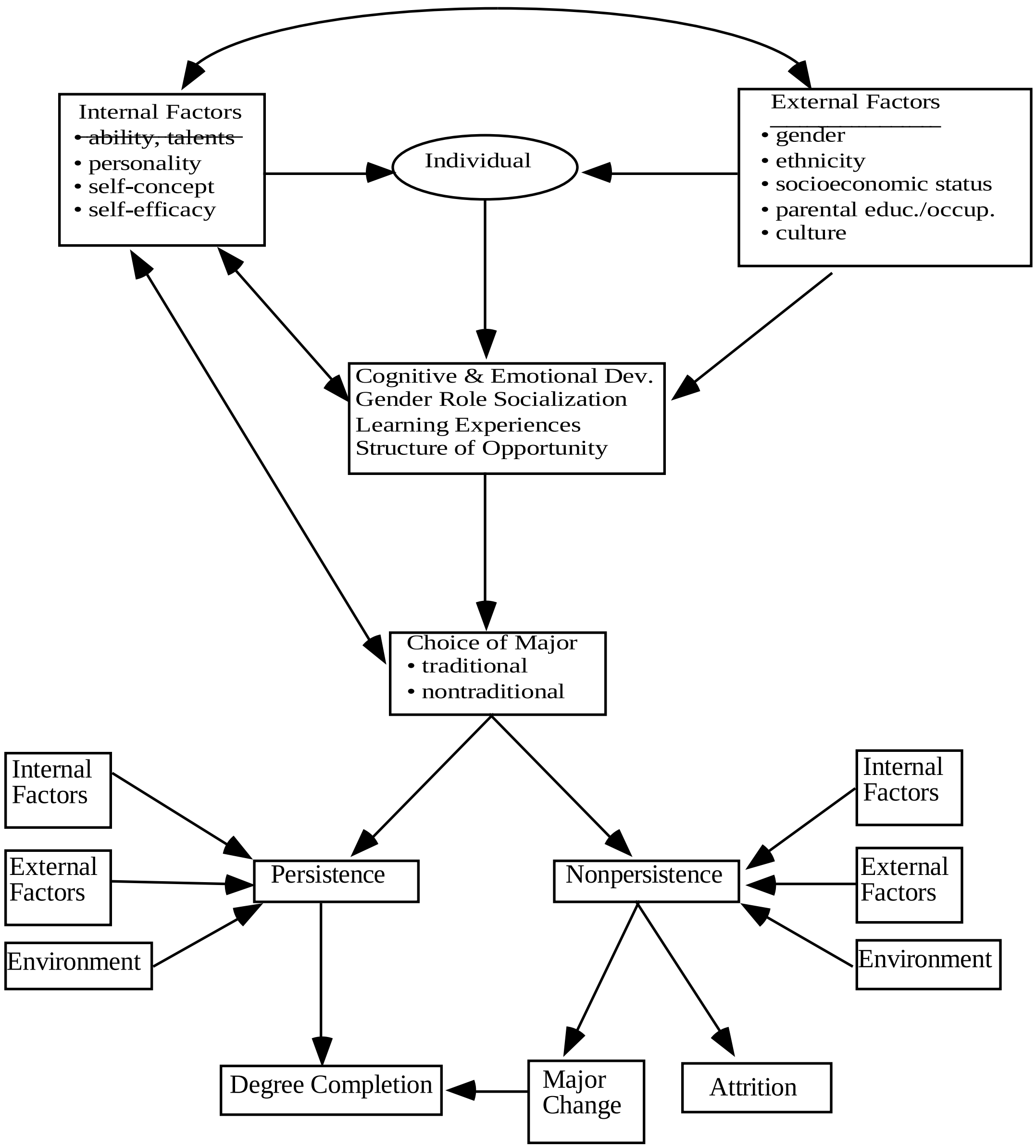

Figure 3.1. Conceptual Framework of Main Dimensions Under Study

design considerations, addressed in Chapter 1, pay explicit attention to the assumptions that underlie a study and the fit of those assumptions to the method. They include the following: (1) determining a focus for the inquiry; (2) determining fit of paradigm to focus; and (3) determining the "fit" of the inquiry paradigm to the substantive theory selected to guide the inquiry. The remaining design considerations include: (4) determining where and from whom data will be collected; (5) determining successivephases of the inquiry; (6) determining instrumentation; (7) planning data collection and recording modes; (8) planning data analysis procedures; (9) planning the logistics; and (10) planning for trustworthiness. The present chapter addresses design considerations 4-10.

3.4. Selection of Sample

Persistence was defined in Chapter 1 as having completed a minimum of two full years of study in engineering in good academic standing. Non-persistence was defined in Chapter 1 as withdrawal from or leaving engineering anytime after entry. Therefore, the population for the study were the 467 women at the junior and senior levels enrolled in engineering programs, and those who left those programs, at a large land grant research university in the Southeastern portion of the United States. According to Castaneda & Winer (1985), "self-analysis and local research are necessary to understand the students at a specific university." Enrollment data at the time of the study are shown by academic level and ethnicity in the following table:

Table 3.1. Number of Women Enrolled in Engineering by Academic Level and Ethnicity.

Level	African Amer	Asian	Caucasian	Hispanic
Juniors	16	11	152	2
Seniors	29	7	146	4
Totals	45	18	398	6

Qualitative samples tend to be purposive, rather than random (Miles & Huberman, 1994). Persisters were selected through a purposive sampling frame, that is, participants were recruited after aspects of the study were defined. Since the potential Caucasian persister group was larger than that of the other persister groups, Caucasian persisters were sampled through a random purposeful sampling frame. Because a decision was made to include women of various special population subgroups, a stratified purposeful sampling frame was used to illustrate those subgroups and to faciliate comparisons among them. A snowball sampling procedure was the most pragmatic and efficient way to sample non-persisters. Persisters were able to name and refer women they knew who had left their engineering majors. In many cases, they could also ascertain reasons for the choice to leave the university or switch to other majors. These proposed reasons were often confirmed in actual interviews with non-persisters who elaborated on their experiences. Both persisters and non-persisters were contacted via phone and e-mail using the contact scripts in Appendix 1.

Theoretical sampling is the "process" of data collection for generating theory whereby the analyst jointly collects, codes, and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges" (Glaser & Strauss, 1967, p. 45). The basic question in theoretical sampling is what subgroups does one turn to next in data collection and for what theoretical purpose (Glaser & Strauss, 1967). In some cases, theoretical sampling was used in an effort to include additional members of special client groups from which further information was sought. The final sample is shown in Table 3.2.

Table 3.2. Final Sample of Study Participants.

	African American	Asian	Caucasian	Hispanic	Rural Students	Totals
Persisters	9	4	8	2	5	28
Non-persisters	2	0	4	2	0	8
Totals	11	4	12	4	5	36

Since the study focused on the phenomenon of persistence, a greater percentage of persisters were included in the final sample. The non-persister group provided a useful comparison group and increased the range of reported experiences.

3.5. Procedures

A program of cooperative research that utilizes more than one technique within the same research project compensates for the inherent weaknesses in both techniques and provides a means of triangulation. Individual and small focus group interviews were the chosen methods of data collection, and an eclectic framework based on the work of several researchers was utilized. The primary purpose of both interviews and focus groups are to focus discussion between the researcher and the research participants, producing data that are textual rather than numerical. The focus of these techniques is on what the person experiences in a language that is as loyal to the lived experience as possible (Rudestam & Newton, 1992). The primary goal of this research project was similar to that of Sally Hacker (1990) in her study of engineering at the Massachusetts Institute of Technology, that is, "being with people," to learn about their perspectives and experiences in the culture of engineering.

Qualitative research utilizes the self as an instrument, and in-depth interviews and focus group interviews are two primary examples of the self as instrument. Miles & Huberman (1994) outline criteria of a good qualitative researcher-as-instrument method: (1) some familiarity with the phenomenon under study; (2) strong conceptual interests; (3) a multidisciplinary approach, as opposed to a narrow grounding or focus in a single discipline; and (4) good "investigative" skills, including doggedness, the ability to draw people out, and the ability to ward off premature closure.

Focus group methodology has several advantages. The "hallmark of focus groups is the explicit use of group interaction to produce data and insights that would be less accessible without the interaction found in a group" (Morgan, 1988). The main advantage of the focus group is the opportunity to observe a large amount of interaction on a topic in a limited period of time. Morgan (1988) emphasizes the use of focus groups to learn about participants' experiences and perspectives. Small focus groups were designed and conducted utilizing texts by Morgan (1988) and Krueger (1988).

Individual interviews provided a means for in-depth analysis of each participant's story. McCracken (1988) and Spradley (1979) provided guidelines for in-depth, confidential face-to-face interviews. Interviewing involved two distinct but complementary processes: (1) developing rapport, and (2) eliciting information (Spradley, 1979). Spradley (1979) refers to rapport as a "harmonius relationship between the interviewer and the participant/respondent. It means that a basic sense of trust has developed that allows for the free flow of information" (p.79). Developing rapport involves the following processes:

Apprehension → Exploration → Cooperation → Participation.

<u>3.5.1 Pilot Study</u>

The first phase of data collection, one small focus group and two interviews, was a pilot study with Caucasian persisters as shown in Table 3.3. All participants in the pilot study and data collection phases were contacted via electronic mail and/or telephone. See the contact scripts in Appendix 1. Interview and focus group scheduling forms, as shown in Appendix 2, provided a means of organizing and scheduling interviews and groups. A day before the focus group and interviews, participants were given a phone call as a reminder. See the reminder scripts in Appendix 3. Each participant completed the consent form in Appendix 4 prior to participation. Focus group participants also completed the demographic sheet in Appendix 5.

Table 3.3. Pilot Study.

Date	Method	Location	Participant(s)
September, 1996	Focus Group (persist)	Student Center	Caucasians
September, 1996	Interview (persist)	Academic Building	Caucasian
September, 1996	Interview (persist)	Academic Building	Caucasian

The purpose of the pilot study with Caucasian persisters was to test the procedures, specifically the focus group questioning route, the interview guide, the equipment, and the time needed to conduct both. Collecting focus group data in the first phase of the pilot study aided in devising the interview schedules and in the clarification and exploration of issues in a more in-depth and intimate manner later in the in-depth interviews. Following the pilot study focus group and interviews, participants were asked to provide feedback on the wording and content of questions. Prior to the second phase of the data collection, questions which were unclear were revised for clarification. It was also determined that small focus groups which resembled small group conversations was the best means of soliciting information from all group participants.

<u>3.5.2 Data Collection</u>

The second phase of data collection consisted of 4 focus groups and 19 interviews, as shown in Table 3.4, conducted throughout the fall semester 1996.

<u>3.5.3. Focus Group Interviews</u>

A total of 5 small focus group interviews, including the pilot group, were conducted. "One important determinant of the number of groups is the number of different population subgroups studied" (Morgan, 1988, p. 45). Breaking the groups into different population subgroups allowed for comparisons among the subgroups. Two to five members per small group produced a dynamic of higher involvement in the life of the group and encouraged a larger personal contribution from each group member (Krueger, 1988). Focus groups of Hispanics and non-persisters were not conducted. There were only six Hispanic American women students at the junior and senior academic levels, and only two of the six could be contacted. Because the first two nonpersisters became somewhat emotional in the recall of their experiences in their freshman year in engineering,

Table 3.4. Data Collection.

Date	Method	Location	Participant(s)
Week 4	Interview (persist)	Academic Building	Caucasian
Week 4	Interview (persist)	Academic Building	Caucasian
Week 5	Focus Group (persist)	Student Center	African Americans
Week 5	Interview (persist)	Academic Building	African American
Week 5	Interview (persist)	Academic Building	African American
Week 5	Interview (persist)	Academic Building	African American
Week 6	Focus Group (persist)	Student Center	Asian
Week 6	Interview (persist)	Academic Building	Asian
Week 6	Interview (persist)	Academic Building	Asian
Week 7	Interview (nonpersist)	Academic Building	Caucasian
Week 7	Interview (nonpersist)	Academic Building	Hispanic American
Week 8	Focus Group (persist)	Academic Building	African American
Week 8	Interview (persist)	Academic Building	Hispanic
Week 8	Focus Group (persist)	Academic Building	Rural Students
Week 8	Interview (persist)	Academic Building	Rural Student
Week 8	Interview (persist)	Academic Building	Rural Student
Week 9	Interview (persist)	Academic Building	Hispanic
Week 9	Interview (nonpersist)	Academic Building	African American
Week 9	Interview (nonpersist)	Academic Building	African American
Week 11	Interview (nonpersist)	Academic Building	Caucasian
Week 11	Interview (nonpersist)	Academic Building	Caucasian
Week 11	Interview (nonpersist)	Academic Building	Caucasian
Week 12	Interview (nonpersist)	Academic Building	Hispanic American

it was determined that the safest procedure for talking to nonpersisters was the individual interview format.

The setting of the small focus group interviews was either a conference room in the student center or a conference room in an academic engineering building during the evening and weekend hours. After refreshments and the completion of a demographic sheet and consent form, each small focus group began with an icebreaker activity which allowed each participant to make an individual, uninterrupted statement of an autobiographical nature. Each participant was asked to introduce herself and to tell the group something about herself and her family. A questioning route utilizing open-ended questions was used in the data gathering phase. (See Appendix 6.) Each participant was compensated with refreshments and payment for participation as incentives for participation as recommended by Krueger (1988). The verification form in Appendix 7 was utilized to verify all payments made to focus group participants.

All group interviews were audiotaped, and a secretarial assistant transcribed the tapes verbatim. Process notes that described reactions to both the participants' views and the research process itself were also kept by the researcher. Careful attention was paid to the nonverbal aspects of the interaction, for example, turn-taking, eye contact, pauses in interaction, patterns of speech, and analysis of conversations (Morgan, 1988). The use of a diary or journal to record impressions, reactions, and other significant events that may occur during the data collection phase of research can be a useful source of information (Rudestam & Newon, 1992). Two days after the focus group interview, each participant was contacted via telephone for a brief thank-you and given the opportunity to express any other thoughts that may have occurred following the focus group. (See Appendix 8.)

3.5.4. Individual Interviews

The setting of the in-depth interviews was the researcher's private office in an academic engineering building during the evening and weekend hours and other hours convenient to the participants. The researcher operated the tape recorder, and a secretarial assistant transcribed all tapes verbatim. Immediately following the interview, the researcher made fieldnotes and recorded impressions. Spradley (1979) recommended the journal contain a record of experiences, ideas, fears, mistakes, confusions, breakthroughs, and problems that arise during the data collection process. "Making an introspective record of field work enables a person to take into account personal biases and feelings, to understand their influence on the research (Spradley, 1979, p. 76).

An interview guide or questionnaire utilizing open-ended questions was used in the data gathering phase. (See Appendix 6.) The questionnaire had several functions: (1) it provided structure and organization and ensured that all the terrain was covered in the same order for each respondent, (2) it established channels for the direction and scope of discourse, and (3) it protected the larger structure and objectives of the interview (McCracken, 1988). The interview guide was basically a semi-structured interview schedule with open-ended questions designed and intended to establish a conversation with the participants.

Each interview began with a set of biographical questions which allowed the researcher to ascertain the simple descriptive details of the respondent's life, that is, geographical origin or locality, parental educational levels and occupations, birth order, and occupations of adult siblings. The primary goal of the interview guide was to develop a theory of persistence through the use of open-ended questions, thus allowing the participants the flexibility to frame and structure their responses. A fundamental component of qualitative research is that the phenomenon under study must unfold through the participants' eyes (Marshall & Rossman, 1989). Each interview participant received payment for participation as recommended by Krueger (1988). The verification of payment form in Appendix 7 was utilized to verify all payments made to interviewees. Two days after the individual interview, each participant was contacted via telephone for a brief thank-you and given the opportunity to express any other thoughts that may have occurred following the interview. (See Appendix 8.)

One solution to question proliteration is the use of major questions with subquestions for clarify and specificity (Miles & Huberman, 1994). Grand-tour questions, or open, non-directive questions, were developed utilizing Spradley (1979). The "first objective of the qualitative interview is to allow respondents to tell their own story in their own terms" (McCracken, 1988, pp. 34-35). The use of grand-tour questions facilitated the telling of one's own story. Semantic relationships developed through the use of mini-tour or probing and secondary questions. Mini-tour questions are identical to grand-tour questions except they deal with a much smaller unit of experience. Thus, the final questionnaire consisted of a set of biographical questions followed by a series of grand-tour question areas and a set of mini-tour questions within each of those grand-tour questions.

Relevant variables for the focus group questioning route and interview schedule were grounded in the literature relevant to the career development of women in general, the career development of women in non-traditional fields, and persistence in engineering. In general, the literature review serves two primary purposes: (1) it provides a critical process that makes the investigator the master, not the captive of previous scholarship, and (2) it aids in the construction of the interview questionnaire by specifying categories and relationships that organize the data (McCracken, 1988).

3.6 Data Analysis

The approach to data collection, as well as the data analysis, was eclectic in that ideas and suggestions were borrowed from several other qualitative researchers. The techniques of listening to the voices of participants and becoming immersed in the data as an aid to data analysis were modeled after those utilized by Brown & Gilligan (1992) and Morgan and Spanish (1984). It is crucial to have understood the dynamics of each particular case before proceeding to cross-case explanations (Miles & Huberman, 1994).

In their study of girls' psychological growth and development, Brown & Gilligan utilized a voice-centered method. A "voice-centered method is an attempt to maintain the relationships which are central to the process of psychological growth and also the process of inquiry by maintaining voice and thus articulating difference" (Brown & Gilligan, 1992, p.30). Thus, rather than focus on "objects to be studied or people to be treated, judged, tested, or assessed," they speak about "authentic or resonant relationships" (Brown & Gilligan, 1992, pp. 39-40). Since phenomenology attempts to get beneath how people describe their experience to the structures that underlie consciousness, important skills for the researcher include listening, observing, and forming an emphatic alliance with the participant (Rudestam & Newton, 1992). "Intuition is the most powerful (and most obscure) of the analytic devices at our disposal" (Berreman, 1966, p.45).

"To be senstive to and work with the particular nuances, climate and atmosphere of the setting," Brown and Gilligan (1992) sought to create a responsive and resisting practice that was tied to a way of listening to others. They termed their method of data analysis a "Listener's Guide." Their Listener's Guide, "in attending to realities of race, class, and gender (who is speaking in what body, telling what story from whose perspective, and in what societal and cultural frameworks)", is primarily a feminist method (Brown & Gilligan, 1992, p. 29). "Listening joins conversations with listening to audiotapes and reading over interview transcripts" (Brown & Gilligan, 1992, p. 25). Guided by their voice-sensitive methods, they listened to a person's story at least four times, each "listening" attending to a different focus as follows:

Table 3.5. Listener's Guide for Interview Transcripts (Brown & Gilligan, 1993).

Listening	Goal of the Listening
First Listening	To get a sense of what was happening, to follow the unfolding of events, to listen to the drama (the who, what, when, where, and why of the narrative)
Second Listening	To listen for "self" - the voice of "I" - and responding to the text both emotionally and intellectually
Third and Fourth Listenings	To attend to the ways people talk about relationships, especially institutionalized restraints and cultural norms and values

Initial analysis of the interview transcripts utilized this technique. The matrix in Appendix 9A was utilized to keep track of all listenings. By listening to each person's story at least four times, the researcher “can begin to sort out different voices that run through the narrative and compose a polyphonic or orchestral rendering of its psychology and its politics” (Brown & Gilligan, 1992, p. 25).

Morgan and Spanish (1984) outlined four aspects of group discussion that can serve as the basis for observing and interpreting cognitive processes in self-contained focus groups. Their techniques provided a Listener’s Guide for the focus group transcripts as shown in Table 3.6. Strauss (1987) suggested rereading [or relistening] to fields notes of contrasting groups to become sensitized to what is different about them.

Table 3.6. Listener’s Guide for Focus Group Transcripts (Morgan & Spanish, 1984).

Listening	**Goal of the Listening**
First Listening	To pay attention to the difference between what participants find interesting and what they find important.
Second Listening	To listen for differences in perspectives by paying attention to how questions get asked and answered.
Third Listening	To pay attention to how participants agree and disagree in the group. [“Participants often become consciously aware of their own perspectives when confronted with an active disagreement or an explicit attempt to research consensus” (Morgan, 1988. p., 29)]
Fourth Listening	To pay attention to attempts to resolve differences and build consensus.

The matrix in Appendix 9B was utilized to keep track of all focus group listenings.

Following the listenings of interview and focus group interview transcripts, the basic qualitative analysis process included steps outlined by Miles & Huberman (1994) including: (1) affixing one to several word codes to the interview and focus group interview transcripts in the left-hand margins; (2) noting reflections and other remarks in the right hand margins; (3) sorting and sifting through these materials to identify similar phrases, relationships between variables, patterns, themes, distinct differences between subgroups, and common sequences; (4) isolating these patterns and processes, commalities and differences and taking them out to the field in the next wave of data collection; (5) gradually elaborating a small set of generalizations that cover the consistences discerned in the database; and (6) confronting these generalizations with a formalized body of knowledge in the form of constructs or theories. Since qualitative analysis implies that the data are in the form of words as opposed to numbers, this six step process facilitated the reduction of data into themes or categories and the interpretation of those themes and categories.

Strauss and Corbin (1990), utilizing an inductive technique called a constant comparative method (Glaser & Strauss, 1967), provided a model for this process of analysis. Data were collected, written up, and reviewed line by line, typically within a paragraph. Codes were written in the left-hand margins while reflective remarks were written in the right-hand margins. Coding is analysis; therefore, data were first systematically coded into as many themes and meaning categories as possible through first level coding which provided a device for summarizing segments of data (Strauss & Corbin, 1990). The goal of coding is to review a set of field notes, transcribed or synthesized, and to dissect them meaningfully, while keeping the relations between the parts intact (Miles & Huberman, 1994). As the categories emerged, the relationships between those categories and their theoretical implications began to make sense. Gradually the theoretical properties of the meaning categories crystallized and formed a pattern. Pattern coding is a way of grouping first level coding summaries into a smaller number of sets, themes, or constructs (Strauss & Corbin, 1990). The patterns that emerge are sometimes called “grounded theory” (Glaser & Strauss, 1967).

Krueger (1988) described this process of analysis along an “analysis continuum:

Raw data → Descriptive statements → Interpretations.

The presentations of raw data include the exact statements of the participants as they respond to specific topics while descriptive statements are summary statements of respondent comments. Chapter 4 includes both presentations of raw data as well as summary statements. Interpretation is the most complex role of the researcher and builds on the descriptive process by presenting the meaning of data. Chapter 5 was aimed at presenting the meaning of the data. A technique of using memos, a means of writing-up ideas about codes and their relationships, provided a means of going beyond codes to personal, methodological, and substantive theorizing (Miles & Huberman, 1994).

To facilitate interpretation and presentation of meaning, the analysis consisted of three concurrent flows of activity: data reduction, data display, and conclusion drawing and verification (Miles & Huberman, 1994). Anticipatory data reduction occurred in the process of conceptualizing the framework, deciding which groups to study, which research questions to ask, and which data collection approaches to choose (Miles & Huberman, 1994). Data reduction consisted of the process of selecting, focusing, simplifying, and transforming the data that appeared in the transcriptions.

A data display is an organized, compressed assembly of information that permits conclusion drawing and action (Miles & Huberman, 1994). A display such as the one presented in Appendix 10 provided an organizational scheme for reduction and analysis of data based on the study’s questions. Each participant was treated as a case; therefore, the question × case matrice also provided a means of case analysis and comparison across cases. Thus this method of analysis combined a case-oriented and variable-oriented approach. “Story” approaches need to be married to “concept” approaches (Miles & Huberman, 1994). Reading across the rows gives a thumbnail profile of each participant, and reading down the columns makes comparisons between the experiences of different participants across the different concepts or variables. Since the questions were organized in a developmental fashion, the matrix display is also a time-ordered display which organized data by time and sequence.

Qualitative researchers are always interested in events and preserving the chronology and illuminating the processes occurring in those events (Miles & Huberman, 1994). Uniqueness resides in the individual’s developmental history over time (Miles & Huberman, 1994). The case analysis form helped in the preparation of summaries of information from each interview and pieced together a focused narrative for each individual case. Selected narratives are presented in Appendix 20. These narratives were reviewed and verified by the participants and permission was given to include them in the Appendices.

Strauss (1987) and Lincoln and Guba (1985) suggest that coding and recoding are over when the analysis itself appears to have run its course, that is, when all of the incidents can be readily classified, categories are "saturated," and sufficient numbers of "regularities" emerge. This rule of thumb was also used as a guideline for ending the data collection and analysis phases of the study.

3.7. Addressing Reliability and Validity in Qualitative Inquiry

In traditional empirical research the importance of reliability, internal validity, and external validity of measures and procedures are of utmost importance. Qualitative inquiry should also address the issues of reliability and validity; however, when traditional definitions of reliability and validity are applied to qualitative research, problems emerge. The corresponding terms in naturalistic inquiry are "auditability," "credibility,", and "fittingness" (Guba & Lincoln, 1981).

Reliability concerns the replication of the study under similar circumstances. The naturalistic investigator derives consistency through coding the raw data in ways so that another person could understand the themes and arrive at similar conclusions.

In naturalistic inquiry credibility or truth is ascertained through structural corroboration. Such corroboration might be accomplished by spending sufficient time with subjects to check for distortions (prolonged engagement), exploring the participants' experience in sufficient detail (persistent observation), and checking multiple sources of data such as other investigators, written records, diaries, field notes, and so on. This is the process of triangulation. Peer debriefing, revising working hypotheses as more data become available, clarifying tentative findings with the participants, and videotaping interviews for comparisons with the recorded data are typical procedures for adding to the credibility of the study (Rudestam & Newton, 1992, pp. 38-39). The present study utilized two corroborative methods of data collection (interviews and focus group interviews). The following methods of triangulation were also utilized: persistent observation, checking multiple sources of data through a comprehensive literature review, recording field notes, and clarification of categories and narrative stories with the participants as techniques of structural corroboration.

External validity refers to the generalizability of the study. The qualitative study emphasizes the "thick description" of a relatively small number of subjects within the context of a specific setting. In selecting participants, the issue is sample bias, not generalizability (Morgan, 1988). Using interviews and focus group interviews "to learn about the full range of experiences and perspectives in a broad population can be a fool's errand (Morgan, 1988). Thus, "generalizations to other subjects and situations are always modest and mindful of the context of individual lives. That is, phenomenological research uses sampling which is idiographic, focusing on the individual or case study in order to understand the full complexity of the individual's experience. For this perspective, there is no attempt to claim an ability to generalize to a specific population, but instead, the finding are relevant from the perspective of the user of the findings" (Bailey, 1992, p. 75).

Wolcott (1990) presented nine points to satisfy the validity (correctness or credibility) question of qualitative studies:

(1) Talk a little, listen a lot -- A sociable "sit and visit" situation should exist where the subject feels comfortable discussing topics with the researcher. The researcher must be attentive and responsive without talking too much and hearing too little.

(2) Record accurately -- The researcher should make every attempt to record precise words of the participants. Words should be recorded as soon as possible to prevent the reinterpreting of behavior before it has been recorded.

(3) Begin writing early -- The intent of writing early is to record what one suspects and to identify holes in the information.

(4) Let readers "see" for themselves -- It is a good idea to include primary data in the final report. This allows the researcher to let the expressed thoughts of others become a point of focus rather than focus only upon what the researcher observed and interpreted.

(5) Report fully -- Every discrepant detail is not reported; however, if an issue is not fully resolved the inclusion of such discrepancies may lead to possible intrepretations every bit as valid as the researcher's.

(6) Be candid - Subjectivity is seen as a strength of qualitative approaches.

(7) Seek feedback -- Having a continual source of feedback checks for accuracy and completeness. Feedback also provides a reality check where the reporting or the interpretation of the event needs to be more developed or is overblown and needs to be brought back to reality.

(8) Try to achieve balance -- Achieving a balance between events that occurred or statements made is warranted in order to avoid a disproportionate amount of attention being given to outlying, yet more provocative, data.

(9) Write accurately -- this process checks for coherence and internal consistency as well as for style and grammar (pp. 128-134).

Wolcott's nine points aided in a strive for a valid study and valid reporting of results.

3.8 Presentation of the Results

Each qualitative analysis requires the researcher to devise his or her own method for presenting the results. The results in Chapter 4 are presented in two primary ways. First of all, data are presented in categories. Following a conceptual definition of the meaning of the category, relevant quotes that illustrates this meaning are presented. The categorical presentation provides an understanding of the categories of findings relevant to career development in a non-traditional field and persistence in engineering. Secondly, developmental narratives similar to those presented in Brown & Gilligan (1992) are presented in the Appendices. This narrative presentation provides an in-depth understanding of the experiences of a few select participants.

CHAPTER 4

RESULTS

4.1. Overview of the Study

As discussed in Chapter 1, previous research conducted on the topic of women's persistence in engineering, mathematics, and science undergraduate majors has been quantitative in nature and has documented the importance of (1) traditional pre-enrollment academic variables, (2) family background variables, (3) individual variables, (4) environmental variables, and (5) support systems. The present study was designed to examine the topic qualitatively and explore the following questions through the stories of women who have either persisted or failed to persist in engineering majors:

- What experiences have been influential in undergraduate women's selection of engineering as a major?
- How does the culture or climate of engineering education influence the experiences of these undergraduate women?
- How do individual, educational, social, and environmental characteristics and strategies contribute to undergraduate women's persistence in their engineering majors?
- Which of these characteristics and strategies differentiate between female persisters and non-persisters, in other words, what are the differences between academically successful undergraduate women who leave their engineering majors and those who remain in them?
- How do characteristics and strategies of persistence and non-persistence compare for women of different groups, that is, African American women, Asian women, Caucasian women, Hispanic women, and women from rural geographical areas?

Therefore, one major purpose of the present study was to understand if there were identifiable differences in the stories of women from different ethnic and geographic groups, or despite these differences, what were the common themes among them.

4.2. Reflections on the Qualitative Process

While the processes of qualitative data collection and analysis were often overwhelming, frustrating, and tedious, a qualitative approach provided the most appropriate framework for an in-depth study of a phenomenon which had previously been examined through quantitative studies only. Through interviews and small group conversations, the meanings participants gave to their experiences as undergraduate women engineering students contributed to a more in-depth understanding of the reasons these former and current women engineering students left or remained in their engineering majors. The use of both quantitative and qualitative methods to study complex phenomena such as persistence is recommended.

The qualitative paradigm has several advantages. One primary advantage of the qualitative research process was that it provided a holistic and developmental view of the participants' experiences, that is, the complex interaction of individual, educational, environmental, and social conditions occurring from early childhood through the present time. While, by necessity, participants were asked to recollect most of their experiences, they were, for the most part, able to do so. A second advantage of the qualitative paradigm was the opportunity to be spontaneous and flexible with the interview guide in each individual or group interview. A flexible questioning route enabled the exploration of each participant's unique experiences through additional probing questions relating to specific events. That is, the interview guide allowed flexibility to interject questions relevant to a participant's own experiences. A third point relates to the advantage and importance of good counseling and interviewing skills in facilitation of the data collection and analysis process. The ability to be sensitive, responsive, and empathetic was crucial. Likewise, the simultaneous use of listening, questioning, probing, and summarizing facilitated the process of analysis and interpretation. A final advantage was the wealth of information obtained through this qualitative process.

Qualitative research requires an intensive involvement with the research process including a commitment of time and effort as well as the coordination of many overlapping and ongoing aspects of that research process. It was sometimes difficult to hand off tapes to a transcriber for transcribing, listen to tapes, correct and edit transcribed interviews, and code transcripts simultaneously as recommended by a grounded theory approach. The logistics of scheduling interviews and groups, having equipment on hand, providing food and drinks, having $10 bills on hand for payment, and submitting costs incurred for payment were also challenges.

4.3. Codes and Emergent Themes

The interview guide and questioning route were organized in a developmental fashion, from the family background and events occurring in childhood to the present time. All individual interview and group interview transcripts were coded. To make sense of the data, Miles and Huberman (1994), as well as Corbin & Strauss (1990), recommend organizing those initial codes into themes, also known as categories, the goal of which is to look for patterns in the data. Although the interview guide and questioning route were organized in a logical fashion, the themes were allowed to emerge in an inductive fashion; in other words, no prior assumptions were made about the interrelationships among the data prior to the observation and analysis process. Please note that the following key will be used throughout the remainder of Chapter 4: AF = African American, AS = Asian, CA = Caucasian, HI = Hispanic, RU = rural, P = persister, and N = non-persister. Codes 1 - 9 refer to participant numbers as used in an organizational scheme for data analysis. For example, ASP3 refers to Asian Persister #3.

4.4. Family Background Variables: The Developmental Socialization Process

Influences on choice of engineering major and persistence in that major include a host of family background variables, including parental educational and occupational attainment, birth order and family systems, gender issues in the family, parents' philosophies and values, and family hardships and tragedies. Parental influence was a complicated web of all these variables.

4.4.1. Parental Education and Occupational Attainment

Previous studies have demonstrated that women engineering students often had an engineering role model, particularly a father who was an engineer. In many cases, particularly with the Caucasian students, instances were confirmed where fathers, brothers, uncles, and grandfathers are or were engineers or non-degreed engineeers practicing as engineers [ASP3, RUP4, CAP1, CAP2, CAP3, CAP6, CAP7, AFN4, CAN6, HIN8]. Most of these students tended to downplay the significance of the impact, as far as their engineering professions, those male family members had actually had on their own choice of major. For example,

> *My uncle on my mother's side is a chemical engineer. I didn't even realize that's what he did until I told him that's what I was going into. [RUP4]*
>
> *I knew my uncle and grandfather were engineers, but I really didn't see anything that it was about. [HIN8]*

In fact, many of the participants with engineering fathers did not really spend much time with their fathers, and some indicated that their fathers were "workaholics" or always on the job. One Asian participant whose father works in the medical profession stated

> *My dad is sort of a role model for what I don't want to be, instead of what I do want to be, so that eliminates medicine and dentistry. [ASP4]*

Likewise, the literature indicates that parents of undergraduate women in engineering have attained higher than average educational levels. These previous findings were not confirmed in the case of all participants in this study. (Refer to Appendix 11.) Thirty (30) percent (n= 21) of all 72 parents graduated with high school diplomas, 19 percent (n = 14) graduated with bachelor's degrees, and 14 percent (n = 10) graduated with master's degrees. Seventy (70) percent (n = 7) of both bachelor's and master's degrees were held by Caucasian parents. In one case, the parents of a Hispanic persister [HIP2] have less than a middle school education. Eight (8) (n = 6) percent of all parents had less than a high school education or either a professional degree (law, medicine, dentistry, pharmacy) or a Ph.D.

4.4.2. Birth Order and Family Systems

Previous research on the impact of birth order on a young woman's selection of engineering as a major has been inconclusive. While research has indicated that first born children are often over-achievers, ambitious, and determined, the birth order of these participants ranged from being an only child to being the last born of a relatively large number of siblings. Thirty-nine (39) percent of all participants were first born or only children.

For the Asian group, two of the four participants [ASP1, ASP4] were only children. One of those [ASP1], a young woman from Korea, had been adopted by Caucasian parents at the age of eight years. She stated that the adoption changed the course of her life and created educational opportunities that would not have been available otherwise.

There were two first-born children among the African American group [AFP4, AFP7] and none among the Hispanic group; however, both African American and Hispanic participants in general had relatively more siblings than the other groups. The comments made by some of these students indicated that they had struggled financially in their pursuit of higher education. The structure of opportunity inherent in an engineering degree has been a huge motivator in the persistence of these participants in their engineering majors.

Among the Caucasian, rural, and non-persister groups, there were ten first born children [CAP4, CAP6, CAP7, RUP1, RUP3, RUP4, AFN3, AFN4, HIN6, CAN8] and five women in these three groups [CAP2, CAP3, CAPS, RUP3, CAN7] have older brothers who are engineers. Those participants with older brothers talked about playing and tagging along with their brothers and their brothers' friends and competing with their brothers in academics and sports.

4.4.3. Gender Issues in the Family

Within the same family, the relationships parents had with their individual children, as well as their expectations for their children, were often very different. These differences have influenced who most of these young women have become, and thus their choice of a non-traditional major and their persistence in that major. Sometimes differences in relationships and expectations created competition between sons and daughters. For example, some parents often had higher expectations of their sons by pushing them to participate in sports and/or academics. As one Caucasian participant stated

> *My parents didn't push me to do sports or anything like that. I was the smart one. I pushed myself more so I could get out of the shadows of my brothers. [CAP8]*

Sometimes fathers purposely created competition between a son and daughter, for example,

> *When I was little, if there was something I didn't want to do, sometimes my dad would say, "a boy could do that or a boy could do that better." I wanted to be stronger than my brother, faster than my brother. [CAP4]*

In one case, a father who wanted his second child to be a son, rather than a daughter, had a typical father-daughter relationship with his first daughter and a more typical father-son relationship with his second daughter.

> *He wished I was a boy . When my sister was born he didn't really care that she was a girl, because he thought he was going to have another child. Then when he had me, I think he realized he wasn't going to have anymore kids. [CAP1]*

This young woman became her father's sidekick when it came to working on the car, building a deck on the house, and general work outdoors and around the house on weekends.

4.4.4. Parents' Philosophies About Parenting

Participants were asked to identify their parents' philosophies on rearing children, including the values they stressed as important and the greatest lessons they learned from their parents. In almost all cases, the value of education was stressed. As one African American participant so eloquently stated,

> *I think the best lesson that I learned was never to do less than those who have gone before you. It's expected of you to keep the torch burning. People are looking at you to be a leader . So I always do the best, I never do anything less. [AFP7]*

Parents in general also stressed independence, self-reliance, individual responsibility, a strong work ethic, the importance of family, and a balance between work and family. Many parents also stressed the importance of religion, faith, and the difference between right and wrong. African American, Asian, and Hispanic families also tended to stress the value of reciprocity in their extended families as evidenced by their reliance on immediate and extended family members for financial assistance in emergencies. For example, the siblings of an African American persister took over her car payments when she couldn't afford to make them herself. An Asian persister knew she could rely on her wealthy uncle if her parents, independent business owners, ran into financial difficulties. Asians and Hispanics also tended to stress a respect for elders and authority figures as evidenced by their shock at the disrespect shown by their Caucasian peers toward high school teachers and college professors. These values and philosophies have had a significant impact on every aspect of the participants' lives in general, but their persistence in their engineering majors in particular.

4.4.5. The Role of Mothers and Sisters

Previous research on persistence in engineering fails to substantiate the role of the mother in the education of her children, as well as her influence on occupational choice. Mothers, many of whom were strong educators in the home as well as in the workforce, were the force behind many of these young women.

> *My mom really got involved at school because she hasn't worked since both of us were born. She knew exactly everything I had to do, but my dad [an engineer] didn't know. He had no idea what I had to do. He had no idea who my teachers were, if I had homework, what classes I was taking. He had absolutely no idea. [CAP1]*

In some cases, mothers with teaching degrees and technical degrees chose to leave the workforce to rear their children and provide support for their education. In the cases of the two young women with the highest SAT scores [CAP1, CAP2], both mothers had math backgrounds in college and stressed the importance of math for their daughters' futures. For example,

> *My mother used to set me down and she would take my homework that I did for class, like my math homework. She'd check it, and she'd say you have two mistakes. She didn't say number one and number four are wrong She said you have two mistakes. And I had to go find them, and she wouldn't let me stop until I fixed them. [CAP1]*

Another participant stated,

> *She always had games and ways of teaching. She would make flash cards and monopoly games just to teach us something like our letters or whatever. She would always play games so I always thought the way to learn was through the creative way and the fun way, like songs and things. She was a big home schooler. [CAN6]*

This non-persister, although bright in math and science, came to love and thrive on the creative arts; the rigidity of engineering education stifled that creativity.

While brothers with engineering degrees are often believed to be role models, older sisters were role models in some cases. One of the Hispanic participants [HIP1] stated that her older sister, a Civil Engineering major at another university, was her role model. An African American participant who had made some of the same choices and sacrifices her sister made stated

> *My older sister has been a role model for me. She had a plan. She knew she was going to college. She never had a boyfriend in high school or college. Her mission was to be able to take care of herself and everything [AFP2]*

Mothers, often feeling regret about some of their own choices, sometimes gave their daughters warnings about life and the importance of being independent and self-sufficient rather than dependent on others. Five of the 36 mothers had become single parents due to death and divorce. Their warnings applied to personal life choices, for example

> *My mother always said, "don't marry because you think the guy is going to support you. He could leave you or whatever. If it's going to happen you want to make*

sure you can be on your own. If you ever get into a relationship where you're in trouble, you want to make sure you can leave and support yourself." [HIN2]

They also applied to occupational choice as well,

My stepmother told me that if she had to do it over again, she would go into engineering. So that's why I decided I wanted to at least try engineering. [AFP9]

4.4.6. Family Hardships and Tragedies

Many of the participants described personal tragedies and family hardships, and the impact those hardships and tragedies have had on their motivation to be successful in life and, in the case of persisters, their ability to deal with any barriers and obstacles they have encountered with the climate in engineering. These hardships and tragedies include the death of parents [AFP7, HIN2] and the death of a twin sister [AFP3] who was abducted and murdered in their senior year of high school. Participant AFP3 stated,

They [the EF faculty] don't know where I come from, what I've been through. I mean if I can survive some of the things that I had to go through before I even got to college, I could go through this [freshman year in EF] and still come out all right. I mean this was just another small mountain, another thing to get over. [AFP3]

Other tragedies and hardships included a fire which destroyed the home and all personal belongings [AFP1], siblings with disabilities [ASP3, AFP5, CAN1, HIN2], fathers diagnosed with Post-Traumatic Stress Disorder [RUP1, CAN7] after serving in the Vietnam War, and parental divorces [AFP1, AFP9, CAP6]. Participant AFP1 described the divorce of her parents and the effect it had on her persistence,

Our parents getting divorced made me more determined to get an education and succeed. We're not rich people and when my parents got a divorce, we just really took it hard. My friends tell me I'm just so independent, and that's probably why I want to prove to myself I can do it and not ever have to worry about [financial] circumstances. [AFP1]

4.5. Individual Background Variables

In addition to family background variables, several individual background variables were influential in a nontraditional choice of major, including leisure and extracurricular activities, academic abilities and backgrounds, and personality. In some respects, these variables could also be considered family variables in that parents were very influential in the choices their daughters made in terms of academic paths and leisure activities.

4.5.1. Influence of Leisure and Extracurricular Activities

Participants were asked to identify their preferences for toys and activities in childhood. These preferences and activities covered a wide range. Appendix 12 lists both individual preferences and categorizes those preferences. Previous research indicates that women engineering students were tomboys in childhood, however, there were many participants who preferred reading, board games, and other sedentary activities. One interesting finding was that, although some of the Caucasian and rural women [CAP1, CAP3, CAP4, CAP7, RUP4] stated that they hated or disliked

Barbie, some of the African American women [APP2, AFP4, AFP9] had preferences for playing with Barbie.

Many of the participants [ASP1, AFP6, CAP3, RUP2, RUP4, HIN2] did refer to themselves as "tomboys," a term used to describe preferences for playing outdoors, playing with brothers and other boys in their neighborhoods, and playing with toys that are considered to be traditionally male toys. Leisure activities and preferences related to engineering included Legos, cars, trucks, models, computers, computer games, tinkering around the house, and spending time with male relatives on their jobsites. As one Civil Engineering major [CAP7] stated, "Legos = civil engineering." Not surprisingly, most brothers did not reciprocate by participating in traditionally female activities or by playing with traditionally female toys. Closer relationships with boys in childhood has, in many cases, led to preferences for friendships with men in young adulthood; thus, associations with male faculty and peers in their engineering majors has not been unusual for many of the participants.

In addition to the image that women engineering students are tomboys, the literature also portrays the image that they are masculine or unfeminine too. In actuality, many parents believed in the importance of a balance of extracurricular activities in childhood, for example,

> *I played with the guys a lot so my mom was always leery that I would turn into of those brute women. So she always had me in dance class. I always had to do so many feminine things. [AFP7]*

In particular, those "feminine" things included dance and music.

> *What she said about balance, I think that's what my parents tried to create. I went outside and played with the boys, but I also took jazz, tap, clarinet, and piano for years. [AFP4]*

Many parents thought of music and dance "hobbies" as avenues for structure and discipline, as well as balance and well-roundedness. In the case of one non-persister who took jazz, tap, ballet, violin, and piano lessons during most of her childhood, these hobbies led to a switch from an engineering major to a theater arts and biology [her “parents’ math and science contingent”] double major with a goal of a career in musical theater. She stated,

> *Ballet and tap and jazz and piano and violin were considered hobbies. They [my parents] didn't realize what it would do to me. You know they didn't realize what they started . I can't live without it now. [CAN6]*

Likewise, an Asian participant [ASP 1], who had taken ballet since the age of 8, came very close to making a career with the Joffrey Ballet Company her occupational goal.

Sports, as well as music and dance, provided structure and discipline and often led to a competitive nature for many of these young women who participated in almost every sport imaginable from early childhood through high school, including organized athletics. One of the non-persistors [CAN8] who had participated in track and aerobics while in high school has decided to coach track and/or teach aerobics when she graduates from college.

The influence leisure can have on occupational goals was evident in two other cases. From the time she was five years old, one participant showed horses and spent the summers on the national rodeo circuit. She would have become an animal science major in college if she had had good memorization skills.

> *I love animals and animal science, and it would have been interesting to me, but I can't memorize. I can't do it, so I don't think I could have made it through the biology and the physiology and everything else. [RUP3]*

She chose engineering instead, and currently spends her free time being involved in the Block and Bridle Club at the university.

One participant, who at the time was very uncertain about her engineering choice, decided to become a camp counselor between her freshman and sophomore years in college and loved it. She stated,

> *I was like, man, I like being with kids way more than I like these engineering classes I'm taking. Maybe I'm not cut out to be an engineer. Maybe I should switch to something else. [CAP2]*

On the advice of a co-op supervisor, she decided to stay in engineering, but she switched from Mechanical Engineering to Industrial Engineering, a more people-oriented discipline. She has also decided to drop out of the workforce after the birth of her own children to stay home with them and perhaps “home school" them as well.

4.5.2 Personality

Participants were asked to describe their own personalities. Appendix 13 displays the corresponding codes and words. Most persisters described themselves with such words as competitive, assertive, independent, motivated, determined, disciplined, strong sense of self, ambitious, over-achiever, resilient, and confident. While a few of the non-persisters described themselves similarly, two [CAN7, HIN8] in particular described themselves as being more easy-going and non-competitive. These non-persisters did not respond well to the stress, pressure, and competitiveness of their engineering programs. The descriptions of persisters imply that they tend to be "Type A" personalities in that they are competitive, they thrive on challenges, respond to stress by working well under pressure. Whether these participants started out in life or engineering having these qualities or whether they adapted along the way is unclear.

> *Definitely you have to have strong determination, be strong willed. I think sometimes just the fact that it is overrun by men, you have to be competitive and aggressive. [CAN1]*

> *I think that I've become really independent because of the way that I've been raised in my family. [CAP6]*

> *Personally I'm a pretty competitive person. I think it all stems from having a really bad softball coach as my guidance counselor. We just lost every game because we were a bad team, and I took it personally. [CAP8]*

Many persisters described two striking features of their personalities. They are goal setters, that is, once they make something a goal, they are going to follow through no matter what. If they believe they can follow through, they are resilient enough to avoid the influence of anyone who attempts to change their minds. Any adversity they experience, whether it be individual, environmental, or social barriers or obstacles, gives them all the more motivation to succeed and prove to themselves and others that they are capable of succeeding.

> *I'm just as bull-headed and stubborn as I can be. If I want to do something, I'm going to do it. If I believe I can do something, no one's going to change my mind. [AFP6]*

> *Tell me I can't do something, and I'm going to do it just to prove you wrong. It motivates me. [CAP7]*

> *Once I start something, I have a really hard time giving up on it. And I want to quite a bit, but I just keep on pushing, pushing, pushing. [RUP1]*

> *Once I decide on something, and I make that a goal, then that's what gets done. That's just the way I am. Like in the 8th grade, I decided I was going to be valedictorian no matter what it took. And that's what I did. [RUP4]*

The Myers-Briggs Type Indicator (MBTI) proposes that most engineers fall into the category "ISTJ" (Introverted Sensing with Thinking) or some slight variation of it. However, there were exceptions to the rule – not all persisters fit this mold. Some perceived themselves to be outgoing, intuitive, and feeling. One persister, who was uncertain at one point about engineering, described the results of testing that indicated she is an "ENFP" (Extroverted Intuition with Feeling) – the complete opposite of the typical engineer.

> *I'm an ENFP. He [a career counselor] looked at my personality, and my personality is not like a typical engineer. He said that's good one of two ways. First, if you're an engineer, you'll be unique because there aren't many of you who persist in engineering. Secondly, if you don't want to be an engineer, here are other options. [CAP2]*

4.5.3. Academic Variables and Background

One strength of this study is that it examined the significance of pre-enrollment variables in undergraduate women's choice of an engineering major as well as persistence in that major; however, factors influential in persistence were not limited to quantitative measures such as math and science ability, grade point average, class rank, and SAT scores. These quantitative measures were more influential in the actual choice of major and admissions process rather than the ability or willingness to persist with the major choice. Since previous quantitative studies had focused attention on those variables, this study was not primarily concerned with those pre-enrollment variables.

Appendix 14 lists the academic strengths, academic weaknesses, final high school grade point averages, class rankings, and SAT scores as recalled by all participants, including persisters and non-persisters. In some cases, participants were unable to recall their exact averages, ranks, or scores. Several participants attended high schools which did not rank their graduating seniors, and one participant did not have a rank because she attended four different high schools. What is noteworthy is the fact that persisters and non-persisters as a whole had similar strengths, weaknesses, grade point averages, class ranks, and SAT scores. Average SAT varied slightly among the five groups, with average scores of 1002, 1060, 1230, 875, 1108, and 1161 for African Americans, Asians, Caucasians, Hispanics, rural students, and non-persisters. (No attempt was made to verify SAT scores, and missing data were accounted for in the calculations.) The average

SAT scores of non-persisters were higher than the averages for African Americans, Asians, Hispanics, and rural students. In some cases, the SAT scores would be considered well below the average, say 750 to 1000, for all undergraduate students admitted to the College of Engineering. These cases included primarily African American and Hispanic persisters, thus raising the issue of potential bias in the test itself. In fact, two participants [ASP3, CAN5] questioned the value of the SAT and other standardized tests as a measure of actual intelligence or ability.

4.5.4. Reasons for Choice of an Engineering Major

Participants were asked to discuss their own personal reasons for choosing engineering as a major. Appendix 15 lists frequency counts and comments organized by categories. The reasons stated for an engineering major were very diverse. Three participants chose engineering as a major due to a concern and appreciation for the environment and/or a desire to make a contribution to society. Surprisingly, only one participant, an out-of-state African American student, was recruited by the university. As discussed below in Section 4.5.4.5, the role of guidance counselors in the choice of engineering as a major was minimal. This is evidenced by the fact that 33 percent of all participants stated that their choices were accidental or based on a lack of information, the belief that there were no other logical choices, or a process of elimination. Test results were influential in only one case. Six students mentioned that their original plans to major in others fields such as medicine had failed or changed.

The majority of participants mentioned math and science ability, exposure and hands-on experience, and the structure of opportunity afforded by an engineering degree as major influencers on their choices to majoring in engineering.

4.5.4.1. Math and Science Ability

The most often stated reason for choosing engineering was math and science ability, for example

> *I don't know if it goes in the genes or what, but I was really strong in math when I was in high school. [CAP6]*

> *I really didn't go into engineering because I had a love for it necessarily. I was good at math, had good spatial abilities. It was a logical choice. [CAP3]*

As previously mentioned, most of the participants has strengths in math and/or science or at least perceived that they did compared to their high school classmates. Differences in academic backgrounds and school systems are discussed in section 4.6.3.

4.5.4.2. Exposure and Hands-on Experience

After math and science ability, exposure to engineering was the second most often stated reason for choosing engineering as a major. Exposure was gained through formal camps and summer programs, for example

> *I went to Argonne National Laboratory and got to play with electronic microscopes and accelerators. I was in a cloud. I mean this stuff just really excited me. I realized I can do that and it led me into engineering [CAP2]*

I went to this one engineering camp that my parents sent me to and it was in Hoboken, New Jersey at Stephens Institute of Technology. They had manufacturing and mechanical engineering there, and it was really interesting. It was cool to see a college that offered hands-on engineering learning – really cool robotics and stuff like that. [CAP6]

In at least one case, summer camp did not turn out as expected,

I went to summer science camp, and I signed up for computers, physics, and astronomy. The physics and astronomy were full, so I got stuck in Psychology. I hated it. I thought it was the stupidest thing I had ever done. [CAP7]

Exposure was also gained more informally through hands-on experiences with fathers and grandfathers, both at home and on the job. This type of hands-on exposure tended to influence daughters and granddaughters more in their engineering major choice than engineering degrees per se. For example,

My father likes working with his hands. He likes to build things like wood stoves so I was always there watching, and he taught me a lot. I think he instilled the wanting to know how things work. [RUP5]

My dad is an engineer by practice. He and all of his uncles, all of the males in my family, have been involved in construction and have been engineers by trade. I would ride along with him on the bulldozers and watch. [RUP3]

I loved to help my father working on the car or fixing stuff in the house. I was just a hands-on person, wanting to always fix something. [AFP6]

My granddad was a construction worker, but I had the idea that he was an engineer. He would take my sister and I along to help with the sand, carry the sand, help make all those little gadgets for the construction, put the columns together, and the foundations and the blocks. He would teach us everything so I really liked that. [HIP2]

Engineering fathers also helped, or attempted to help, with homework. For example,

I asked him for help with my algebra. This is a true story. He literally explained algebra to me using calculus. [CAP8]

My father tried to use this little navigation wheel to help me with my physics. [CAP7]

This trend continued well into college. Several participants talked about the advantages associated with having a father who is an engineer, that is, being able to call home for help with homework and projects.

Hands-on experience was also gained through high school coursework other than math and science, and experience working with computers. Although only a few participants [AFP8, CAP1, CAP4] had this type of hands-on experience, typical courses included introductory engineering, electronics, architectural and technical drawing. For example, *I guess in a lot of high schools, those [vocational] courses aren't done very well, and the teachers aren't really good teachers. A lot of vocational people just take those classes, but in my high school, the teachers who taught those courses were really good. [CAP1]*

This same participant gained extensive computer experience through her school newspaper and an independent study in which she taught herself AutoCad. She also later gained formal hands-on engineering experience through her local county government. She definitely "came into engineering running," but her background was the exception not the rule. With the exception of one participant [AFP4], all participants with hands-on experience have persisted in engineering, perhaps because they made more informed decisions about their majors.

<u>4.5.4.3. Structure of Opportunity</u>

The structure of opportunity, including opportunities to get a job after graduation, a variety of job opportunities, and high salary potential was very appealing to many of the participants, both persisters and non-persisters, as well as their parents. For example,

My parents always thought that math and science majors would always be in demand and on the cutting edge. They've said all my life that the way to go and the way to live comfortably and with the things you want is to go into a major that is something. [CAN6]

She [my mother] said that you make a lot of money being an engineer, and I wanted to make a lot of money. That's the only reason I did it – to make a lot of money. [AFP8]

My mom always tried to stress engineering, thinking that women engineers are going to make all the money and everything. [HIN8]

What I've always wanted to do is animal behavior which is what I've gone back to. But I figured – I looked at the job perspective after graduation - and it was really bleak. So I was looking for something that I'd have more opportunity in, and engineering obviously is a giant field. [CAN1]

All my brothers are like "yeah, you should be an engineer because after you do it for the first few years, you can make $70,000 - 80,000 dollars. "That's what I was thinking about – it didn't matter if I liked doing it! [CAP6]

My stepmother used to always bring home these magazines and stuff that said how many jobs [were available for] minority women in engineering. [AFP9]

Unfortunately, in at least seven cases [AFP8, HIP1, HIN2, AFN3, CAN5, CAN6, HIN8], parents and other individuals pressured these young women to pursue engineering degrees. Five of these participants later dropped out of engineering. Those who left engineering had the support of at least one parent or they were strong enough to stand up for what they personally wanted to do. The decision to switch majors was less difficult in those cases where participants had a parent's support than it was in those cases where the parents objected or disagreed with the change.

4.5.4.4 Parental Pressure

Parents who pressured their daughters to pursue engineering weren't necessarily engineers themselves. For example, the mother of one participant [HIN8] who later dropped out of engineering, was an Equal Opportunity Employment Specialist with the federal government. Of course, the nature of her job required that she be in tune with those occupational areas in which few women are employed. Many parents who had pressured their daughters had personally struggled to get ahead in their own lives, for example,

> *I guess my parents struggled to get ahead in their lives. At the time, I hated my parents for it [pressuring me to major in engineering]. My father always tends to force his beliefs on us. [HIP1]*

In fact, only one participant [CAN6] who was pressured to major in engineering had an engineering father as well as other male engineering relatives.

> *My dad is an engineer, my uncle is an engineer, my grandfather was an engineer, my brother is an engineer, you know, everybody in my family is an engineer named John. I didn't know what else to do. That's what I was supposed to do. [CAN6]*

Parental pressure to major in engineering or a related field, more than likely stemmed partly from society's views of the prestige and value of occupations as well as the structure of opportunity afforded by those occupations. Many participants commented on the prestige associated with being an engineering major, for example,

> *In general society thinks of engineering as something special and something better than average. Engineering is a good thing. Off-hand when I tell people I'm an engineering major, they say, "oh, you're one of the smart ones." [CAP1]*

> *I guess I feel kind of a respect when I tell people that I'm an engineering major, you know, and I want to be respected. [CAP3]*

> *Just graduating with an engineering degree looks good. Even though I really don't want to do engineering, it just looks good to have majored in engineering and done well in it. [AFP8].*

> *Even though I was struggling in engineering, I think I felt better being there than I do in Psychology. I know professors have this sort of elitist notion about engineering so struggling in it was kind of good. [AFN4]*

Two of the non-persisters [CAN5, CAN6] came to believe that many young women stay with engineering because they are more concerned with how they are perceived rather than whether they are happy in the major.

> *People have this perception that engineering is one of the more stable jobs that pays really well like doctors, engineers, and lawyers. There's a lot of prestige involved. I think it's more for the exterior, what you are perceived as, what you put out. [CAN6]*

> *I think a lot of times people "ooh" and "aah" when they hear you're an engineering major. "She must be so smart, That's so hard, how do you do it?" And that*

makes a lot of people feel good about themselves, because, you know, when people are complimenting you or are in awe of your academic major, then that makes you feel like you're doing something special. But, on the same note, I think that if you rely on other people to reinforce your confidence and to enable you to feel good about yourself, your problems run far deeper than just deciding what major you want to pursue. [CAN5]

4.5.4.5. Role of Guidance Counselors

Participants were asked what role their guidance counselors played in their knowledge of engineering or their choice to major in engineering. (See Appendix 16 for a list of responses to the question, categorized by positive, neutral, and negative responses.) In only three cases did counselors have a positive impact [AFP4, CAP1, CAP4]. In these three cases, parents of the participants included two educators in the same school system, a secretary in the guidance office, and a very "strong" and educated mother.

In the majority of cases, counselors played a very minimal role in participants' knowledge of engineering. Even in those schools with a small student-to-counselor ratio, 53:1 in the case of one private all women's college preparatory school, the interaction and influence was minimal. In most cases, the counselor's impact was negative. Career guidance activities were limited to standardized testing that sometimes underestimated the potential of these students. In general, counselors lacked knowledge about career opportunities in math, science, and engineering professions.

4.5.4.6. Degree of Certainty About Major Choice

Many of these young women made uninformed choices about their majors; that is, they fell into it, they went into it blindly, they didn't know anything about it, they made a choice through a process of elimination that started with only a few options. The degree of certainty about the choice could have an impact on persistence, but certainty might not guarantee persistence in the engineering major. Participants were asked to describe the degree of certainty, from very uncertain to very certain, they experienced in their initial choice to major in engineering. Appendix 17 shows the degree of initial certainty and major changes for all participants.

For the Asian group, two of the four participants [ASP1, ASP4] were certain about their choices; however, ASP4, although a rising senior, is still uncertain about Electrical Engineering. Two of the nine African American participants [AFP2, ASP4] were certain about their choice while none of the Hispanic participants [HIP1, HIP2] were certain. Three of the five rural participants [RUP2, RUP4, RUP5] were certain, and, surprisingly, only one of the eight Caucasian participants [CAP1] was certain. Only until they moved into their current majors, with the exception of ASP4, and, in most cases, gained some relevant work experience, did uncertain participants become certain about their choices. Of the seven non-persisters, only one [CAP5] was certain about her choice. The significant issue is that many of the participants who felt certain prior to enrollment started to doubt their choices with their experiences in the first year of engineering, for example

I was REAL certain . Man, I've got a good head on my shoulders, I can do this! After the first semester, I was like "ugh, maybe I should think about this a little bit more." [AFP5]

Some of the girls I talked with last year said, "I don't think l can do this. Maybe I shouldn't be an engineer." They took the professor literally [women don't make good engineers]; they took it seriously. It's a shame that somebody's attitude like

> *that can really damage what someone thinks they want to do for their career. [CAP8]*

> *My sister [a civil engineering student as another university] had the same problem. She didn't like some of the early classes she took, and we were always questioning, "why are we engineers?"*

4.6. The Culture and Climate of Engineering and Institutional Factors

As women in non-traditional majors, most of the participants have had experiences that are alike, in some ways, other women who experience college life. These experiences fall under the category of "The Freshman Year Experience." However, unlike women in more traditional majors, the experiences of these participants, as well as other young women in engineering majors, are very unlike those women in traditional majors. The differences can be attributed to enrollment in non-traditional majors and the culture and climate of engineering education, which sometimes creates obstacles and barriers to the pursuit of their goals and higher education. For minority women, including African American and Hispanic women, institutional fit is also an issue. Appendix 18 lists codes for comments to question about experiences in the climate of engineering.

4.6.1. The Freshman Year Experience

As first year students, these participants, as well as other college students, are entering another stage of human development, of which one task is a search for identity. First-year students are also away from home and parents for the first time in their lives in most cases, and the opportunity to assert their independence can be overwhelming for some. Students are also making new friends and learning how to get along with roommates and peers, as well as making important choices about sexual and other behaviors, such as drinking and experimentation with drugs. A change in environment, in combination with all the task and behaviors associated with the developmental stage, sets the stage for a host of personal problems and difficulties which can impact persistence in any major. For example,

> *I don't think I was ever really made aware of how big of a change it would be. I was more worried about leaving home. My parents weren't going to be there. What am I going to do? It was very hard for me to adjust. [AFN3]*

> *When I got here it was so big, and there was nobody I could just call – you know, all the things that come with being on your own. You have to think about money, school, and trying to have a social life. It was too much for me at the time. I felt overwhelmed by the school and the classes. [AFP1]*

> *I was finding out my identity through finding out what I wasn't supposed to do. [CAN6]*

Personal problems and experiences affected the persistence of at least three of the non-persistors [HIN2, AFN3, CAN5]. Participant HIN2 experienced some depression, weight gain, and financial difficulties as well as roommate problems. Raised in the Catholic church, she and her first roommate, a Jewish student, clashed because of their different religious beliefs. Her second roommate, a pyromaniac, was arrested for setting and attempting to set several dorm rooms on fire, including their own. Participant AFN3 was assaulted by a male engineering student.

I had other personal negative experiences. I was assaulted and that semester I ended up withdrawing. I had straight F's on my report card, and he [my advisor] never once called me and asked what happened. He lost me in the shuffle. [AFN3]

Participant CAN5 developed an eating disorder in her second semester. She attributes the eating disorder to life-long parental pressure, a perfectionist personality, and the stress of her freshman year in engineering. As one African American participant stated,

We have this vision of college and how college is supposed to be, and it's not supposed to be this stressful. You're not supposed to have this many late nights. You're not supposed to struggle this hard for something that you wanted so badly. I mean, this really doesn't make any sense. [AFP6]

A rigorous and rigid academic program, the lack of academic preparation in terms of preparatory courses and computer background, and a negative climate in engineering, in combination with normal developmental and adjustment issues was overwhelming for many of these participants.

4.6.2. The Non-Traditional Major Experience

As non-traditional majors, many participants commented on the effects their majors have had on their experiences in general, and their experiences with engineering education in particular. Because there aren't many women in the field, some of the participants [AFP1, AFP7, AFP9, CAP3, CAN6] felt they were challenged and gained motivation and strength from the fact that they were pioneers, creating a name for women, or "carrying the torch," as one participant commented.

I'm a mentor in the Minority Engineering Program, and I know that there are professors up on the top of the hill in ABC Hall who are just completely against women in engineering. That just makes me want to go at it more because it really bothers me when people are like that. So I've just shown myself that I can earn respect and kind of create a name for women in engineering [CAP3]

When you walk into your classrooms and you see that there's only two women in there, or maybe you're the only one, you know, it kind of rubs. Maybe I can get through this, and tell somebody else they can get through it too. [AFP1]

The African American participants especially felt they were "always the first in everything." The Hispanic participants [HIP1, HIP2] were going against their traditions to carry the torch for other Hispanic women, and for that reason, studying non-traditional majors was especially difficult for them.

Engineering majors, male and female, who leave engineering often transfer to business. After initial enrollment, many African American participants [AFP4, AFP8, AFP9, AFN4] were taunted about being in the pipeline for a switch to a business major.

That's one of the things they told me during the summer when I told someone I was an engineering major. "No you're not, you're pre-business." [AFP4]

I got this e-mail and it said, "this is the course of your life. You struggle in engineering for maybe a semester or two or three, and then you switch to business. You graduate with a business degree and you're a certified public accountant." [AFP8]

I was trying not to be one of those people who converted to business from engineering. [AFN4]

Interestingly, no other participants commented on the business pipeline.

As non-traditional majors, these participants have discovered a "good old boys' network" which can also act as an obstacle or barrier. Because engineering faculty and other individuals have this "elitist notion that engineering is superior," [AFN4] several of the participants [ASP2, CAP1, CAP4] commented on how they constantly receive the admiration of friends. Some participants [CAP3, RUP1, AFN3] also perceive that they are constantly having to earn the respect of faculty and peers in engineering by working harder to prove themselves, for example

My professor at ABC Community College didn't think the girls could hack it. He wasn't very tolerant of women in engineering. By the end of the two years, I had his respect. I had to earn it because he didn't start out thinking I could do it. [RUP1]

For participants [CAP1, CAP8, RUP4, RUP5] who prefer associating with their male peers, this good old boys' network is not viewed as an obstacle.

One effect of the engineering organization or good old boys' network, are style differences, including personality and communication preferences and patterns, which are sometimes barriers or obstacles for women. Differences in communication impact every aspect of the engineering culture, from the classroom to working in groups with male peers to working on the job in an internship or co-op position. For example,

We [men and women] just don't think about things the same way, and something you might think of as important, they're not going to think that's important at all, and you're really on two different wave lengths. [CAP1]

Women are obviously perceived traditionally as the more nurturing and dependent type. In stuff like engineering, you just can't be like that. [CAN1]

Because of these style differences, "women are sometimes viewed as having less ability, partly because they generally aren't as assertive as men" [ASP4] and they often don't have a network of study partners like the men do. The perceptions that some women engineering students are less able affects the perceptions people have of other women engineering students, as explained by one participant,

When women ask a question, and they come across sounding not as intelligent as the men in their class, it definitely hurts women, not only the individual, but all the other women in the class. I've been in that position too. I have been like "why is she asking that?" You know, it almost embarrasses me, because I think they are going to think the same about me. The whole education thing is just making sure that you sound intelligent and educated, and not that those women weren't, they were very smart women, but they just didn't come across that way. [CAP2]

Another effect of being in a non-traditional major is the difference in work loads between participants and their non-engineering friends, roommates, and hallmates, for example

My roommate was a physical education major. She never had to do any work or whatever. You know, her weekends started on Wednesday and ended on Tuesday. So it was different. It was really different. [AFP3]

I guess I just don't have that much respect for other majors. There are those people who complain about having a lot of work to do, and I can't stand it because I know that it's not that much to do. [ASP2]

Most all of my close friends are engineers, but neither of my roommates are. It's different when you have different work loads. Sometimes it's kind of hard. It's easy to get distracted if you know everybody wants to go out and do something and you really need to do some work. [CAP4]

The girls on your hall, they weren't really any engineers, and they're usually into their psych or business and so forth. I couldn't really relate to them class-wise. I wish I could have picked an engineering roommate instead of been dealt a roommate. [HIN2]

Affirmative Action hiring practices also affect these non-traditional engineering majors who feel some ambivalence about the issue. It also affects the perceptions and attitudes of others toward women and minorities. As one non-persister commented, in defense of her brother who recently graduated with an engineering degree, "I think it discriminates against the men." [CAN6] Although these participants hope Affirmative Action will help them get jobs, they also don't want to be hired strictly because some people perceive that Affirmative Action guarantees them a job.

I hope it helps me get a job, but at the same time, I don't want to think that's why I'm going to get a job. I want a job because I deserve that job over anyone else who is applying for the position. [CAP1]

I don't believe that women should get jobs they can't perform based on maybe a quota or a lower standard. [AFP1]

With more and more women entering majors and occupations traditionally held by men, the nature of the workplace or organizational culture changes. Male engineering students are having to learn to work with female engineering students in their classes and groups. Male engineering professors are having to learn to teach female engineering students, and men who have never worked with women in equal positions in the workplace, are having to learn to work with women. As one participant stated,

In college the guys are learning to deal with women professionally a lot easier. I think it's pretty easy for a women because she's around men all the time. I think it's harder for a man because women seem to be just entering the workplace more and more. A lot of men haven't had that much experience with dealing with women whereas women in our field have been dealing with men the whole time because it's a man's field. [CAP1]

Many non-persisters [CAN1, AFN3, CAN6] commented on the potential for discrimination, including gender and racial discrimination, in the workplace, for example,

There's so much that stems from sexual discrimination, like salary differences, major salary differences. [CAN1]

4.6.3. The Freshman Year Experience in Engineering

Students who enter the engineering program as first year students do not enter with the same academic background, foundation in math and science, and exposure to computers, thus creating a major roadblock to effective and successful performance. Problems in academic performance are created when there are differences in high school programs and offerings. Not everyone "comes in running." For this reason, students sometimes get discouraged and leave the program, because they are competing with many students who come from engineering preparatory schools and Science, Math, and Technology (SMT) magnet schools. If they don't leave out of discouragement, some still feel the effects of that lack of background, for example

> *The only thing I had was like in 5th grade . We had computers and played games on them. We didn't have anything else, and they just threw us in with the computer and said, "learn it." It was like they expected you to know the stuff. It was awful. [AFP6]*

> *If you're coming from a situation where you're not really introduced to the higher levels of math and science and taking the engineering design courses, then you come in at a disadvantage. That's anybody, but you're probably going to find more minorities in that situation than Caucasians. [AFP9]*

> *Statics, deforms, stuff like that, I had no confidence in because really we hadn't done anything like that before. There was no foundation to build on. There was no background for me to catch up with. Once you missed the bottom layer, you're just messed up all the way through. I can hear the word "moment" and I cringe! [RUP1]*

Deficits in the background were especially prevalent among African American and rural students who were competing with students from school systems with higher per pupil expenditures for resources such as computers and strong SMT programs.

> *Part of it was that I didn't have the kind of background everybody else did. I didn't have as good of a chemistry class, I didn't have as good of a physics class, and stuff like that. So when I got to things like statics and more in-depth chemistry, I didn't know as much as everybody else did. [ASP2]*

> *I did feel at a disadvantage because of the northern Virginia schools. The students there got 20-30 AP credits sometimes so they're already ahead of you. I found that discouraging just because they weren't offered [at my high school]. [RUP4]*

> *I was weak in my math when I came here. I was always a good math student, but it was only compared to 29 other liberal arts girls. [RUP3]*

Many students also lacked adequate study skills and study habits when they entered the engineering program. As very bright and intelligent students, they have performed at a very high level with relatively little effort. Many of these participants commented on their lack of study skills in that they performed poorly for the first time or even earned their first F's ever.

I never ever studied for an A. I remember when I got my first F on a test. I just didn't understand at all. I couldn't believe I got an F. I didn't know how to tell my parents. It was the worst feeling in the world. [AFN3]

When I first started, I had a really rough first semester. You know, going from high school where it's really easy and you can just breeze by with A's and B's without even studying. It was a wake up call. The first year was the roughest. [AFN3]

I had never experienced doing poorly in a class even if I didn't attend a class or whatever. I got frustrated pretty quickly with it so the first roadblock I ran into it wasn't that hard to choose to turn the other way. [CAN1]

Sometimes the non-persisters especially had a difficult time dealing with failure for the first time, whereas the persisters usually reevaluated their study skills and habits, made adjustments accordingly, and gained a more realistic view of themselves.

It was kind of an eye opener admitting that I don't really know it all, and there are some things I just won't grasp. [ASP1]

In some cases, non-persisters gave up because the "freshman rule" policy created a safety net. They could drop the course(s), save their quality credit average, and then transfer to another department.

The freshman year was called a "pivotal" point for women engineering students. Many of these participants, persisters as well as non-persisters, started out at a disadvantage. In addition to weak backgrounds or poor study habits, many of the participants were intimidated and scared by the "horror stories" they heard before they even arrived, that is, there's a high flunk-out rate for women, it's going to be a bad experience, you're in the business pipeline, you'll get negative grades on tests.

I really think it's more the intimidation before you get here than it is the actual work that you do. [RUP1]

You're down here and they're way up here and you feel like they just must be really smart. And so what might seem like a perfectly reasonable question to you, you feel like might really be beneath them or something. I think that's one thing that makes them intimidating [ASP2]

These participants confirmed that faculty themselves contributed to this fear and intimidation through warnings and biased comments in the classroom.

One of the classes I went to, maybe it was over the orientation, I was told only one in ten girls usually make it. The others drop out. [HIN2]

I've heard other girls in engineering fundamentals say that their teacher just came right out and said, "women should not be engineers. Women do not make good engineers." [RUP4]

4.6.4. Experiences with Faculty

As two participants [CAP1, CAP2] stated "your professors make it or break it for you." Most of the participants had relatively little to say about the faculty in their own majors because they were fairly content in those majors, therefore, much of the discussion in these sections sounds very negative. Some of the participants [CAP1, CAP2, CAP4] did have good experiences in their freshman year in engineering because they had good teachers who were helpful and supportive. With the exception of one non-persister [CAN7] who had participated in a gender-clustered EF class, all of the non-persisters had bad experiences in their freshman year, particularly with the "weed out" phenomenon.

In some instances, participants commented that faculty in their majors were unapproachable, too busy to help, unwilling to help, unwilling to be flexible, or ill-equipped to deal with personal problems that impede success.

> *I went to my professor for help. He said, "I have so much work to do. You can go see the TA." The TA didn't even have office hours during that time. I just wanted to say something to him like, "I pay you to teach me. I pay you to help me, whether the TA has office hours or not." [AFP3]*

> *I was in the hospital for a week, and I went to tell my professor because I had missed a test. Basically he called me a liar. [AFP4]*

> *I was at my wit's end. My grandmother had another stroke, my grandfather was having brain surgery, I was trying to break my housing contract, and I had to go to court that day. I went to my professor to tell him I wouldn't be in class that day and to turn in my homework. He said, "I don't accept early homework, and I don't accept late homework." [AFP7]*

> *He made a mistake on my grade and didn't want to change it because he had too many things to do. [AFP4]*

Rigid attitudes held by faculty and the "rules" of the engineering culture were "turn offs" for many of the participants, particularly those who had changed to other majors.

> *There are these rules. You go by the rules and that's the only way. [HIN8]*

> *I remember going into the EF [Engineering Fundamentals] Office. I was wearing a hat. I hadn't showered for two days because of all the work. This professor was like "take your hat off before you go in there because no one is allowed to enter the EF Office with a hat on." That pretty much pushed me over the edge. [CAN1]*

> *I'm the kind of person who wants to have a coke in class or be comfortable. EF was like we have to do this, we have to do that, we have to be this way. [CAN7]*

> *I remember going to some of the classes as a freshman that even had a dress code - like girls couldn't wear sandals even in the summer. Guys couldn't wear hats. I didn't like that at all. [HIN8]*

It's such a structured curriculum. You have to do it this way. You have to have your handwriting this way. You have to turn it in on this sheet of paper. That's not me at all. I'm more creative than that. [CAN1]

Even though most of the non-persisters switched their majors to other non-traditional disciplines, their perceptions of the climate in their new majors was more positive. For example, new majors were perceived to be friendlier, more laid back, less hostile, and more close knit than engineering.

Most comments about faculty centered on the freshman year and the faculty in the engineering fundamentals division. Although some participants were fortunate to have had good experiences with engineering fundamentals in their first years, more often than not, the participants had had very negative experiences and perceived most of those faculty to have biased attitudes toward women and minority women. As one participant astutely commented,

The climate is bad especially where you have some of the older generation engineers. Those are the men who have the problem with women because that's been their mentality the whole time. There's still one or two professors who think women don't belong in engineering, and there are people out in industry who don't think women belong in engineering. So I think as we move on and those people retire or the old ones are weeded out, it will be much better. Right now we have the a mixture of two or three different generations - all with a different kind of thinking. [ASP2]

Younger men from I'd say 30 down are fine with [women in engineering]. The ones in the middle age range know they should be fine with it, but older men – like in the 50-60 range – are very difficult, very, very difficult to work with. And the older professors can be obviously very chauvinistic. [RUP3]

Participants also commented on the conflict between the research and teaching mission of the university. Faculty appeared to not want to teach, and often referred students to teaching assistants or brushed them off when they needed help.

I understand that the school is a research institution, but I still feel that the professors should want to teach. I mean if you're teaching, you should want to teach. All of my chemistry professors are involved in research, but they are very animated, very excited, very helpful. These are just characteristics about professors that lack within the engineering fundamentals department. [CAN5]

They're not very approachable, but if more would be approachable, students would feel at ease and go see them when they're having problems. [AFN3]

4.6.5. The Classroom Climate

Tokenism, or the experience of being the only female or the only minority female in a classroom was an experience shared by all of the participants; however, for some of the participants, it was perceived to be more negative than it was by other participants.

It can be difficult just being in that major. Nobody else is like you. I can't really find anybody that I can relate to. I felt kind of weird sometimes. Everyone else is white or male. [HIP1]

You start looking around and you think maybe I shouldn't be here because there are very few women. Because there are so few women there wouldn't be anyone to talk to at times about the way you were feeling. [CAP2]

Tokenism often intimidated participants and prevented them from asking questions in class or speaking out in class.

Most of the females don't really talk or whatever in class. Most of the people who ask a lot of questions or ask any questions in my classes are the white males . [AFP8, AFP9]

At my all-girls' school, they really promoted women's independence there. We were the most independent women on earth. When I came here, I quit talking in class after two weeks. [RUP3]

Participants often felt they were ignored or discounted in engineering classes as compared to other classes, perhaps because they were one of few women in the engineering classes.

I had a class that had a lot of women in it. I did really well in it. I felt like I was actually treated normal. The teacher actually looked at me and stuff. When I'm in my engineering classes, not all the professors will even look me in the eye. It seems they're pretty much directing everything towards the guys. [RUP2]

Several participants, by virtue of having preferences for male friends and being around males, did not perceive tokenism to be all that negative.

As previously discussed, students enter the program without the same foundation and academic background. Although this can be frustrating for an instructor, faculty often discouraged, degraded, or ignored students who were working below the average for the class by teaching to the average and upper end of the distribution.

The EF instructor didn't want to spend the time to make sure everyone was up to the same level. That in itself probably had more to do with it than your pre-college background. [AFN3]

The teachers have attitudes that if you don't get it right then and there, then you shouldn't be there. I started doubting myself. [AFP5]

I think the EF Department here is terrible, and I think that they really discourage people and they make people want to drop out of engineering. I think EF should be taken away. [AFP8]

On the other hand, one participant related the story of a situation in which the EF instructor went out of his way to help and her male friends perceived an injustice.

My second semester professor would spend extra time with the women. I don't know if he thought we didn't understand, but he would spend extra time with us. Some of my guy friends would be like "man, that's not fair. Why is he spending more time with you?" [CAP2]

Participants frequently commented on the difficulties they had getting used to the expectations of their professors. While most of them assumed engineering study would be much more difficult than high school, they believed faculty made it more difficult than necessary to "weed out" students.

> *These first courses are weed-out courses, and they were really trying to weed you out by the way they present the material to you. It's not a simplistic way – it's like a round about way. [AFP7]*

> *The work isn't hard at all, but they make it really difficult. They give some really hard problems. I thought they were supposed to teach us how to solve problems analytically. I think a lot of grading is on how to solve problems that some of the professors can't even solve themselves. [AFP8]*

4.6.6. The Weeding Out Experience

The first two years of engineering study are considered to be "weed out" years. Students frequently commented on the weed out process, but they could not ascertain a reason for it. One could hypothesize that the phenomenon relates to the culture of engineering, that is, if engineering faculty have this "elitist notion that they are superior" to other majors and disciplines, then naturally the members of that culture might attempt to weed out the students who don't meet their expectations, who aren't worthy of being in that elitist group by their standards of admission.

One participant wondered why students weren't weeded out in the admissions process like students were at other universities.

> *I was actually talking to other students from other universities, and they were saying how most of their schools weeded out more so in the application process to the university. And then once they got to the university, it wasn't hard. It seems like there's always a weed out somewhere, but I think I would rather have them weed me out before I got here than to wait for me to get in the program and try to weed me out then. [AFN3]*

Part of the problem is that students, unfamiliar with ABET accreditation standards, fail to see the relevancy of some courses in their own engineering majors. Many participants pointed out that some of their courses had been irrelevant, particularly courses like Fortran, chemistry, and physics; however, the ESM (Engineering Science and Mechanics) courses like statics, deformable bodies, and dynamics were almost unanimously voted to be the weed out courses. One particular problem faced by women was the inability to visualize 3-D objects and structures, and at least two non-persisters [CAN6, HIN8] commented on it.

Some participants, particularly non-persisters, were very discouraged by the weed out phenomena and very much opposed to it.

> *My high school was competitive, but it wasn't as tense and unfeeling as EF. I didn't expect anyone to hold my hand, but I don't understand why they have to weed everyone out. [CAN5]*

> *I felt like a lot of times they were trying to challenge us way too much. It was just the weed out section, and I don't feel like I should have to be weeded out if I want to be there. I don't feel like they should be purposely trying to challenge us over and*

above what's normal just to see if we have the guts to stay with it. That was the most frustrating thing. All I heard was weed out, weed out, weed out. [CAN6]

On the other hand, persisters, who were at one time very frustrated and uncertain about engineering themselves, ironically came to see value in weed out, perhaps through a process of indoctrination into the engineering culture.

In some ways it's [weed out] probably good for you because you're going to face that. You're going to get into industry somewhere and someone's going to criticize you because you're a woman, and they don't think you can do what you know you can do. It's good experience. [CAP8]

I kind of agree with the weed-out type of the way it's done, because if you let anybody who just has an inkling of a notion, "well I think I'll be an engineer," if you let anybody stay, your classes get bigger and bigger. Then you find that the ones who are capable of doing the work don't get the attention they deserve. I don't see how you can lower the standards or something just to include them. [RUP4]

Many faculty fail to connect theory to applications and hands-on learning in the classroom. This is particularly problematic for women who usually have not gained that type of experience and knowledge in childhood and adolescence. For example,

A lot of guys have had experience with cars since the day they were born. They know things that really you learn over the years, not in a class . It's just general knowledge that I know I never learned when I was growing up . I was very confident in the academics, but the hands-on stuff not as much because I really haven't had the experience. [RUP1]

Persisters confirmed the value and importance of hands-on learning.

I need to touch it. I need to feel it. I need to see it. I can't just read it and pick it up and absorb it and do it. It's difficult for me in that respect. [AFP7]

The class that made me actually like engineering wasn't until my junior year, and he [the instructor] had hands-on learning experiences. That helped a lot because you can see things. That made me actually like it, and I got a good grade in the class. [RUP2]

Again, a lack of exposure and hands-on learning was common among those who failed to persist in engineering.

They didn't give us enough examples. I mean they gave us the theories, they gave us the formulas, but I tried to apply them, and I'm like you never told me how to apply this. You never told me how I am supposed to figure it out . If that missing connection were filled, I would have been a lot better. [CAN6]

One way in which participants had gained hands-on experience was through internships and co-op positions. Most participants found their work experiences to be good learning experiences and opportunities to apply their knowledge in real-world settings. Only one participant [CAN5] left engineering after her internship with the ABC Company.

4.6.7. The Culture of Industry and Related Work Experiences

Eighty-six (86) percent of all persisters had gained work experience related to their majors through either summer internships or cooperative education. Only one of the eight non-persisters had similar experience. Through these formal co-op and summer internship experiences, most participants gained not only hands-on work experience related to their majors but an added interest in and excitement for their majors. These participants had not seen the applications through their freshman and sophomore level coursework; therefore, on-the job experience provided them with a more complete view of their majors.

> *By then, I had had three years in engineering, and by that point I had gotten the impression that all I would be doing was sitting at a desk punching numbers in the calculator and stuff like that, but it was a lot different. I was actually out in the field inspecting. It gave me a broader view of what you can do in engineering. [ASP3]*

In some cases, participants made decisions about what they did and did not want to do within those disciplines after graduation. For those participants who had had doubts about their majors, the internships added to their certainty about their major as well as their confidence in their own abilities.

> *I got this internship at this good engineering company. It really helped my confidence because everyone was like you're doing a great job . Then I started feeling like it was just school that's contributing to me feeling really low. [RUP2]*

In some instances, participants also gained knowledge about organizational and workplace culture that has prepared them for "Corporate America." They often discovered that the climate of an organization can depend on the field. In particular, the more traditional areas of engineering may create a more negative climate for women.

> *I think it depends on what field you're in. I worked for a construction site in Raleigh, North Carolina. It was difficult. You have to prove yourself. It doesn't matter how big and brawny you are, if you're a woman you're going to have to prove yourself out there. [RUP3]*

> *I went for an interview at ABC Tobacco Company a few weeks ago. It was all men practically who worked there except for one woman I saw the whole time I was there. They took me around and introduced me to the people in the area. They introduced me to one of the guys, and he totally wouldn't even look at me. He wouldn't even say hi to me. He just kept looking out the window the whole time. [RUP2]*

One African American participant, who had dealt with racism on her co-op job with a furniture manufacturer, had a much more pleasant experience on a summer internship.

> *On the last job I had, I was the first black intern they had and the first female intern. When I left my boss told me I was the best assistant he ever had. It wasn't you're the best black assistant or you're the best female assistant. [AFP3]*

At least one non-persister felt the experience she would have gained on the job would have contributed to more focused goals.

I could have gotten into an applied setting or whatever. It would have been helpful, and then maybe it would have helped me to become more focused in my work. I would have seen real world application. [AFN4]

4.6.8. Peer Attitudes and Bias

Participants also commented on the negative and biased attitudes of their male peers in engineering, particularly in the freshman year. Sometimes male peers perceived that women are not meant to be engineers, that women are less technical, and less able to solve problems.

I can remember receiving an A on one of my EF tests, and the boy who was sitting next to me got like a 70 or something. He made some remark about "how could a girl get an A and I got a C," or something ridiculous like that. [CAN5]

The competitiveness among peers in EF was also problematic for some participants, particularly the non-persisters.

I felt that a lot of times, instead of helping each other, students were trying to show each other up and show everyone how smart they were. It turns out that everyone is in the same position. We all really don't know what we're doing so there's no reason to act superior to your peers. That's what turned me off a lot, and I really found that, in my opinion, the entire EF program was an absolute joke. [CAN5]

I did get the impression that some of the guys were like – you're a woman, this is engineering. I went to a couple and asked them about assignments and stuff. They weren't very open to me. That turned me off. [CAN1]

On the other hand, one non-persister felt like there were circumstances where male peers were willing to help.

It was kinda hard to go talk to a lot of guys in the classes, unless they were trying to hit on you or pick you up, they, basically didn't really want to talk to you other than that. [HIN2]

Two participants related peer bias and negative attitudes to the growth in the numbers of women entering the field and Affirmative Action hiring practices.

I think the men feel like the women are trying to take over in a way. They're trying to get where they're not supposed to be and that could be intimidating for them. [CAN6]

I think a lot of the white students have been told that most of the black students are here filling quotas or something. [AFN3]

Design and group projects create situations in which students, male and female, minority and non-minority, are required to work together. One common complaint was that students were thrown together, expected to work as a group or team, despite having had no training in teamwork.

In the [EF] design projects, no one knows how to work as a team. Everybody is trying to do everything. I mean it's a learning experience. [CAP7]

Working in any group has its pitfalls. You know people have different personalities. [AFP1]

Some students recalled how design projects created conflict with their male peers.

My story about being a woman in engineering was freshman year. We had two girls and two guys in our engineering design group, and the teacher appointed me leader. One guy had this huge problem with me. I got so many cracks the whole semester about being a girl and not being able to do AutoCad. He literally said I couldn't do AutoCad because I was a girl. I felt really amused that the first person in my life to tell me I couldn't do something because I was a girl was a pimple-faced, totally geeky guy. [CAP8]

[My male peers] wouldn't listen to my ideas, I think partly because I was a female so you see, it's still in my generation. It makes you feel bad because you're not effective and you can't contribute. Your ideas are just kind of tossed to the road. [ASP1]

4.6.9. Lack of Female Role Models

Participants frequently commented on the lack of women faculty in engineering, and they perceived this to be one obstacle or barrier they faced in the engineering culture. Many of them had not been taught by a single female instructor, and they believed the status of women students in engineering would improve greatly if there were more women faculty. In at least one instance, a participant commented on women faculty's role in the professional growth and development of women engineering students.

It's that time when you're searching for an identity. The greatest need is just being able to look around and say, "do I want to be like that person?" It's almost like a role model type thing. You see somebody who's been there and say, "you know, is that the type of person that I want to end up being?" For women in engineering, there aren't a lot of people for them to look up and say that's who I want to be. [CAP2]

4.6.10. Experiences with Advising

Students' experiences with advising in engineering fundamentals, university studies (for undecided majors), and their own major departments, have been both positive and negative. Students who started out in university studies were especially unhappy with the advising they received. They were sometimes discouraged, given the wrong information, or the advisors generally had no clue about engineering and advising engineering students.

My second semester, I didn't get very good grades in calculus, and I was told that your grade in calculus determined whether you'd be successful in engineering. So that kind of upset me a little bit, but it just goes to show that the person who told me that was wrong. [AFP9]

When I got here for orientation, everything was all messed up because I was supposed to go to PGE [provisional general engineering], but I was in University Studies. And then once I got my schedule, they said I was in pre-calculus. So I *already had a bad attitude because I had taken that pre-calculus in high school. [AFP7]*

Sometimes students were discouraged by their own freshman year advisors who tried to weed students out through the advising process.

> *During that time [freshman year], students need good advisors. I really didn't get any advice from anybody until once I entered ISE [Industrial and Systems Engineering]. You're basically on your own in EF [Engineering Fundamentals]. [AFP2]*

> *My advisor was always telling me that I needed to change my major. You know I was doing a lot better than a lot of people in the class, but I think he was one of those people who didn't think blacks needed to be in engineering, didn't think females should be in engineering [AFP3]*

Students expect their advisors to be accessible, available, flexible, helpful, knowledgeable, up-to-date with information, consistent, open-minded, and willing to look at options. [AFP1, AFP3, ASP1, ASP3, CAP2, CAP3, RUP3, RUP4, AFN3]. For example,

> *I expect an advisor that is up-to-date with changes and the processes that are going on, and someone who's not going to just toss me off because they don't have time to talk to me. If they're going to be an advisor, I like somebody who's really going to listen to what I have to say and do their best to find an answer if they don't know it. [CAP3]*

One participant described a faculty advisor who fit that description,

> *My advisor in my department is excellent, and she wants me to come in and talk to her. Probably since she's a woman I'm more apt to really listen to her experiences and everything. She would come to school at 7:00 p.m. to meet with me if I needed to. [RUP3]*

Unfortunately positive experiences like this were the exception, and there is much inconsistency across departments after students complete the first year.

In those departments where faculty advisors are assigned, students often commented that they usually don't see their assigned advisors. Sometimes students perceive their advisors to be too busy or they fail to seek them out.

> *Whenever I needed to talk to him about anything, he's just too busy or he's wrapped up in something else. I feel like I'm inconveniencing him. That's the kind of air he puts off, so I don't bother. [AFP1]*

When students did visit their faculty advisors, they frequently received no information or incorrect information

> *You get an engineering professor as your advisor, and it's basically when you go and ask them a question, they do not know the answer. They're not willing to take the time and find them for you. [RUP4]*

My experience in the ABC department with advising is that I'd go and ask them a question and they actually gave me the wrong answer, because they weren't even aware of new changes or something like that, and that really annoys me. [CAP3]

Some of the larger departments have professional advisors as well as faculty advisors, however, the professional advisors often stay very busy with their assigned workload. One participant commented,

I wish they had more advisors in the ABC Department. The advisor knows a lot, but obviously she doesn't have enough time for everyone. [ASP4]

4.7. Social Factors and Sources of Support

Participants were asked to describe the sources of support they had utilized both on- and off-campus. These sources of support included faculty, advisors, family, peers, campus organizations and services, and their own faith and religion. While persisters often described faculty, advisors, and Minority Engineering Programs as sources of support, most of the non-persisters, with one exception, received no support or left engineering without seeking out that support.

If you're undecided like I was, there's not that much support for you. But if you're in it and stick with it, there is a lot more support. [HIN8]

4.7.1. Faculty and Advisors

When students begin their first year studies in engineering with supportive faculty and advisors in a positive climate, it can make all the difference in terms of emotional health and academic performance. Several of these participants [AFP9, ASP3, CAP1, CAP3, CAP4] were fortunate to have that experience. Unfortunately seven of the eight non-persisters felt that no one in engineering had been supportive of them. Their faculty appeared to be aloof, blasé, and concerned more with the university's research mission. They received poor advising or got lost in the shuffle. Several of them switched to other non-traditional majors, including math and chemistry; however, whether their transfer departments were traditional or non-traditional, these departments were perceived to have more positive and friendly climates.

Faculty and advisors across many departments have been sources of support for these participants. Sometimes faculty outside their own majors have been more supportive and helpful. Throughout the interviews and groups, some of the same names kept surfacing. Participants have benefited from interaction with faculty, both within their classes and departments, as well as outside through social functions. Participants were especially appreciative of opportunities to participate in independent studies and undergraduate research with faculty. In many cases, this interaction with faculty has led to improvement in grades and academic performance.

I've had a couple of classes, and they are very supportive. I feel like they have confidence in me. It's back to that – they're way up here and we're way down there – but if they have confidence in me, I must be okay. Just their confidence in me has kept me going. [ASP2]

Teaching assistants were also often mentioned as sources of support. One participant [AFP1] recalled the story of how her TA for a mechanical engineering class would become concerned if she didn't show up for her weekly visits for one-on-one help.

Just as participants have sought interaction with faculty who were willing to interact, they have sought help from advisors and pseudo-advisors, such as departmental secretaries, who are willing and want to help. It was not uncommon to hear participants talk about bypassing their assigned faculty advisors to seek advice from more willing, personable, and knowledgeable faculty. Students whose advisors were female professional and faculty advisors appeared to be the most satisfied with the advising systems in their departments.

> *In both those cases, it was a female that we could talk to and somebody who's always open and will say "well let's sit down and look at the options, the road that you're going down, and let's see where that's taking you." Both of those advisors have been very willing to help. [CAP2]*

Likewise, participants sometimes felt that female faculty were more willing to "bend over backwards" to help.

> *There is one faculty member, a female faculty, who has always stood by me and gotten me jobs. [CAP3]*

4.7.2. Family and Friends

In most cases, participants' families were sources of support. With the exception of two participants [AFP8, HIN2], many of the participants contacted their families when they were in need of support, whether it be emotional or financial support. Participant AFP8 described herself as very independent, and she stated that she had never needed to ask for the support of her parents. Participant HIN2, who also had been independent out of necessity, described her mother's reaction when she resigned her third semester on campus. She arrived home only to find her mother had locked her out of the house. Both of these young women have been self-supporting students from the beginning of their studies.

Supportive parents provided listening ears, empathetic understanding, unconditional love and acceptance, encouragement, and career advice.

> *Nothing has been a real challenge [for my mother] until her doctoral candidate situation now. This has been a long time for her, and through all this, she's had to go to practices and just unbelievable stuff. She's been a source of encouragement because she's told me about her experiences. [AFP6]*

> *The worst time I had was my freshman year. I think I stayed more because my family helped. I just knew that if I was a complete failure in college, I could just always go back home and they were still willing to be there for me and take care of me. They weren't going to kick me out of the house or anything [ASP2]*

> *My dad had a talk with me, and he said you should do what you want. He knew I was interested in environmental science, and he said his parents wanted him to be an engineer and he didn't want to either. He wanted to be a chemist. So he said it's okay to change, but my mother asked me if I was going to pick up trash for the*

rest of my life. I didn't feel as bad because my dad said you can still be successful without being in engineering. [HIN8]

I would always call my mom and usually it's that once in a semester phone call where it's like you're going crazy, you don't have enough money, you're not eating right, you're working too much, you don't have enough time to do your homework. [CAP6]

Participants also relied on friends outside the university, outside their majors, and within their majors as sources of support. Several participants have boyfriends or fiancés who are supportive, many of whom are engineering students as well. At least two participants [CAP1, CAP3] said their engineering boyfriends pushed them to do well academically. Some participants also talked about friends from high school or friends at other universities.

A lot of the people I graduated with have been pretty understanding because a lot of them experienced the same exact thing in different fields at different schools. [AFN3]

Many participants talked about the advantages of having friends within their majors. Whether they purposely chose these friendships or whether the friendships developed because they were together all the time was unclear. Part of it may stem from the fact that many non-engineering friends do not understand and cannot relate to the workloads of their engineering friends and roommates.

When I was a freshman or sophomore a lot of people didn't understand why I was studying so much? Why I was so frustrated? Why I was always fretting? It's really easy for engineers to get into a group and stay there because other engineers understand. [AFP1]

Most of my close friends are engineers, most of the people I've dated are engineers. When we all get frustrated, we're all frustrated together. [CAP4]

Participants also gained some confidence and relief to find that other engineering students feel the same way they do about their classes and workloads.

It's different when you can see other people who have the same struggles and problems and are doing the same type of work. You know my roommate couldn't help me with my homework. Once you find a group of people who are doing the same thing, who've been through the same thing or are going through the same thing, it makes a difference. [AFP3]

I've come to realize that maybe I'm not the only person who's having a hard time. I've also come to feel more normal, whereas if I were left to my own little world, I would feel a little bit inferior to everybody. It's helped me more with my confidence. [ASP2]

4.7.3. Campus Services and Organizations

Campus services and organizations were also sources of support utilized by these participants. The primary supportive organization, especially for African American persisters, had been the office of Minority Engineering Programs (MEP). One of the Hispanic persisters has also been served by the MEP program. African American students, as well as transfer students, have improved their time management and study skills through the Center for Academic Enrichment and Excellence. Both programs have provided helps sessions and tutoring as well as mentoring and general support.

Although most of these persisters had passed through their freshman year before formal mentoring programs were in place, several of them had served as upper-class mentors for minority and women engineering students through the BEST (Black Engineers' Support Team) and WEST (Women in Engineering Support Team) programs. These mentors believed the programs to be very beneficial, not only for the first year students, but also for themselves.

> *For the people who were really interested and for the people who were struggling, I think it was an excellent program. We didn't have to talk about engineering all the time. [CAP4]*

> *I've been a mentor for the past two years, and it's helped me to reinforce myself. I'm telling these people to stay in engineering, why I am staying, and it makes me evaluate why am I here. I think that's helped me, and I'm hoping it's helped them. [CAP2]*

Although sororities and the women, referred to as "no brain hyper-types" in one case, who join them got a bad rap from two persisters [CAP1, CAP3], some participants saw value in them. At least two participants, one persister [CAP2] and one non-persister [CAN5], have benefited from membership in sororities. The non-persister had graduated from an all-girls' private high school and preferred to have a close group of girlfriends. The persister, an extrovert who loves to socialize, felt that she needed time away from her primarily all male classes to associate with women. One of her sorority members, a civil engineering major, had been a role model and mentor for her during her freshman year.

> *My friends have been a great help. I pledged XYZ Sorority the spring of my freshman year. And I found all of the friends I had been missing my fall semester. I really missed having a close group of girlfriends. That's really been a great support system. [CAN5]*

> *Then you have these other organizations where you have girl time because you need that. It's hard when you're around guys all the time . I need to have my feminine side too. [CAP2]*

4.7.4. The Role of Faith as a Source of Support

As previously mentioned, a qualitative paradigm provides the opportunity to be flexible and spontaneous with the interview guide. The second interviewee, a Caucasian participant, commented on the role her faith had played in her persistence. Since the literature on persistence had not addressed faith's role in persistence, I asked each subsequent interviewee what role, if any, her faith or religion had played in her persistence. African American, Hispanic, and rural persisters, in particular, relied on their faith many times to bring them through their struggles.

> *I know that I study, but I also put it in God's hands before I take a test. Praying is just a normal everyday thing for me. [AFP4]*

I have a good support system in terms of my family. And God forbid if I say I'm discouraged because we'll just have to pray on the phone. [AFP7]

At times when I wasn't sure where I was going and other times when I just didn't want to, there were times I really just wanted to drop out. I think my faith in God kept me going. [HIP1]

If it wasn't for God then me and my mom wouldn't have moved on here to this place, the United States. I would be back in Guatemala, with a bunch of children at home, just waiting for my husband to bring me the money. But then God makes things possible, here I am. [HIP2]

I've been borderline so many times that I thought I was going to be kicked out of school. I would just be praying and praying. Every time I got through it by doing that. It seems like whenever I'm close to God, I feel like I'm doing so much better. I go through spells and you can see whenever I'm not close to God, I'm always down and my grades are really bad. [RUP2]

4.8. Special Client Population Issues

There are some issues pertinent to some participants by virtue of membership in special client population groups. While previous research had looked at the topic of persistence quantitatively, it had not accounted for differences among groups, based on gender and ethnicity. In an attempt to learn about the experiences and issues relevant to membership in those groups, African American students, Asian American students, Hispanic students, and students from rural geographical areas were selected. Although transfer students were not initially included in the research plan, there are experiences and issues relevant to them that are worthy of discussion.

4.8.1. Transfer Students

Three participants [HIP2, RUP1,RUP2] transferred from three different community colleges within the state system. The original reasons they chose to attend a community college had to do with financial constraints. As transfer students, they faced several unique problems. First of all, they perceived their foundations to be inadequate for the upper-level courses they were taking, and they weren't up to par with their knowledge of computers and their computer skills.

Catching up later once I didn't learn them in higher classes isn't fun, but I honestly think that if I went back and did it over here then I wouldn't have had the problems with the classes. The reason I don't regret going to a community college first is the communications aspect. [RUP1]

There was more personal interaction there, but I think I got a better education here. [RUP2]

Likewise, they didn't have the time management and study skills they needed to be successful. Therefore, they weren't prepared for the rigor of the engineering program at their transfer institution. Those who transferred from rural areas also weren't prepared for the size of the university in terms of the student body. Fortunately two of the three participants [HIP2, RUP2] benefited greatly from a mentoring relationship with a professional advisor and participation in the Project Success program.

Advisor X got me through engineering, that's all there is to it. She's helped me in everything. I mean it's good to see that in a place where it seems like no one cares that there are individuals who do. It seems like the only people who do care are the women. [RUP2]

When I went to Project Success, I learned that you have to organize your schedule to make sure you do all your work, make a list, set your goals, see what you want to do. And that really helped me a lot. It helped me turn myself around and go back to, like they say, success. [HIP2]

4.8.2. Rural Students

Students from rural geographical areas faced several challenges in the engineering program, two of them common to those faced by transfer students. Like some transfer students who transferred from rural areas, they often perceived the student body to be too large and intimidating. One participant commented that she "felt like a number." Secondly, they sometimes aren't prepared for the rigor of their academic program. Their school systems often don't have the resources to provide higher level math and science courses such as calculus and advanced placement courses, computer laboratories, and first-rate vocational courses such as architectural drawing and drafting.

I didn't even know how to turn on a computer when I got came here. I had to get someone to turn it one for me in the computer labs. That was my biggest stumbling block. [RUP3]

One unique challenge that faces rural students, particularly those from central and southwest Virginia, are the perceptions people from other areas have of them based on their dialects or accents. Sometimes playful teasing crosses the line and turns into hurtful insults.

I had this professor do this this semester. I said something in class, and he remarked [in a mocking tone], "well, if that's not a country accent, then I don't know what is." And this guy was from the north. I mean I was really mad. I think people think it sounds stupid so they don't treat you with much respect. I couldn't believe the professor said that in front of the whole class. [RUP2]

4.8.3. The Intersection of Race and Gender

As women and as minority students, race and gender intersect in the lives of women minority students. The minority women, including African Americans and Hispanics, were unclear whether their experiences or the barriers they faced related to their gender or their ethnicity. As one African American participant stated,

"I've always been black, I've always been female. How can I separate them? I mean it's who I am so it's a reality. [AFP3]

Surprisingly, some minority participants attributed their experiences to being minorities, other attributed their experiences to being female, while still others attributed them to other peoples' perceptions and bad manners.

A lot of times I hear about black-white barriers. I haven't experienced that at all because I know one of the top three guys in our EF class happened to be a black man. And so there weren't any black-white barriers, but the male-female seemed terrible. [AFN3]

In general, these students do not share the same world view as Caucasian students. They often don't understand the nuances of the language and the humor Caucasian students see in situations. They haven't shared the same experiences or been exposed to the same culture and lifestyles. Even those who have lived in the United States all their lives feel that they have been raised in different cultures essentially. Family values of cohesion, respect for elders and authority, and reciprocity are very unlike the American culture. Their experiences in the university have contributed to a "culture shock."

One experience common to all minorities as well as Asian students was tokenism in the classroom. This tokenism created a marginal status for these participants at one time or another, and they felt intimidated and isolated.

> *When you sit in a class of more than one hundred people, and you're the only black person, you're the only female, and regardless of where you look, there's nobody else who looks like you, I mean, just imagine. [AFP3]*

> *It can be difficult just being in that major. Nobody else is like you. I can't really find anybody that I can relate to. I feel kind of weird sometimes. Everyone is white or male. [HIP1]*

Tokenism was all the more evident when it came to group projects and teamwork. Minority students often ended up working by themselves on projects designed for several people or they were forced into groups after group members had already selected their members.

> *Nobody wanted to work with me in my physics lab, and the TA was just watching me struggle because the labs were designed for two or more people. I had to struggle through that lab by myself because nobody would work with me. [AFP4]*

> *There was a lab that I was taping, and everybody was choosing their partner. There were two people left. They had to decide who wanted to work with me, and then the TA had to tell somebody, "you, you work with her." And I was like, "what's wrong with me?"*

If these women did well in their groups or labs, their partners were often surprised at their performance. If they didn't do well, they weren't surprised because they didn't expect them to do well in the first place.

4.8.3.1. African American Students

African American students, more than any other group, were unhappy with the university's environment; therefore, institutional fit was an issue for them. They commented on the fit they experienced with the primarily white university and rural setting.

> *Being here was just not where I wanted to be. It was kind of depressing, and I had a hard time adjusting. I didn't sleep well. I felt slightly isolated here. The most striking characteristic was the rural setting. [AFN4]*

I had a lot of doubt about being at this university. I didn't like it. I hated it. I called home everyday. I wanted to transfer. I didn't like the faculty. That was the problem. [AFP3]

This university wasn't even on my list. My mother made me apply here, and I cried. I cried when I was told that I had to come here. This was the last place I wanted to be. [AFP4]

African American students, although they've never had the experience of attending historically black colleges or universities (HBCUs), have friends who do. Many of the African American students perceived the climates of HBCUs to be more positive and supportive, yet they came to the university for engineering's reputation and because they felt the environment more closely mirrored the real world.

I guess the university depicts a more realistic society than maybe a historical black college would, because you know the world is not all black. [AFP3]

Historically there haven't been many African American women, both students and faculty, in engineering disciplines. African American women engineering students haven't had the opportunity to network with other African American students the way that Caucasian students, particularly males in engineering, network with each other. While some African American students find support systems in their majors, others do not.

I think I have a very good support group in my major . Just being able to see a familiar face, you know, and not feeling along through my struggle. That helps out a whole lot. [AFP6]

In terms of a support system, I don't find that at all in my major. I have one friend, but it's like the blind leading the blind. We're overcoming a lot of obstacles. [AFP7]

Those students who were unable to network in their own departments often networked with the National Society of Black Engineers (NSBE), both on-campus and off-campus. Networking with other members of NSBE provided the opportunity to seek help with academics, talk about problems and concerns, and talk about solutions to those problems and concerns. Once African American students started networking with students from universities, they came to realize that their problems and challenges aren't unique.

It just makes it a lot easier when you can see that you're not in this struggle by yourself. When I was at my first national convention, there were five thousand black people, five thousand educated black people all in one group together. It has made a big difference. [AFP3]

Along with NSBE, the Minority Engineering Program office as well as the director of the program have been the greatest sources of support for these participants. Many of them attributed their success and persistence and gave recognition to the program and it's director, an African American woman with a Ph.D. in engineering.

I can probably say I wouldn't still be here if it hadn't been for Dr. X. That support system is very important. [AFP9]

She kinda serves as a mentor to me. She got her masters and her Ph.D. in my major so I think maybe I could do that. Just to see her success as a black woman helps me to see other women succeeding. [AFP4]

4.8.3.2. Asian Students

Within the Asian culture there are many distinct subcultures. Likewise, the four Asian persisters who participated in the study had come from very diverse backgrounds, including Korean, Indian, Phillipino, and Indonesian. Despite those differences, there were some common experiences. These participants commented on the higher expectations of Asians in terms of academic performance, particularly in math and science. None of these persisters viewed themselves in that light.

When people look at me, they automatically say it, and it upsets me because I'm not necessarily gifted, it's just that I work hard. [ASP3]

As Asian students, they were very confused about the definition of "minority." As women in engineering, they had been one of very few women in the classroom. As Asian women, they were also one of few Asian women in the classroom. Yet, they felt excluded from applying for scholarships designed for minority students. For this reason, they perceived the definition of "minority" to imply either African American or Hispanic ethnicity, thus neither of them had participated in the programs offered by the Minority Engineering Program office.

I kinda got the feeling it was only for African Americans . When I walked by the office, that's all I saw in there. And in America, I think the term "minority" tends to mean African American, so I never went to their programs. [ASP3]

Although they aren't considered minorities, peers sometimes perceived them to be. Like African Americans and Hispanics, they are taunted about Affirmative Action hiring practices**.**

A friend of mine pushes the subject, and it really upsets me. He says, "you know, you're guaranteed a job because you're a double-minority." That just spurs this whole argument. [ASP3]

One participant described the Asian world view of "be seen, not heard." This respect for authority and elders often precludes them from interacting with professors and speaking out in class. One participant [ASP4] commented on how she has followed what her group members want to do despite having good ideas herself. Participants also commented on how they have been shocked at the way American students behave in class, both at the secondary and post-secondary levels.

When I went to high school, they would be talking back to the teacher, things like that. I was like "how can you say that to your teacher?" And with my friends how they fight with their parents. [ASP3]

4.8.3.3. Hispanic Students

The two Hispanic persisters both described their families as traditional Hispanic families, that is, very religious, very united and cohesive, and very supportive of each other. Traditional family views about women and their proper place in society created obstacles for these women. One participant experienced obstacles before she even entered the program.

> *Everybody in high school in my classes, "you can't go for engineering, girls don't go for engineering. That's only for guys. Why are you going into engineering?" And I got the same thing from my mom too. And my mom would say, "you're not going to go away to college. You can't go. That's against our traditions. You can't do that." [HIP2]*

Neither of her parents had even completed middle school. Only after proving herself at the community college would her parents allow her to transfer to the university to complete her degree. While the majority of all persisters are seeking degrees for their own purposes, this young woman's motivation is to give merit to her family, particularly her mother, and provide a good role model for her younger siblings. Although the other persister [HIP1] had the support of her highly educated parents, Hispanics in her community with traditional beliefs ostracized her.

> *It was hard for me to make friends because I was Hispanic, but when I lived in the Hispanic Latino country, I also didn't fit in because I was American. I was part American, and they were kind of prejudice. They sort of tended to outcast me a little bit. [HIP1]*

Because of her more Americanized beliefs, she often felt bothered about the Hispanic culture's beliefs about women and their place in society.

There are very few Hispanic students enrolled in engineering; in fact, these Hispanic women were the most isolated of all participants. These young women felt very isolated in their majors . They felt like they didn't fit in anywhere, and it has been very difficult to make friends.

> *I felt very awkward when I first came because all the Vietnamese would be on this side and all the Americans would be on this side . And everybody would have their own self, but here I am. I am Hispanic. That's probably what made me get bad grades at the beginning, because I didn't have anybody to talk to and say, "look I have this problem, can you help me out." [HIP2]*

Difficulties with the language, not the work itself, also created obstacles for these students whether it was trying to figure out the wording on homework or test questions, understanding the instructors, or conversing with faculty and students. Bilingualism itself could be a challenge at times.

> *I think being bilingual, it's kind of hard to be really good at one language because you're doing two at the same time. I mean my English is good, but the vocabulary is not what is should be. Actually I have trouble speaking Spanish. [HIP1]*

As an officer for the Society of Hispanic Professional Engineers, a chapter that was started last year, one persister [HIP1] had been able to network with other Hispanic engineers. One of the group's goals is to provide a network of Hispanic students, much like the NSBE network for African American students. The other persister [HIP2], a community college transfer, attempted to study in the Minority Engineering Center on two occasions.

I went there a couple of times just to study in the student lounge. Most of the people who go there are African Americans. So they looked at me weird when I got there because I was the only Hispanic. And here I go, I sit down and then I feel like a dot. [HIP2]

4.9. Post-Graduation Plans

Previous studies have demonstrated that women with nontraditional occupational goals have more egalitarian values and tend to have fewer (or no children) than women in more traditional occupations. There is also some concern that the percentage of women actually employed as engineers is actually lower than the percentage of women who have graduated with engineering degrees. This study sought to explore these issues among the participants; therefore, they were asked to talk about their beliefs about the respective roles of men and women in the home and in the workplace as well as their own post-graduation plans, both professional and personal.

4.9.1. Beliefs About Gender Roles

Participants were asked to talk about their beliefs about gender roles, that is, their beliefs about men and women and their respective roles in the home and in the workplace. Appendix 19 lists the codes for each participants' own personal beliefs. Several participants made the point that they aren't "women's libbers" or feminists. Only one participant actually called herself a feminist. Surprisingly, she was one of the Hispanic persisters [HIP1]. The Asian and Hispanic participants all described their beliefs as being more liberal than those of their families, and, in some cases, they experienced some ambivalence about the clash between their own beliefs and the traditional beliefs of their families.

I see my mom just kinda follow my dad, and my dad makes the decisions, and she kind of follows him even though she doesn't agree with it. And I decided to go against that and have my own opinions, but I found that's really hard. [ASP4]

If I go back [to my country], then I'd feel really out of place because people there don't believe the same things I believe. Like men, for one thing, the role of men in the house. I mean I went to school here, and I believe all the American things. [HIP2]

While most participants believed in flexibility, androgynous roles, equality, sharing "50-50" and a balance between personal lives and professional lives, some of them had very traditional beliefs about the rearing of children and the importance of someone in the home to raise and take care of those children.

4.9.2. Personal Plans

Twenty-five of the 36 participants stated that they have plans to marry and raise a family, one participant has plans to marry but have no children, five participants have no plans to marry at all, and four were undecided. Surprisingly, many of these participants have very traditional beliefs about the role of women in the home. Many of those who have plans to marry and have children, especially the Caucasian and rural persisters, plan to stay home with their children when they're young. In fact, two of the participants [RUP3, RUP4] stated that they would love to be housewives if it were an option. One Caucasian persister [CAP2] commented that she plans to home-school her children. Those participants who were planning families were concerned about how they would successfully manage a career and a family. In many cases, they didn't grow up in families where their mothers had to balance both roles. For the African American students, balancing roles wasn't an issue. They planned to balance work and home as they had watched their own mothers do.

4.9.3. Professional Plans

Most participants have very ambitious professional plans after graduation. Twenty-seven plan to work right after graduation, seven plan to attend graduate school immediately after graduation, ten plan to work and attend graduate school at some point, and four plan to own their own businesses eventually. Of all participants who plan to attend graduate school, at least five of those plan to eventually work toward a Ph.D. One participant plans to become certified in a specialized area, and another will work as a missionary in Africa for two years.

Summary

This chapter discussed from a developmental perspective the individual, academic, family, environmental, and social factors and experiences that have impacted the personal and professional lives of twenty-eight persisters and eight non-persisters. Chapter 5 provides a summary of these findings, profiles of persisters and non-persisters, conclusions, suggestions for further research, and recommendations for parents, school systems, and engineering programs.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1. Overview of the Study

The purpose of this qualitative study was to develop profiles of undergraduate women's persistence in engineering, a major traditionally dominated by Caucasian men. Through a developmental life-span and social learning theoretical approach, the study investigated the relevant factors, processes, and experiences involved in undergraduate women's choice of engineering as a major as well as their persistence in that choice.

Previous research on persistence in engineering has been quantitative in nature and based on such academic measures as high school grade point average, class rank, math and science achievement, and SAT scores. This research base has also demonstrated the importance of family background factors such as parental education and occupational levels and individual factors such as academic background, self-efficacy, and personality. A growing body of knowledge has suggested the effect of environmental and social factors such as institutional fit, the climate and culture of engineering education, and social networks and support for persistence. Many of these studies have used a combined sample of men and women while others have made comparisons between men and women on various variables. Studies have also considered differences in persistence rates among various ethnic groups. Women and African American minority students, in particular, have been found to persist at lower rates than Caucasian males. No prior studies have looked at the phenomenon of persistence from the perspectives of the participants, that is, those men, women, and minorities who persist or fail to persist in engineering. Since the literature has demonstrated lower persistence rates for women than for men, this study sought to understand why women persist as lower rates by incorporating the voices of both persisters and non-persisters. The study also considered differences in experiences among women of various ethnic groups as well as women from rural geographical areas. Guided by the tenets of feminist and inclusive research, the assumption was made that all women have strengths and personal viewpoints that are worthy of recognition whether they persist or not in engineering.

Qualitative methodology included both individual in-depth interviews and small focus group interviews which resembled small group conversations. The data were collected in the fall of 1996 at a large land-grant research institution in the Southeastern United States. The experiences of 36 women, including 9 African American persisters, 4 Asian persisters, 8 Caucasian persisters, 2 Hispanic persisters, 5 persisters from rural geographical areas, and 8 non-persisters, were investigated. Non-persisters included 2 African Americans, 4 Caucasians, and 2 Hispanic Americans. Factors that seemed relevant to persistence and non-persistence were family background variables, individual variables, environmental factors in the culture of engineering education, and social factors; therefore, persistence is a complex phenomenon which involves the interaction of many variables. Persisters and non-persisters had no clear cut profiles but presented more complex profiles. One group of persisters made early decisions and stayed the course through academic preparation and hands-on experiences that provided exposure to engineering. A second group of persisters made later decisions based on encouragement and the structure of opportunity for women and minorities. The personalities of one group of non-persisters did not provide a good person-environment fit with the culture of engineering. A second group of persisters left engineering after experiencing personal problems. Perceptions and experiences with the institution itself and the culture of engineering education varied depending on the career decision making process, group membership, and individual factors such as personality. Profiles of persisters and non-persisters are discussed in further detail in section 5.3.

5.2. Summary of Findings

Section 5.2.1 presents a summary of reflections relevant to data collection and analysis. Sections 5.2.2 and 5.2.3 summarize findings regarding family background and individual variables. Section 5.2.4 summarizes findings regarding non-traditional choice of major, and Section 5.2.5 summarizes the experiences of the participants in the culture and climate of engineering education.

5.2.1. Data Collection and Analysis

The initial pilot interview with a Caucasian persister resulted in revisions and clarifications to several questions in the semi-structured interview guide and questioning route which were based on relevant variables in the literature on non-traditional choice of major and persistence in that major. Flexibility and spontaneity with the interview guide allowed for more in-depth probing into personal experiences and stories. An alternate scheme of interview and group interview with each special client population provided the opportunity to explore issues raised in the interview within the group as well. This worked very well as there were issues and experiences common to individuals within those special client population groups. Furthermore, if a participant mentioned an experience that needed to be explored with other participants, a question was added to the next interview guide. For example, when asking about support systems, the third Caucasian participant mentioned the role her faith had played in her persistence. In subsequent interviews the question "what role has faith played, if any, in your persistence in engineering?" was added to the interview guide. It was discovered that the role of faith had been very significant for many of the participants, especially the African American and rural students. This may be attributed to both ethnic and regional differences in philosophies and values.

5.2.2. Family Background Variables

Contrary to what has been published in the professional literature on the backgrounds of women in engineering, math, and science disciplines and professions, these participants, persisters as well as non-persisters, have very diverse individual and family backgrounds. Parental educational levels ranged from less than middle school all the way to professional degrees and doctorates, thus the socioeconomic levels and financial situations of these participants varied considerably. They also varied considerably both among and within the different groups. Many of the participants overcame tremendous obstacles to get to the present point in their education. These obstacles included severe financial obstacles, family tragedies and hardships, inadequate academic preparation, and clashes with traditional family values about the role of women in society.

Parent's occupations ranged from homemaking to service to semi-skilled and skilled to clerical to teaching and education to technical and engineering to professional occupations. Although Caucasian participants were more likely to have engineering role models, especially fathers, brothers, uncles, and grandfathers, many of the participants had no engineering role models at all. In some cases, role models and influential figures were mothers, stepmothers, and sisters. The literature base fails to acknowledge the role of mothers who choose to leave the workforce, raise, and educate their children. On the other hand, those participants with strong mothers who stressed the value of education and encouraged them to do well academically attributed much of their success to their mothers. Many of these mothers wanted their daughters to make better occupational choices than they themselves had made. Parents in general sometimes pressured their daughters to make engineering career choices to either maintain the lifestyles they were accustomed to or to make better lives for themselves.

Participants' birth order ranged from being an only child to a middle child to the last born, and African American and Hispanic families tended to have larger families. When applicable, the occupations of siblings were just as varied as those of parents. The impact of siblings on the experiences of the participants was significant in terms of the gender issues that occurred within the families, and the ways in which parents interacted with their individual children. Fathers especially compared their daughters to their sons or their daughters to the sons they never had. In the former, fathers sometimes encouraged competition between their sons and daughters. In the latter case, daughters often interacted with their fathers in a manner more typical for father-son relationships. Mothers in general tried to maintain a balance between masculine and feminine pursuits.

The parents of participants, as well as the cultures in which they were raised, influenced participants through values and philosophies about life, including the importance of education, a strong work ethic, independence, self-sufficiency, and a balance between home and work. African American and Hispanic families, in particular, placed value on faith and belief in God, family cohesion, and reciprocity. Asian families placed value on respect for authority and elders. Many of these families had experienced tragedies and hardships such as death, divorce, mental illnesses and disabilities as well as severe financial difficulties. The current literature does not demonstrate the importance of philosophies, values, and hardships and tragedies on non-traditional major choice and especially persistence in that choice when confronted with obstacles. However, in the opinions of these participants, all these beliefs and events had had an impact on who they have become and the paths they have chosen.

5.2.3. Individual Variables

In some respects, individual variables could also be called family variables in that parents, in particular, were influential in the choices participants made about leisure and extracurriular activities and academic programs. In terms of schooling, participants attended public schools, private schools, engineering preparatory schools, college preparatory model schools, and, in two cases, all girls' schools. Students who attended more than one high school found it difficult to establish a history with consistent grades and ranks. The two women who attended all girls' high schools where the environments were more collaborative struggled with the competitive environment of engineering education. In fact, many of the participants struggled with the competitiveness of engineering education.

Variations in academic programs and resources created academic deficits for some students, particularly those from rural areas, when they entered their first-year program in engineering. Deficits occurred in higher level math and science classes, computer classes, and vocational classes such as technical drawing, drafting, and other engineering type courses. Students with academic deficits experienced much frustration with engineering education in that faculty assumed a certain level of knowledge and taught to that level. Experiences with setting up and installing computers, as well as running programs, were often described as "cold" and "isolating" by students without prior computer experience. More than one participant described the feeling of turning on a computer for the first time ever and being placed in the position of running a program not more than one week later.

The literature on persistence indicates that women engineering students have academic strengths in math and science and have attained high achievement in those subject areas. Many of these participants did have math and science strengths; however, some perceived they had weaknesses in math and science. Likewise, some persisters as well as non-persisters believed their primary academic strengths to be English and foreign language. Even those who were confident in their math ability prior to enrollment often became insecure about those abilities to the point where they believed their strengths at the college level were in English. Although African American and Hispanic students tended to have lower than average SAT scores, the average SAT scores of persisters and non-persisters were similar. The discrepancies between math and verbal scores were often recalled by participants. While some participants, persisters and non-persisters alike, talked about their high math scores compared to their low verbal scores, others talked about high verbal scores compared to low math scores.

Most students combined academics with leisure and extracurricular activities throughout childhood and high school. The leisure and extracurricular activities of these participants ranged from indoor activities to outdoor activities, preferences for gender traditional and gender non-traditional toys and activities to sedentary to non-sedentary activities, music, dance, and sports, including organized athletics. Participants often called themselves tomboys, and played and competed with their brothers and other boys in their neighborhoods. Rarely did boys reciprocate and play with traditionally feminine toys or play traditionally feminine games; therefore, in the same family, girls were preparing to become non-traditional women while the boys were preparing to become traditional men.

Personality has been shown to be one determinant of non-traditional choice of major. Persisters often described their personalities with descriptors such as competitive, assertive, independent, determined, and confident. While some of these characteristics may have been innate, others developed through experiences with the environment. While some non-persisters described their personalities similarly to persisters, at least two non-persisters described their personalities as easy-going and non-competitive.

5.2.4. Non-traditional Choice of Major

All these factors combined - family and individual background and academic background - as well as personality factors influenced choice of engineering as a major. Students' primary reasons for choosing engineering as a major were very wide and varied. At the top of the list were math and science ability, exposure and hands-on experiences, the structure of opportunity, and encouragement from family or role models. Some students were less systematic in their decision making processes and ended up in engineering accidentally. Again, the structure of opportunity in engineering afforded some students the type of lifestyles they were accustomed to and others the type of lifestyles their parents had never attained. Thus parents sometimes pressured their daughters to choose engineering for the opportunities and prestige it provided. Although middle school and high school teachers and guidance counselors are in the position to be, and very well should be, key players in the career decision making process of adolescents, very few guidance counselors played a role in these participants' decision making and career choice processes. Many counselors in the school system were perceived to be negative, biased, unknowledgable, and concerned only with the logistics of admissions and application processes. While the system is sometimes responsible for the demands on counselors' time and priorities, many of these counselors were perceived to be from the "old school," that is, they were in their positions due to nepotism, they had very traditional beliefs about the role of men and women, or they had biased attitudes about the capabilities of minorities. It is truly tragic that a high school student, despite earning well over a 4.0 average and an award for outstanding achievement, was never encouraged by any of her teachers and guidance counselors to pursue a college education. Perhaps the fact that she was Hispanic and her parents had less than middle school educational levels caused her counselors to foreclose on her own educational opportunities.

5.2.5. Experiences in the Culture of Engineering Education

As women in non-traditional majors, these participants are pioneers. They are motivated by the challenge of creating a name for women in engineering and proving themselves to their peers and faculty. As women in non-traditional majors, they have also dealt with a "good old boys' network" which creates differences in communication, styles of interaction, and personality preferences and patterns. Because engineering is somewhere toward the top of the occupational prestige hierarchy, many of these young woman are held in awe by their friends and acquaintances.

Many of these participants entered their engineering programs feeling uncertain about their choices. Uncertainty, normal developmental tasks and adjustment issues common to the college experience, in combination with a rigorous academic program, overwhelmed many of these students. Many students dealt with severe personal problems as well. Faculty were often unwilling or unprepared to deal with the personal problems that impeded the academic success of these participants. African American and rural students in particular were unhappy with the institutional fit. Minority students were generally unhappy with the rural area and primarily Caucasian student population. Rural students were intimidated by the size of the university.

Experiences with engineering education in the first year were dependent in part on the assigned instructor and the fit with the environment as well as individual factors such as academic background, study habits, and personality. While some faculty were supportive and bent over backwards to help, many others let their biased attitudes about women in engineering spill over into the classroom with such comments as "women aren't cut out for engineering." The "weed out" experience and the way engineering was taught often led to decreased confidence in one's own abilities. Those engineering disciplines that are viewed as more "people oriented" or more "applied" - those that typically appeal to women - are seen as less valuable and prestigious among the engineering faculty and students. For example, those departments which typically have higher enrollments of women, for example, Biological Systems, Civil, and Industrial are perceived to be lower on the hierarchy than those with higher enrollments of men, that is, Computer, Electrical, and Mechanical. Elitist beliefs about the value of the hard core science and math disciplines further contributes to women's decreased confidence about their abilities because they are often choosing the less mathematical and technical disciplines among engineering.

Women not only dealt with faculty bias but with bias from their peers as well. While most female engineering students deal with isolation and tokenism in the classroom and engineering education, for the African American and Hispanic women it was even more distressing. This tokenism often resulted in minority women assuming sole responsibility for projects that were designed to be group projects. A lack of female role models and inadequate advising only exacerbated the chilly climate for these women which brings us to the primary focus of this study - how do some women persist and why do some fail to persist?

5.3. Profiles of Persisters and Non-persisters

As previously mentioned, persistence is a complex phenomenon which involves the interaction of many variables. Persisters and non-persisters had no clear cut profiles but presented more complex profiles. Rather than a single developmental process as the major explanatory concept of the career patterns of these women engineering students, results of this study demonstrated the existence of four patterns. Likewise, almost three decades ago in a longitudinal study, Gribbons and Lohnes (1968) found evidence of four differential career patterns (DCPs) among male and female adolescents and young adults: constant maturity, emerging maturity, degeneration, and immaturity. Some persisters in this study resembled the constant maturity group (early deciders) while some resembled the emerging maturity (emergers) group. Likewise, some of the non-persisters in this study resembled the immature group found in Gribbons & Lohnes study, that is, they initially set unrealistic goals for themselves. Profiles of persisters are presented in section 5.3.1 and profiles of non-persisters are presented in section 5.3.2.

5.3.1. Profiles of Persisters

Those women who persisted in the culture of engineering fit two patterns. One group made early decisions about major and occupational choice, often as early as middle school. Throughout their four years of high school they strategically planned their coursework, including engineering-related courses, and gained hands-on experience with engineering, either informally through traditional male activities such as working on cars or more formally through organized engineering camps and programs. Within the first group were the young women who felt engineering was a logical, natural choice, and oftentimes these young women were Caucasian women with engineering role models. These young women have experienced relatively fewer obstacles and barriers than the second group although the majority of women have experienced some aspect of the chilly climate in engineering education.

A second group of persisters made later decisions about choice of engineering as a major often as a result of encouragement from a family member who suggested engineering for the structure of opportunity it provided for women and minorities. Oftentimes they were not as well informed or as well prepared for engineering education as the first group. Many of the minority and rural women fit this category, and their group membership and tokenism contributed to a greater number of obstacles and barriers than the first group experienced.

Given that there are barriers and obstacles such as inadequate academic backgrounds, poor institutional fit, tokenism and faculty and peer bias, how have these women engineering students persisted? A combination of personality and social support have been the primary means of persistence. The nature of these young women's personalities is to be motivated by not only the structure of opportunity but also by the hardships and obstacles they have faced. These hardships and obstacles have made these women all the more stronger and confident in their abilities. For example, the "weed out" phenomenon gave them all the more incentive to prove to themselves and others that they could succeed in engineering. They have developed a competitive nature, and to give up would mean failure to them. Their resilient spirits have allowed them to take criticism and learn from their mistakes. They have also dealt well with stress and performance pressure. The ability to put things into perspective and know what is and isn't important in life gives balance to their lives, and they have learned that perfection in all endeavors is impossible.

Persisters are also resourceful individuals. They have learned how to play the system, for example, they have learned which instructors to avoid by listening to the experiences of other students. They seek out information even if they have to visit many different campus sources. They have learned how to set goals and achieve them, how to find and utilize sources of support, including other students, faculty, staff, family and friends, how to network, and how to be adaptable. Minority women in particular have had to "put gender and race aside" in a realization that all engineering students are struggling. In most cases, they have also found the right environmental fit within their individual departments and/or they have the support of at least one individual on campus.

Some persisters are passionate about engineering and plan to stick with it as an occupational goal while other persisters have made different plans for their futures. Those who aren't passionate about engineering or don't have their hearts in it, have a global view and vision for those futures. Even though they have no intentions of working as engineers, they view engineering as good training for something else more enjoyable. This, of course, has implications for the future of the engineering workforce.

5.3.2. Profiles of Non-Persisters

While non-persisters did not persist in engineering, in most cases, they are persisting very well in their new majors, many of them also non-traditional majors for women. Like persisters, non-persisters also fit two patterns, those who probably should never have been engineering majors because it wasn't a good person-environment fit, and those who could have made it given different circumstances. Most of the students in this latter group had regrets about leaving engineering. While some non-persisters accepted responsibility and/or blamed themselves for their poor performance in engineering, most of them also blamed the culture and climate in engineering education.

For students in the first group, initial plans to major in engineering were unrealistic for them, and they transferred to other majors that provided a better fit. They didn't fit the "engineering type." As one non-persister stated, "I just couldn't force a square into a circle." For this reason, they also "didn't have their hearts in engineering" to begin with. Oftentimes, they described their personalities as easy-going and creative, and they especially struggled with the "rules" of engineering and the structure of the curriculum. Through their experiences with the obstacles of the engineering culture, they were able to find their own identities.

The second group of non-persisters included many women who were pressured to major in engineering. Like the persisters who were encouraged to choose engineering for the structure of opportunity, this group generally lacked hands-on experience and exposure to engineering. These non-persisters were also intimidated by the "weed out" phenomenon and turned off by the competition of engineering. In many cases, they also dealt with severe personal problems, lack of confidence, and low self esteem. The engineering culture, personal problems, and the inability to perform as well as they did in high school resulted in a drop in their confidence levels. This group had an especially difficult time dealing with low grades. Because they had a narrow view of engineering, they failed to look beyond the first year at the big picture. They also failed to learn the system, and in many cases, isolated themselves and failed to find a source of support.

5.3.3. Answers to the Questions Guiding the Study

Although sections 5.2 and 5.3, as well as subsections within those sections, provide detailed findings, this section provides a summary of findings to the questions that guided the study.

(1) What experiences have been influential in undergraduate women's choice of engineering as a major? Family and individual variables were both influential factors leading to a choice of engineering as a major. Relevant family variables included parental education and occupation, birth order and gender issues in the family, cultural factors and parental philosophies and values, role models, and family hardships and tragedies. Relevant individual variables included leisure and extracurricular activities, personality, and academic variables. The stated reasons for choice of engineering as a major included the structure of opportunity provided by engineering degrees, formal and informal hands-on experiences and exposure to engineering, and math and science ability, among others. While some participants made informed decisions about their engineering majors, many of the participants made decisions based on very limited information

about engineering. The limited roles of guidance counselors and teachers in the career choice process was one possible explanation of their uninformed decisions.

(2) How has the culture and climate of engineering education influenced the experiences of these undergraduate women? Typical and atypical freshman year experiences were intensified by experiences with the culture and climate of engineering. As non-traditional majors, these young women felt like pioneers who were faced with proving their competence and “carrying the torch” for future women students. The freshman year engineering curriculum and climate created a “pivotal” point for undergraduate women in engineering, thus influencing some women to leave their engineering majors. All participants, whether personally or through the stories of their female peers, had experienced some aspect of the “chilly” classroom climate and “weed out,” biased attitudes of faculty and peers, and inadquate advising. In many cases, industry and related work experiences through summer internships or cooperative education provided the impetus to persist in engineering.

(3) How do individual, educational, social, and environmental characteristics and strategies contribute to undergraduate women’s persistence? Persistence was discovered to be a complex phenomenon involving all these factors, many of which are discussed under the first question; however, in terms of individual factors, personality was a prominent factor in persistence. Whether participants’ personality traits were innate or learned is unclear; however, there was some indication that life experiences had contributed to personality development. One prominent academic strategy had been to learn to play the system, with social factors and sources of support playing a major role. In general, social factors and source of support, including family, faith, peers, faculty, and advisors, were of central importance as were environmental considerations such as arrangements for living and studying.

(4) Which of these characteristics and strategies differentiate between persisters and non-persisters? Detailed profiles of persisters and non-persisters are presented in Sections 5.3.1 and 5.3.2. In summary, persisters fit two patterns, that is, early deciders and emergers. Likewise, non-persisters fit two patterns, including poor person-environment fit and circumstantial. In terms of personality, persisters were motivated by obstables and barriers in their environments. They had been adept at playing the system and utilizing sources of support. On the other hand, non-persisters lacked hands-on experience with engineering and failed to see the big picture of engineering. There was also a higher incidence of parental pressure to major in engineering among the non-persister group.

(5) How do characteristics and strategies of persistence and non-persistence compare for special populations? The findings here were inconclusive, due in part to small samples of each group; therefore, conclusions demonstrate trends that are based mainly on intuition and prior knowledge of special client populations. However, one finding is clear -- special group membership creates features that compound women’s typical experiences with the culture and climate of engineering, for example, faculty and peer bias, tokenism, isolation, poor institutional fit, and poor academic foundation.

5.4. Discussion

In the data collection and analysis, and write-up of Chapter 4, I was inspired by the strengths and stories of these young women, and I am leaving the dissertation process with the shared opinion that they truly are pioneers forging a path for the next generation of women engineers. While most of the truly positive events appeared to be internal to the participants, most of the negative events seemed to be external, environmental events. Therefore, I was also struck by the negativity of the findings as I wrote Chapter 4, reread it, and wrote again.

The nature of humanity is to sometimes talk and complain about those things that are negative in our lives and to remain silent about those aspects of our lives that are more positive. These participants had been very frank and vocal about their negative experiences with the engineering culture and very subdued about those experiences that were more positive. Even still, their stories should not be discounted. Although perceptions often have no place in the world of hard science, there does appear to be a clear gap in the perceptions of faculty and students about the culture and climate of engineering. Although data were retrospective and subject to the error of reminiscence, it did provide evidence of a chilly climate for women, and especially for minority women, in engineering at this land-grant research institution. African American women, in particular, recalled long lists of other African American friends and acquaintances who had either left engineering and transferred to other departments or who had left the university altogether after experiencing the negative climate. Even those participants whose experiences had been more positive could recall the negative stories of friends and acquaintances. Findings did indicate a serious problem with the climate of engineering education.

While many of the characteristics of persistence were probably innate personality traits, many of them were also learned through the socialization process and other learning experiences. In some cases, parents, in particular, often considered the male gender the ideal and encouraged their daughters to choose traditional male activities and majors. On the other hand, their sons were not encouraged to pursue traditionally feminine activities and majors. In some cases, a family tradition of holding males in higher esteem has resulted in a low tolerance for traditionally feminine ways of behavior; thus, many of the participants criticized other women in general and stated a preference for associating with male engineering students. Thus, findings also demonstrated the influence of gender issues in the family as one determinant of choice of engineering major.

This study demonstrated the existence of many choice points throughout childhood and the developmental process, rather than a unique choice point, that determines the direction of career and occupational choice. However, too much was being left to chance in the lives of some of these participants. Many of these participants started out with a very narrow range of occupational preferences based, in part, on a hierarchy of prestige rather than actual interest in the field. Interest in engineering and certainty about the choice of an engineering major - as well as interest and certainty in any other choice - cannot be realized without relevant experiences along those choice points. A concern for the reasons of choice of engineering major and with the fit of the choice to personality and self-concept is crucial. A lack of informed decision making and a lack of impact of guidance and counseling are both serious matters. Some means of increasing the efficiency and competency of counselors in all school systems has been justified through this study. Although decades ago many career theorists, including Super and Hansen, emphasized, the importance of developmental frameworks for major and career choice, few teachers and counselors have utilized these frameworks in their practices. In particular, students from lower socioeconomic groups and special groups, such as minorities, women, and students from rural geographical areas, and emergers, that is, those students who are career immature, need special attention as they progress through those choice points along the educational stream. The fact that some of these participants ended up where they are today is a tribute to their persistence and self-reliance - certainly not to the dedication and concern of those individuals who could have made a choice to be influential and helpful.

A final comment worth making is about the emotions that were often elicited through the interview process, both my own and those of the participants. Many of the participants had dealt with individual and family hardships and tragedies. Descriptions of classroom and laboratory experiences, especially among special groups, provided evidence of blatant sexual harassment. Why students put up with it is obvious -- they were uninformed about options and they feared being ostracized. The fact that the administration puts up with it is alarming and completely unacceptable. Non-persisters, in particular, often became somewhat emotional in the recollection of their experiences with engineering and their decision to leave their engineering majors. One way in which this group of young women justified their decision to leave or rationalized that decision, was to comment on the fact that other engineering students don't really like engineering. Rationalizing their decisions and externalizing their failure perhaps enabled them to minimize their pain and psychological dilemma. In the case of some participants, it was obvious that their pain still existed and that the experience of processing that pain was on-going. Through these often painful descriptions of experiences, one truly gets a sense of the connection between occupational choice, wellness, and mental health.

5.5. Recommendations

The findings of this study indicate many recommendations for parents, schools, universities, and industry. Since these young women were telling their own stories about their own personal experiences, they were given the opportunity in the study procedures to make their own recommendations for exposing and encouraging young girls and women to choose engineering as well as recommendations for retaining women engineering students in their engineering programs. Many of the following recommendations came from the mouths of those who have lived the experience.

5.5.1. Recommendations for Parents

Pressuring children to make occupational choices based on limited information is almost as injurious as failing to encourage them at all and results in a great deal of resentment. Occupational interests develop through hands-on experience and education. Providing early hands-on exposure to the tools of engineering, promoting problem solving, decision making, and independence are avenues for promoting non-traditional occupational choice. Younger children should be exposed to a wide variety and balance of extracurricular activities as well as math, science, and technology in the schools and in the home. Non-specific gender roles should be encouraged for girls as well as boys, and girls should receive the same encouragement for effort and academic achievement as boys do. When children are ready to make decisions about occupational choice, they will be better prepared to make informed decisions.

Parental involvement in a child's education is crucial. Parents, teachers, counselors, and administrators should be partners in the education of all children. Parents are and should be advocates and proponents for their children by using their influence to ensure the latest computer technology, hands-on learning through the classroom, and first rate vocational programs in the school systems. For example, Hansen (1995) provides descriptions of programs such as "Born Free" (Build Options, Reassess Norms, and Free Roles through Educational Equity), "Operation Smart" (Science, Math, and Relevant Technology), "Family Math," and "Family Science." These programs involve parents and children in cooperative problem solving and expand appreciation and comfort with the applications of math and science (Hansen, 1995). Parents can also be instrumental in making suggestions for and assisting with career guidance activities in the schools and developing industry partnerships with those schools.

5.5.2. Recommendations for Schools

Career guidance activities should be integrated in the everyday classroom through a developmental framework beginning in early elementary school. Teachers can also be instrumental in demystifying math and science through hands-on learning and laboratory exercises, technology in the classroom, and creativity. These career development and academic programs, as well as programs that increase girls' self-esteem, should continue well into middle school. The middle school years are a crucial time for young girls. Oftentimes self-esteem and math self-efficacy begin to plummet at this age. One strong suggestion for math and science coursework is to build in exciting and intriquing hands-on activities which improve spatial abilities and boost confidence and interest.

Guidance counselors at all levels should work with the teachers in their schools to strengthen career guidance activities in the classroom and outside the classroom and implement a developmental career development framework. To be effective career counselors, they should be extensively trained in career counseling and guidance activities, career guidance technology, and more informed about non-traditional occupations. They should also be exposed to issues relevant to special client populations in order to be more responsive to female, minority, and low income students and their career development needs. Girls and minorities should be encouraged to pursue higher level math and science courses when planning programs of study. Neglecting these student groups only perpetuates their disadvantaged status in society and in the workforce.

Counselors should be instrumental in education about and exposure to non-traditional occupations through shadowing experiences, exposure to role models, field trips to industry and universities, summer programs, and career days which include women in non-traditional areas. Local chapters of professional engineering societies are excellent sources of potential speakers and presenters. Teachers and counselors alike can heighten awareness about various non-traditional options for boys and girls and present them as viable options. Teachers and counselors can also be instrumental in establishing local chapters of clubs and organizations which expose girls and minority children to math, science, engineering, and technology.

Counselors should acquire and maintain up-to-date information about summer programs, as well as academic programs, in engineering at the university level. Partnerships with industry as well as partnerships with community colleges and universities can provide exposure and ease the transition to post-secondary education. Students should be prepared for engineering study through study skills and time management as well as education about support services and student organizations at the university level. Schools and universities must work together to provide "bridge" programs for qualified students.

Teachers, counselors, and administrators should beware of foreclosing on students before given the chance to succeed. Whether a student is in a vocational or pre-college track, he or she should be supplied with the best opportunities for a quality education through strong vocational programs as well as math, science, and technology programs.

5.5.3. Recommendations for Engineering Programs

Programs for women engineering students, such as support and counseling, tutoring, and mentoring are crucial for the "pivotal" first year when many women and minority women get discouraged and leave engineering. Small group counseling and mentoring with similar kinds of students is crucial, and results of this study indicate a continuing need for programs in those areas. Results of this study also indicate a need for changes at the institutional and cultural level.

When asked the question, "what recommendations do you have for retaining women in engineering?", one rural participant commented "I always got the feeling they weren't trying to keep us." This perception as well as most of the 36 stories told by these women indicate the need to rethink the mission of the university and its commitment to women and minority women in engineering. While the situation for women has improved greatly since the establishment of the Minority Engineering Programs in the fall of 1992, there is still a great deal more progress that needs to be made. This progress needs to come in the form of changed attitudes toward the role of women in society as well as changed attitudes about women's capabilities as far as non-traditional occupations such as engineering are concerned. These are suggestions for "cultural" change, that is, working on the system to improve the climate and culture of engineering education.

Women in general should be met with a welcoming attitude. This welcoming attitude should begin at orientation and continue throughout their studies in the university. We are losing potential students by the way we treat our students in that persisters and non-persisters alike are advising friends and acquaintances to attend other universities.

The academic backgrounds of rural students and minorities should be more closely monitored and evaluated in an effort to provide bridge programs. The importance of remedial academic preparation in math, computers, and engineering fundamentals, should be stressed to both students and parents through the admissions and recruiting process. Students without prior computer experience especially need some training in computers.

Faculty and advisors should build on students' developmental needs for social relationships by connecting engineering students with other engineering students, both in the first year and later in their major departments. Opportunities for interaction between faculty and students inside and outside the classroom provide students with a better fit and sense of belonging. Faculty and advisors must also be willing to listen and prepared to deal with personal problems that impede academic success by making referrals to campus resources. Women engineering students should be housed with other women engineering students in the dormitories, thus providing programs such as structured study hall, team building, and mentoring. Since many of these participants felt disconnected from other women in their own majors, helping women make connections with other women in their majors, as well as in the first year, is also recommended. A review of the existing Minority Engineering Programs is needed to make the program more inclusive of all women. Some Caucasian and Asian women haven't taken full advantage of the programs because they don't view themselves as "minorities." Transfer students who enter engineering programs after their first two years of study at other institutions aren't aware of the programs offered by the Minority Engineering Program.

Faculty, as well as teaching assistants, need to be provided with training in gender and ethnic group sensitivity, for example, the use of gender and racial clustered groups in the classroom as well as in the laboratories and group projects helps to avoid tokenism and isolation. As new faculty and teaching assistants are hired, they should be required to participate in this training as part of their orientation program. Faculty should also be provided with instruction in teaching methodologies, including collaborative teaching methods, which promote collaboration rather than competition. Courses perceived to be "weed out" courses, including first year engineering courses, should be tracked for attrition rates, and the manner in which those courses are taught should be evaluated. Faculty should also be instructed in small group dynamics and team building so they can teach these skills to students in their own classes in preparation for group projects. Faculty should promote teamwork among students as well as among themselves by discontinuing their criticisms of other departments. Computers should be integrated across the curriculum throughout all four years of study. Students should be involved in early hands-on experiences through the classroom and laboratories, shadowing experiences, cooperative education, and summer internships. Students, especially those in the "pivotal" first year, have a right to non-biased instructors who are enthusiastic about teaching.

Women believe they are better served by other women. The advising system in the first year should be revamped to provide more female and minority advisors. Women, in particular, desire unbiased, trained female counselors. Many of them are uncomfortable and intimidated by talking to men. Additional women and minority faculty members who can serve as mentors should be hired. A handful of women and minority faculty cannot be expected to mentor all women and minorities in the college. Women in general are also more interested in creative outlets. Rather than telling them engineering is creative, show them how it is creative and spark their interests in this manner, for example, a brochure and webpage entry titled "Engineering and Creativity" is one suggestion.

Faculty and advisors should take a proactive, rather than a reactive approach, in monitoring students' performance and progress, for example, automatic notification and communication about withdrawals and resignations from the dean's office to advisors encourages advisors to contact students about their situations. Potentially successful students are being lost simply because they got lost in the shuffle or fell through the cracks.

5.5.4. Recommendations for Industry

Partnerships with middle and high schools provide opportunities for students to gain shadowing experiences. Since so many of these young women were motivated by the structure of opportunity, industry-sponsored scholarships for women and minorities will provide further encouragement for choosing engineering as their major.

The finding that many of these young women have personal plans related to traditional beliefs about family and children, has implications for the future of industry and "Corporate America." Industries must do their part in encouraging women and minority women to choose and stay in engineering because women and minorities will be a significant part of the future workforce.

Because many areas of engineering are still predominately male-dominated, industry, like engineering programs, must make cultural changes. Gender and sensitivity training for employees at all levels, a more equitable reward system, flexible and creative benefits for family leave and parenting, flextime, flexspace and other creative work-at-home situations are keys to keeping women employed in the profession.

5.6. Suggestions for Further Research

Several areas are worthy of further research. Whereas women are migrating to departments such as Industrial and Systems Engineering, Civil Engineering, and Biological Systems Engineering, enrollments of women in other disciplines such as Aerospace and Computer

Engineering remain very low. This study found a hierarchy of prestige within the culture of engineering and among the various disciplines; therefore a study which profiles the "personalities" of the departments would provide a more in-depth glance into the environments and cultures in those departments and insight into reasons for low enrollments of women. The culture and climate of other colleges within the institution should also be studied and compared to engineering.

Since the study included only small samples of special populations and non-persisters, conducting similar studies with larger samples is recommended. For example, non -persisters in this study had transferred to other majors within the same institution. Another group of non-persisters exists in those students who transferred to other institutions or left the university altogether. For example, African American students especially transferred to engineering programs at other institutions. Perhaps such a study would provide insight into how to retain these students.

Since this study was limited to one institution in the Southeastern portion of the United States, in-depth qualitative studies of programs at other institutions should be conducted to determine if there are regional and cultural differences among other engineering programs.

A research project in partnership with programs such as Upward Bound could be utilized to identify talented female middle school and early high school students who could then be exposed to engineering through academic and career counseling and guidance activities, summer programs at the university, and hands-on activities through laboratory and industrial experiences. These young women could be tracked longitudinally to determine if these experiences led to choices of engineering majors.

A "Determination to Persist" instrument based on findings from this study, factor analyzed and tested for reliability and validity would provide a means of ascertaining women's likelihood to persist in engineering as well as suggestions for proactive retention programs.

Finally, a survey of career guidance practices, as well as obstacles to career counseling, at the high school level, is strongly recommended.

5.7. Conclusions

Persistence in engineering majors is a complex phenomenon involving family, individual, environmental, and social factors, that is, no single developmental pattern provided an explanation for the choice of an engineering major. While most of the truly positive events relevant to persistence appeared to be internal to the participants, most of the negative events seemed to be related to perceptions of external, environmental events. In other words, even those young women who were persisting in their engineering majors often perceived a negative climate in engineering. Although special group membership and the intersection of race and gender were compounding features of perceptions of an existing chilly climate in engineering, particularly in the first year program, differences in subgroups tended to wash out due to insufficient numbers and the crossing of boundaries. In fact, the intersection of race and gender resulted in the inability to separate those boundaries in the end.

While poor person-environment fit, perceptions of a negative climate in engineering, and personal problems often contributed to non-persisters leaving their engineering majors, even among the persister group, there were women who did not really want to be engineers. This fact substantiates the need for a commitment to developmental career counseling models from the elementary through high school levels. Only until we provide all students with all viable options and see value in all those options can men and women truly realize their potential and make the appropriate personal decisions about occupational choice. The ultimate decision needs to be found within the individual, and as this study has so poignantly demonstrated, we need to recognize the role of women's personal resources and strengths as one means of their persistence.

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APPENDIX 1

CONTACT SCRIPTS

(via electronic mail and phone)

Interview

Hello ___(student's name)___, my name is Leslie Graham. I am a Ph.D. Candidate in Counselor Education as well as an Academic Counselor in Industrial and Systems Engineering here at Virginia Tech. My dissertation topic deals with women's persistence (or non-persistence) in engineering. Specifically, I am interested in the choice of major process and the influences on non-traditional choice of major, experiences with the culture and climate of engineering education, and strategies of persistence. Your input and experiences are very valuable to my research. Each participant will receive $10.00 compensation for a 60 minute interview. Are you interested in participating in an individual interview?

(Refer to Interview Scheduling Form.)

Focus Group

Hello ___(student's name)___, my name is Leslie Graham. I am a Ph.D. Candidate in Counselor Education as well as an Academic Counselor in Industrial and Systems Engineering here at Virginia Tech. My dissertation topic deals with women's persistence (or non-persistence) in engineering. Specifically, I am interested in the choice of major process and the influences on non-traditional choice of major, experiences with the culture and climate of engineering education, and strategies of persistence. Your input and experiences are very valuable to my research. Each participant will receive $10.00 compensation,as well as food and soft drinks, for a 90 minute interview. Are you interested in participating in a focus group?

(Refer to Focus Group Scheduling Form.)

APPENDIX 2A

INTERVIEW SCHEDULING FORM

Study: Profiles of Persistence: A Qualitative Study of Undergraduate Women in Engineering

Location: 271 Whittemore Hall

Date/ Time	Name	Race	Phone #	E-mail/ PID	Follow-up?

APPENDIX 2B

FOCUS GROUP SCHEDULING FORM

Study: Profiles of Persistence: A Qualitative Study of Undergraduate Women in Engineering

Group: ______________________________

Date: ______________________________

Time: ______________________________

Location: ______________________________

Name	Race	Phone #	E-mail/ PID	Follow-up?

APPENDIX 3

REMINDER SCRIPTS

(via phone)

Interview

Hello __(student's name)_____, this is Leslie Graham. I would like to express my appreciation for your willingness to participate in an individual interview for my women in engineering study. This message is a reminder of the interview which will be held on ______(date)__ at ____(time)__ in ____(location)_____. You will receive $10.00 compensation for your participation. I look forward to meeting you. If you have any questions in the meantime, please call me at 231-6388.

Focus Group

Hello __(student's name)_____, this is Leslie Graham. I would like to express my appreciation for your willingness to participate in a focus group interview for my women in engineering study. This message is a reminder of the group which will be held on __(date)__ at _____(time)__ in ____(location)_____. You will receive $10.00 compensation for your participation. Refreshments and soft drinks will also be served. I look forward to meeting you. If you have any questions in the meantime, please call me at 231-6388.

APPENDIX 4

INFORMED CONSENT FORM

Virginia Tech

Research Title: Profiles of Persistence: A Qualitative Study of Undergraduate Women in Engineering

Investigators: Leslie Pendleton Graham, Ph.D. Candidate, EDSP
Dr. Carl McDaniels & Dr. Kusum Singh, Co-Chairs

I. The Purpose of this Research

This research is being conducted as part of a Ph.D. dissertation requirement. The purpose of the study is to develop women's profiles of persistence in engineering. The data will contribute further to the understanding of the career choice processes of women in engineering, their experiences in the engineering environment, and their strengths and ways of persisting.

II. Procedures

Qualitative research methods will consist of either a one-time focus group or individual interview. Each group member/participant will be asked to respond to a series of questions by relating individual experiences. Both focus group interviews and individual interviews will run one-and-a-half (1 1/2) hours.

III. Anonymity and Confidentiality

The results of this study will be kept strictly confidential. Focus group members are expected to respect the privacy of other group members by keeping the group discussion confidential. Reports of the findings of the study will not reveal the identity of individuals. Participants will have the option of receiving a written summary of the findings at the end of the study.

The individual interviews and focus groups will be tape recorded. A verbatim transcript will be completed with all names and identifiers removed. Tapes and transcripts will be secured by the Principal Investigator who will destroy the tapes after completion of the dissertation.

IV. Hazards

There will be no risk, including either physical hazard or emotional stress, to the group members or participants. Those participants deemed to be in need of academic advising, career advising, or personal counseling will be referred to the appropriate resources.

V. Compensation

Participants in individual interviews and focus group members will receive $10 compensation immediately following the interview or focus group.

VI. Freedom to Withdraw

Participants are free to withdraw from this study at any time.

VII. Approval of Research

This research project has received human subjects approval from the Institutional Review Board (IRB).

VIII. Participant's Permission

I have read and understood the informed consent form and conditions for this research project. My questions about the project have been answered to my satisfaction. I hereby acknowledge the information supplied on this form and give my voluntary consent to participate in this study.

____
Participant's Signature

____
Participant's Printed Name

____
Address

____
Phone Number

____
E-mail Address

✂---

Should I have any questions about this research or its conduct, I may contact:

Leslie Pendleton Graham, Investigator	231-6388
Dr. Carl McDaniels, Committee Co-Chair	231-6890
Dr. Kusum Singh, Committee Co-Chair	231-9729
Dr. H. T. Hurd, Chair, IRB Research Division	231-9359

APPENDIX 5

DEMOGRAPHIC SHEET

1. Where do you consider home?

2. Where did you attend schools, elementary, middle, and secondary levels?

3. If relevant to you, what is your birth order? Tell me the gender and ages of your siblings? (List oldest to youngest and include names.)

4. If relevant, what are the educational levels and occupations of your siblings? (Use the same order as above.)

5. To the best of your recollection, what was your high school rank and final grade point average. (This information will be kept confidential.)

6. What were your academic strengths in middle school and high school?

7. To be best of your recollection, what was your SAT score? (This information will be kept confidential.)

8. List all major changes at the university.

APPENDIX 6A

INTERVIEW GUIDE

Family Variables

Where do you consider home?

Tell me about the schools you attended from elementary school through high school.

What are the educational levels and occupations of your parents?

Starting with the oldest and going to the youngest, tell me the gender and ages of any brothers and sisters.
    Educational levels and occupations of any adult siblings?

Explain your parents' philosophies on raising children, e.g., values, beliefs, etc.

Individual Variables

When you were growing up, what were your own personal preferences for toys and other play activities?

Describe your own personality.

What were your academic strengths and weaknesses in middle school and high school?
    High school rank? Final grade point average? SAT scores?

Discuss your reason(s) for choosing engineering as a major.
    Influential individuals? Role models?
    Related hands-on experiences? Exposure?
    Role of guidance counselors? Teachers?

Describe the degree of certainty, from very uncertain to very certain, you experienced in your choice of engineering as a major?
    Beliefs about capabilities as far as engineering?
    Current perceptions compared to those early perceptions?

Culture and Climate of Engineering

How has being a woman in a non-traditional major affected you?

Describe your experiences in the engineering classroom, beginning with the first year?
    Role of faculty?
    Role of advisors?
    Role of peers?

Does the culture or climate or engineering present any barriers for women?
    If yes, how have you persisted?
    If no, how do women in general persist?

Describe any relevant work experiences you've had?

Sources of Support

What role have the following played in your persistence?
- Faculty?
- Advisors?
- Minority Engineering Programs?
- Family?
- Friends?
- Faith?
- Other?

General

What advice do you have for encouraging girls and young women to choose engineering as a major?

How can these girls and young women be encouraged to persist in an engineering major?

Tell me about your own personal beliefs about men and women and their respective roles in the home and in the workplace.

What are your post-graduation plans?
- Personal?
- Professional?

Is there anything I haven't asked that is relevant to your background or experiences?
- Anything you would like to add?

Can you name any female engineering students you know or knew who left engineering?
- In your opinion, why did she leave?

APPENDIX 6B

QUESTIONING ROUTE

Demographic Work Sheet

Please introduce yourselves by telling the group about your families.

Explain your parents' philosophies on raising children, e.g., values, beliefs, etc.

Individual Variables

When you were growing up, what were your own personal preferences for toys and other play activities?

Describe your own personalities.

What were your academic strengths and weaknesses in middle school and high school?
High school rank? Final grade point average? SAT scores?

Discuss your reason(s) for choosing engineering as a major.
Influential individuals? Role models?
Related hands-on experiences? Exposure?
Role of guidance counselors? Teachers?

Describe the degree of certainty, from very uncertain to very certain, you experienced in your choice of engineering as a major?
Beliefs about capabilities as far as engineering?
Current perceptions compared to those early perceptions?

Culture and Climate of Engineering

How has being women in non-traditional majors affected you?

Describe your experiences in the engineering classroom, beginning with the first year?
Role of faculty?
Role of advisors?
Role of peers?

Does the culture or climate or engineering present any barriers for women?
If yes, how have you persisted?
If no, how do women in general persist?

Describe any relevant work experiences you've had?

Sources of Support

What role have the following played in your persistence?
Faculty?
Advisors?

Minority Engineering Programs?
Family?
Friends?
Faith?
Other?

General

What advice do you have for encouraging girls and young women to choose engineering as a major?

How can these girls and young women be encouraged to persist in an engineering major?

Tell me about your own personal beliefs about men and women and their respective roles in the home and in the workplace.

What are your post-graduation plans?
Personal?
Professional?

Is there anything I haven't asked that is relevant to your background or experiences?
Anything you would like to add?

Can you name any female engineering students you know or knew who left engineering?
In your opinion, why did she leave?

APPENDIX 7

VERIFICATION OF COMPENSATION

Title of Project: Profiles of Persistence: A Qualitative Study of Undergraduate Women in Engineering

Project Investigator:
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Counselor Education Department
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My signature below verifies that I received $10 compensation for participation in either a focus group interview or an individual interview.

Printed Name	**Signature**	**Student ID#**

APPENDIX 8

FOLLOW-UP SCRIPTS

Interview

Hello ______(student's name)_____, this is Leslie Graham. I am calling you for two reasons. First of all, I would like to thank you once again for participating in the Women in Engineering interview. Your "story" is very important to my research. The second reason for my call is to give you the opportunity to share any additional pieces of information that have come to mind since the interview. (Wait for response.)

Record response:

____
____
____
____
____

______(student's name)_____, you have been very helpful. Would you like to receive a summary of findings at the end of the study? ______Yes_________No.

Focus Group

Hello ______(student's name)_____, this is Leslie Graham. I am calling you for two reasons. First of all, I would like to thank you once again for participating in the Women in Engineering focus group. Your "story" is very important to my research. The second reason for my call is to give you the opportunity to share any additional pieces of information that have come to mind since the group. (Wait for response.)

Record response:

____
____
____
____
____

______(student's name)_____, you have been very helpful. Would you like to receive a summary of findings at the end of the study? ______Yes_________No.

APPENDIX 9A

LISTENING GUIDE CHECKLIST FOR INTERVIEWS

Interview	Listening 1	Listening 2	Listening 3	Listening 4
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

APPENDIX 9B

LISTENING GUIDE CHECKLIST FOR FOCUS GROUPS

Focus Group	Listening 1	Listening 2	Listening 3	Listening 4
1				
2				
3				
4				
5				

APPENDIX 10

DATA MATRIX DISPLAY

Participant	Q1	Q2	Q3	Q4	Q5
AFP1					
AFP2					
AFP3					
AFP4					
AFP5					
AFP6					
AFP7					
AFP8					
AFP9					
ASP1					
ASP2					
ASP3					
ASP4					
CAP1					
CAP2					
CAP3					
CAP4					
CAP5					
CAP6					
CAP7					
CAP8					
HIP1					
HIP2					
RUP1					
RUP2					
RUP3					
RUP4					
RUP5					
CAN1					
HIN2					
AFN3					
AFN4					
CAN5					
HIN6					
CAN7					
CAN8					

APPENDIX 11

PARENTAL EDUCATION LEVEL

Partic-ipant	<M.S.	<H.S.	GED	H.S.	A.S.	Some Coll.	B.A./ B.S.	Some Grad.	M.S./ M.A./ MBA	Post-master	Prof.	Ph.D.
AFP1				F			M					
AFP2		M		F								
AFP3				M	F							
AFP4								M	F			
AFP5				M,F								
AFP6				F	M							
AFP7									F	M		
AFP8				F		M						
AFP9				M,F								
ASP1			F				M					
ASP2				M							F	
ASP3						F	M					
ASP4				M							F	
CAP1									M,F			
CAP2							M		F			
CAP3							M		F			
CAP4							M		F			
CAP5				M			F					
CAP6				F		M						
CAP7						M			F			
CAP8				F					M			

Key: M = Mother
F = Father

APPENDIX 11

PARENTAL EDUCATION LEVEL

Partic-ipant	<M.S.	<H.S.	GED	H.S.	A.S.	Some Coll.	B.A./ B.S.	Some Grad.	M.S./ M.A./ MBA	Post-master	Prof.	Ph.D.
HIP1											M	F
HIP2	M,F											
RUP1				M,F								
RUP2				M,F								
RUP3				M		F						
RUP4						F			M			
RUP5		M		F								
CAN1							M,F					
HIN2						M,F						
AFN3		F			M							
AFN4						M	F					
CAN5							M				F	
HIN6								M				F
CAN7							M,F					
CAN8				M			F					

The professional category includes pharmacy, dentistry, medicine, and law.

APPENDIX 12

EXTRACURRICULAR AND LEISURE ACTIVITIES

Academic-related
Computers
Debate Team
Drill Team
School newspaper

Art
drawing
painting

Board games
Battleship
Memory
Monopoly
Trivial Pursuit
Trouble

Dance
ballet
jazz
tap

Make believe/pretend
build forts in the woods
teacher/school
Spiderman & Superman
Tonto & Lone Ranger
war games

Music
clarinet
piano
singing
taping & mixing songs
violin

Toys (traditional female)
Barbie dolls
Barbie stuff
Cabbage patch
dolls and doll houses
stuff animals

Toys (traditional male)
Legos
Lincoln logs
Matchbox cars
Models
Tonka trucks

Toys (gender neutral)
blocks
Smurfs

Non-sedentary
aerobics
berry picking
climbing trees
hiking
hopskotch
playing on the playground
jumping rope
ping pong
riding bikes
running
sandbox
shopping
sledding
water skiing
weight lifting

Sedentary
computer games/Atari
picnics
reading
talking/conversing
watching TV/movies

APPENDIX 12

EXTRACURRICULAR AND LEISURE ACTIVITIES

sports
basketball
baseball
cheerleading
dodgeball
field hockey
football
kickball
lacrosse
rugby
soccer
tee-ball
tennis
track
softball
sports camps
swimming
volleyball

family
going out to eat
hanging out
picnics
sports
vacations (parents and grandparents)
visiting relatives

cultural
Indian functions and religious festivals
cultural parties and fiestas

animals
farm animals
horses
pets - dogs and cats

activities with mother
getting hair done
shopping
talking

activities with father
animals
building things
cars
fishing
shadowing on the job
sports
talking
tinkering around the house

APPENDIX 13

CODES FOR PERSONALITY

AFP1: determined, independent, introverted, confident, achiever, goal-oriented
AFP2: motivated, strong, determined, works under pressure, confident, assertive
AFP3: strong, resilient, determined
AFP4: goal-oriented, assertive, strong, determined
AFP5: mature, confident
AFP6: motivated, bullheaded, stubborn, achiever
AFP7: feeling person, friendly, motivated, individualistic, strong, steadfast
AFP8: confident, independent
AFP9: goal-oriented, balanced
ASP1: competitive, pragmatic, strong, responsible, independent, adaptable, disciplined, motivated, structured, strong, self-assured, confident
ASP2: achiever, competitive, motivated, achiever, leader, organized
ASP3: independent, shy, thinking person, competitive
ASP4: shy, reserved, motivated, responsible, hard worker
CAP1: hard worker
CAP2: extroverted, outgoing, feeling person, emotional, intuitive, self-reliant, likes a challenge, confident, self-assured
CAP3: high strung, achiever, ambitious, independent, hard worker, motivated
CAP4: perfectionist, hard worker, determined, likes a challenge, humorous, disciplined, motivated, competitive
CAP5: independent, balanced
CAP6: independent, strong, resilient
CAP7: motivated
CAP8: strong, competitive, motivated, determined, competitive, high strung, goal-oriented
HIP1: strong, self-assured
HIP2: family-oriented
RUP1: motivated, disciplined, responsible, structured, stubborn, achiever, hard worker
RUP2: determined, dominating, ambitious, likes a challenge, strong willed, loyal dedicated, passionate, competitive, insecure
RUP3: strong willed, good reasoning, hard worker
RUP4: goal-oriented, hard worker, determined, motivated, shy, confident
RUP5: independent, motivated, likes a challenge, determined, stubborn, hard worker, leader, confident, works under pressure, resourceful
CAN1: introverted, independent, competitive, determined, self-reliant
HIN2: introverted, reserved, hard worker
AFN3: determined, competitive, likes a challenge
AFN4: quiet, assertive, helpful
CAN5: self-assured, capable, confident, perfectionist, motivated, strong, responsible, intelligent, opinionated, hard worker, leader
HIN6: hard worker, laid back, easy-going
CAN7: perfectionist, over-achiever, goal-oriented, creative
CAN8: creative, silly, laid back, easy-going, non-competitive

APPENDIX 14
ACADEMIC VARIABLES:
Academic Strengths & Weaknesses, High School GPA & Rank, and SAT Scores

Participant	Academic Strengths	Academic Weaknesses	High School GPA	High School Rank	SAT Scores
AFP1	math	science	3.7	10/170	1200
AFP2	math, science	none	4.3	2/136	970
AFP3	math, science	none	3.8	none	?
AFP4	science	english	3.7	20/?	1050
AFP5	math	english	> 3.0	↑ 30%	1250
AFP6	geometry, science	english	4.2	1/?	780
AFP7	math, genetics	govt, physics	3.75	↑ 10%	880
AFP8	math	none	3.5	12/?	1010
AFP9	english, foreign lang.	math,science	?	43/480	880
ASP1	english	drafting, math	3.8	7/300	?
ASP2	english	math	> 4.0	2/>100	1190
ASP3	life sciences, math	english, chemistry	≈3.5	82/618	1000
ASP4	math	english, soc sci	3.0	?	990
CAP1	math, science	english, writing	3.9	2/?	1370
CAP2	math, science	english lit, hist	4.3	3/313	1280
CAP3	math	english, testing	3.8	↑5-10%	≈1050
CAP4	math, science	none	4.3	1/?	≈1340
CAP5	math, english	physics, chem	3.5	none	1300
CAP6	math, science	history	3.8	11/≈450	≈1000
CAP7	math, chem	english, PE	4.0	1/125	1380
CAP8	math, science	english	>3.0	20/170	1130

Key: AF = African American, AS = Asian American, CA = Caucasian, HI = Hispanic, RU = Rural, P = Persister, N = Non-Persisters

APPENDIX 14
ACADEMIC VARIABLES:
Academic Strengths & Weaknesses, High School GPA & Rank, and SAT Scores

Participant	Academic Strengths	Academic Weaknesses	High School GPA	High School Rank	SAT Scores
HIP1	math, chemistry	physics	3.5	?	≈1000
HIP2	french, english	english	>3.0	20/170	1130
RUP1	math, english	chem, applied sci	4.0	1/216	1220
RUP2	math, science	english	4.0	8/373	1020
RUP3	math, science	history	4.2	1/?	≈1200
RUP4	math	memorization	3.2	5/30	1030
RUP5	math, chem	english	3.7	≈20/500	1070
CAN1	math, science	none, memorization	4.3	2/≈390	1250
HIN2	math	french	3.3	?	1120
AFN3	math, science	none	3.4	≈40/370	1100
AFN4	math, english	none	>3.3	11/36	1060
CAN5	math, science	foreign lang, art	4.0	13/106	1090
HIN6	math	none	≈3.0	varies*	?
CAN7	english, science	expository writing	4.0	1/334	1290
CAN8	french, english	math	?	25/200	1220

Key:
AF = African American
AS = Asian American
CA = Caucasian
HI = Hispanic
RU = Rural
P = Persister
N = Non-Persisters

*Participant attended four different high schools; therefore, her class rank varies among the four schools.

APPENDIX 15A
REASONS FOR ENGINEERING CHOICE OF MAJOR: FREQUENCY COUNTS

Reasons	AF	AS	CA	HI	RU	N
accidental			1		1	
appreciation for envir			1	1		1
contribution to society						1
encouragement	2	1	1		1	2
exposure/hands-on exp	3		7	1	4	1
academic background			3			
influence of role model	1		5	1	3	
interest	1	1	1			
math/science ability	6	2	7		3	5
mechanical aptitude	1				1	
no other choices		1	1			1
original plans changed	1	3			1	1
parental pressure	1			1	1	4
personality					1	
practical/applied	2		3		1	3
process of elimination		1			2	1
received written info	1	1				
recruited/scholarship	1					
spatial ability			1			
structure of opportun*	4	1	3		1	6
test results	1					
uninformed	1				1	1

*The structure of opportunity includes opportunities to get a job after graduation, a variety of job opportunities due to being a broad field, and high salary potential.

APPENDIX 15B
REASONS FOR CHOICE OF ENGINEERING MAJOR:
SELECTED COMMENTS

<u>accidental</u>
I just fell into it. It just happened.

<u>appreciation for the environment</u>
Living in rural areas and other countries gave me an appreciation for the environment. I was always an environmental green peace person.

<u>contribution to society</u>
I wanted to do something where I could make a contribution to society.

<u>encouragement</u>
My teachers encouraged me because I was good in math and science. My brothers encouraged me because of the money potential.

<u>exposure/hands-on experience</u>
I attended an Engineering Awareness Program at Georgia Tech. I loved to help my father work on the car or fix stuff. I used to tinker with the iron and radio like take them apart and put them back together.

<u>high school background</u>
My choice of classes and life experiences led up to it. I took introduction to engineering, architectural drawing, and I learned how to use the computer by working with the school newspapers. I took an independent study my senior year and taught myself AutoCad.

<u>influence of role model</u>
My sister is a role model. We are the first in my family to go to college. My dad is a role model for what I don't want to be. My dad told me I should be an engineer.

<u>interest</u>
I always wanted to be an engineer. I wasn't good in math and science in middle school, but when I got to high school, I started enjoying it. People told me I was good at it, so I took an interest in engineering. I had an interest in it, maybe an influence from my father and brother.

<u>math and science ability</u>
Everyone said I was good in math and science. My dad put it into my head because I love math and science.

<u>mechanical aptitude</u>
I have an aptitude for mechanics. My brother had an aptitude for electronics. Where it comes from I don't know. My physics teacher told me I should do something with mechanics.

<u>no other choices</u>
I don't know what I would have done if I didn't go into engineering. There was no choice because of everything I had been doing up until that point.

original plans changed/failed
I was going to major in biology and go to medical school, but I changed my mind. My mind set wasn't to go to college, actually it was more on joining the Joffrey Ballet Company. I wanted to be a pediatrician, but I was rejected, and I'm still mad about it.

parental pressure
My mother made me go to an engineering high school and then engineering camp.

personality
I'm not a people person.

practical/applied
I wanted a major that didn't require a master's degree to get a job - that left engineering and accounting. My father instilled the idea of wanting to know how things work.

process of elimination
It was a process of elimination. I don't like biology. I don't like business. What's left?

received written information
I received letters from another college about their biomedical engineering program, and it sounded interesting. My stepmother always brought home these magazines about opportunities for minorities in engineering.

recruited/offered scholarship
It was primarily a financial decision. The school of engineering was offering a lot of scholarship money. I didn't want my mother to have to pay for it.

spatial ability
I took a test in high school and found out I have good spatial ability.

structure of opportunity
It's a broad field. You can do anything with it. Basically I wanted to make a lot of money. There was no money in teaching, and engineering pays well.

test results
I took a test in high school to see which professions I liked, and it turns out the scores put me in engineering.

uninformed
I didn't really think about it at all. I was uneducated about it. I really didn't have a clue what I was getting into.

APPENDIX 16
ROLE OF GUIDANCE COUNSELORS

<u>Positive</u>

My counselor was a great counselor. She suggested engineering. I was one of her favorites. [AFP4]

I had a really good guidance counselor in high school. He knew that I had a very strong mother who was right on top of things when it came to picking colleges. [CAP1]

I had an awesome guidance counselor. I could talk to him about anything. He was really helpful with applications and scholarships. [CAP4]

<u>Neutral</u>

Our guidance counselors just wanted everyone to go to college somewhere, major in something. They didn't really push one major over another. They were more into getting the numbers to apply to school, getting people accepted to school. [AFN3]

Their philosophy was pick a good school, then figure out what you want to do. [AFN3]

She helped with applications and scholarships and everything like that, but I don't know if she knew anything about engineering in general. [CAP6]

<u>Negative</u>

The top three people who graduated in my senior class were females, including me. When we would talk to him, he would basically tell us that Tech was hard and not to come crying to him if we don't do well. I always had the mentality that I could do it so I never really let him bother me. He really wasn't a good counselor. [AFP2]

You find that a lot of guidance counselors at high schools aren't encouraging black students to go into fields such as engineering and medicine and things like that. [AFP3]

My guidance counselor was a slouch. He did not do his job. As far as telling you what kind of engineering schools they had in your state or whatever, he had no clue. [AFP5]

My guidance counselor had his select few. I had really low SAT scores, and I was like well that shouldn't matter because I still had good grades. [AFP7]

I think if I would have asked him about it, I don't think he would have known much about engineering. I guess he would have tried, but I don't think I would have gotten much out of it. [ASP2]

The only guidance I got was from that standardized test. I really kind of went into engineering blindly. [CAP3]

She asked me what I thought I might want to do, and I said, "I don't know. I'm good in math, maybe something in the math field." And she told me, "there's nothing in the math field." But had she told me about engineering or something like that, I probably would have taken technical drawing and all those kinds of classes. [CAP5]

I remember they gave us this stupid career test. You fill out all this information and it tells you what you're geared to do. I think I was geared to be one of those people who paint billboards. That's as much as I remember from guidance in high school. [CAP8]

I can never remember talking to my guidance counselor about anything school-related. He was my softball coach the three years of high school, and he wasn't a very good coach either. [CAP8]

Actually my counselor was really, what do you call it? Not helpful at all. Counselors that really care for their students will say, "look at this, or read this book, and find out if you're interested." But I got nothing from her. [HIP2]

They looked down on me for coming to [this university]. I know they were thinking Redneck Tech. [RUP3]

My guidance counselor was a jerk basically. [RUP4]

APPENDIX 17
DEGREE OF CERTAINTY AND MAJOR CHANGES

Participant	Degree of Certainty	1st Major	2nd Major	3rd Major
AFP1	Uncertain	GE	ME	
AFP2	Very Certain	GE	ISE	
AFP3	Certain	US	ISE	
AFP4	Uncertain	GE	ChE	ISE
AFP5	Very Certain	GE	ISE	
AFP6	Fairly Certain	GE	ME	
AFP7	Uncertain	US	MSE	
AFP8	Neutral	GE	ISE	
AFP9	Neutral	US	ISE	
ASP1	Very Certain	GE	EE	ISE/STAT
ASP2	Uncertain	GE	ESM	
ASP3	Uncertain	US	CE	
ASP4	Certain	GE	EE (uncertain)	
CAP1	Very Certain	GE	DE	
CAP2	Uncertain	GE	ME	ISE
CAP3	Uncertain	GE	CE	
CAP4	Uncertain	GE	ChE	
CAP5	Uncertain	GE	ISE	
CAP6	Uncertain	GE	BSE	ISE
CAP7	Uncertain	GE	CE	
CAP8	Uncertain	GE	ISE	
HIP1	Uncertain	GE	MSE	
HIP2	Uncertain	GE	EE	
RUP1	Uncertain	GE	CE	
RUP2	Very Certain	GE	ESM	
RUP3	Certain	GE	BSE/CE	
RUP4	Uncertain	GE	ChE	
RUP5	Certain	GE	ChE	
CAN1	Uncertain	GE	ANSC/Pre-Vet	
HIN2	Uncertain	GE	MATH	
AFN3	Uncertain	GE	ISE	MSCI
AFN4	Uncertain	GE	ISE	PSYC
CAN5	Certain	GE	ChE	CHEM
CAN6	Uncertain	GE	TA/BIOL	
CAN7	Uncertain	GE	LAR	
HIN8	Uncertain	US	BSE	ENSC

APPENDIX 18
CODES FOR EXPERIENCES WITH THE CLIMATE OF ENGINEERING

AFP1: weed out, adjustment, bad experience in EF, institutional fit, overwhelmed, ESM classes bad
AFP2: white males, isolation, bad experience in EF
AFP3: poor advising, faculty bias, tokenism, visibility
AFP4: bad experience in EF, group work ineffective, white males, peer bias
AFP5: bad experience in EF, faculty bias, different culture
AFP6: tokenism, bad experience in EF, isolation
AFP7: poor advising, peer bias, all nighters, weed out, ineffective teaching methods, different culture, faculty bias
AFP8: faculty bias, faculty warnings, level of difficulty exaggerated, females silent
AFP9: visibility, males talkative
ASP1: isolation, bad experience in EF, poor advising, weed out, peer bias
ASP2: out of control, intimidation
ASP3: poor performance, group work ineffective, unenjoyable, wanted to leave, adjustment, females silent, males talkative, homework challenging
ASP4: intimidated, unaggressive, isolation, follower, group work ineffective
CAP1: diversity, opportunities, goal and task oriented
CAP2: good experience in EF, discouragement, peer bias
CAP3: adjustment, lacked study habits, disliked curriculum
CAP4: visibility, vocal
CAP5: ESM courses bad
CAP6: bad experience in EF, bad first choice, weed out
CAP7: Fortran stupid, ESM courses bad, weed out, male staff bias
CAP8: confidence lowered, peer bias
HIP1: bad experience in EF, ESM courses bad
HIP2: bad experience in EF, isolation, faculty bias
RUP1: intimidation, poor foundation, adjustment
RUP2: bad experience in EF, mean faculty, institutional fit, hated dorms, poor performance
RUP3: poor foundation, multiple choice testing, peer bias
RUP4: bad experience in EF, picky professor, CAD useless
RUP5: professors' expectations unclear, no faculty support
CAN1: bad experience in EF, computer emphasis, no faculty support, intimidation, peer bias
HIN2: intimidation, girls drop out, honor code, isolation, faculty relate to males
AFN3: bad experience in EF, poor performance, isolation, adjustment, weed out, faculty bias
AFN4: bad experience in EF, adjustment, institutional fit, out of control
CAN5: faculty warnings, unfeeling, competitive, EF a joke, learning not fostered, too much pressure
HIN8: didn't fit in, poor advising, isolation, cold
CAN7: didn't fit mold, bad experience in EF, challenging
CAN8: uninterested, weed out, engineering roommate good

APPENDIX 19
CODES FOR BELIEFS ABOUT ROLES

AFP1: equality, flexibility
AFP2: balance
AFP3: androgyny, flexibility
AFP4: sharing, flexibility
AFP5: androgyny, individual responsibility
AFP6: women are strong, equality, sharing
AFP7: women are strong, flexibility, man should work, dual responsibilities
AFP8: prefers role reversal
AFP9: 50-50
ASP1: individuality, effective parenting, homemaking and career
ASP2: women can work; children need parent at home; children need guidance, time, commitment; modeling for children
ASP3: beliefs have changed with acculturation, equality
ASP4: equality, sharing, independence
CAP1: communication is key
CAP2: traditional, family is first
CAP3: equality, career is priority, ambition
CAP4: flexibility, androgyny
CAP5: dual roles, father should be involved with children
CAP6: dual roles, father should be involved with children
CAP7: dual roles, father should be involved with children
CAP8: balance, individuality
HIP1: feminist, bothered by traditional roles
HIP2: careers for women
RUP1: androgyny
RUP2: discrimination exists, inequality, need progress
RUP3: homemaker, matter of choice, flexibility
RUP4: dependence is risky
RUP5: economic necessity, equality, 50-50, sharing
CAN1: equality, androgyny, 50-50
HIN2: 50-50, androgyny, independence
AFN3: family is priority
AFN4: balance, sharing
CAN5: equality, parent at home
HIN6: missing data
CAN7: parent at home, androgyny
CAN8: missing data

APPENDIX 20

SELECTED NARRATIVES

Narrative One
A personal tradegy enables this Industrial Engineering student to overcome the obstacles she faces in her college experience.

Aqua grew up in Richmond, Virginia, the daughter of an accountant and teaching assistant. Her parents instilled the values of family, education, right and wrong, and belief in God in their three daughters. As a child, Aqua enjoyed playing with other children, running track, attending sports camps, and shopping with her mother. Her twin sister's life ended tragically in her senior year in high school when she was abducted and murdered. Aqua missed most of her senior year. This tragedy and Aqua's faith in God would later provide her with the ability to overcome any future obstacles she would encounter as an engineering student.

Aqua's older sister attended the University of Richmond and majored in spanish and international studies, with a minor in anthropology. She now works for a bank. Aqua's plans for a college major were more pragmatic. Since she didn't want to go to graduate school, Aqua's options included only those majors which would provide the opportunity to get a job after graduation. In her mind, the best two options were engineering and accounting. Since Aqua had strengths in mathematics and science in high school, her mother encouraged her to try engineering. Her model college preparatory high school had provided exposure to engineering through guest speakers every Wednesday, and she had attended mandatory summer school where she gained further exposure. Aqua's high school guidance counselor basically provided no help in her decision making process; she believes guidance counselors in general fail to encourage black students to pursue higher education and professional careers.

Although Aqua was certain about her major, she did have some doubts about the university's rural setting and primarily white student and faculty population. In actuality, it was a "culture shock." As a freshman in engineering, Aqua's advisor discouraged her from pursuing a major in the field, and negative faculty attitudes and tokenism in the classroom further contributed to a stressful first year. Although she was discouraged, her strong personality left her unaffected by the biased opinions of the faculty and motivated to continue. After her sophomore year, her maternal grandmother died and her mother became seriously ill. She dropped all her classes the week before Thanksgiving and went home. Overcoming hardships and tragedy weren't new to this young woman. She could overcome anything.

Although she got along very well with her roommate, a physical education major, the drastic difference in their work loads created some resentment. Networking with other black students, both on and off campus, helped Aqua learn to play the system and provided the support she needed to persist. Because Aqua is adaptable, determined, and mature, she also developed the time management and study skills required to be a successful engineering student. Unintimidated by faculty, she makes certain her instructors know her name.

An internship with a company in Richmond helped prepare Aqua for corporate America. Although she dealt with some racism and symbols of racism on her previous co-op job with a furniture manufacturer, she earned the reputation of being the best assistant her supervisor had ever had. After graduation, she plans to get a job and work toward certification as a safety specialist. Although she didn't divulge her personal plans at the time of the interview, she recently became engaged and plans to marry in the near future.

Narrative Two

Originally from Korea, a young woman who becomes an accomplished ballet dancer chooses engineering as a major for pragmatic reasons.

Lee was born and lived in Korea the first eight years of her life. Adopted by American parents, she then moved to a coastal city. At the time, neither of Lee's parents had completed high school though both later earned GEDs. Her mother eventually went back to school for her B.A. in English and now teaches school and works as a Technical Editor for the government. Her father had been in the Marines, and later became a private investigator and bondsman. Lee is an only child. As a young child, she was not into frills and traditionally feminine toys such as dolls; she preferred activity and always being on the go.

The two values stressed by Lee's parents were the importance of caring for your teeth and getting a good education. A student at the Governor's School for the Talented and Gifted, Lee became a very disciplined young woman. Following many hours of ballet practice after school, Lee often stayed up until the early morning hours to complete her homework and study. Although in retrospect, she realizes she was talented in mathematics, at the time she believed mathematics to be a weakness. In high school, her primary academic strength was English while her primary weakness was drafting. She graduated 7th in a class of 300 with a grade point average of 3.8.

Lee was certain she wanted to be an engineer, and engineering offered the promise of a good job and salary, and thus the ability to be financially independent and self-reliant. Although Lee was told by almost everyone that she was good in math and science, her guidance counselors actually told her college was not in her future. This gave her more motivation to prove them wrong. Originally she had planned to pursue a professional career with the Joffrey Ballet Company, but later changed her mind.

Lee's first choice for an engineering major was Electrical Engineering. She had interned in an Electrical Engineering Department at a local military facility. Unhappy with that major, Lee chose Industrial Engineering through a process of eliminating several other options. She later added Statistics as a double major after discovering an aptitude and appreciation for the highly quantitative aspect of her major - somewhat ironic for a young woman who doubted her mathematics abilities at one time.

The fact that Lee has persisted in her studies is somewhat amazing given her experiences. Although she is an assertive young woman who is not fearful of being vocal about her ideas, her ideas were sometimes ignored by her male peers. She has also experienced the effects of the higher expectations that people in general have for Asian students which might partially explain her choice, more often than not, to stay home and study while her peers were going out and having a good time. A network of other Asian students has been one source of support.

As a freshman in General Engineering, Lee received some bad advice from an advisor, thus leaving her with a bad taste for engineering. She later experienced an extremely biased Statistics professor who has continually given his advisees conflicting advice. A combination of resourcefulness and independence has enabled Lee to often seek out her own information and resolve the discrepancies in the information provided by some of h

After graduation this spring, Lee will work for a large consulting firm in Florida although she would eventually like to relocate to the West coast where there are opportunities for her and her fiance, a graduate student in Electrical Engineering. Although she has never been a person to go with the norm, Lee believes in a balance between a career and a personal life. There is no doubt this determined young woman who loves a challenge can realize that goal.

Narrative Three

A young Hispanic woman defies the traditional roles dicated by her culture and pursues a degree in Electrical Engineering.

Born in Guatemala, Lis moved to northern Virginia at the age of fourteen. Her father, a mechanic, dropped out of school in the 5th grade while her mother, a housekeeper, dropped out in the 6th grade. Her parents would later divorce and her mother would remarry her stepfather, a painter with a master's degree in business. The second child of her birth parents, she has two younger siblings, one boy and one girl, ages 10 and 11. Her older sister obtained an associate's degree in Social Work, but currently stays at home to care for her two small sons; she expects a third child in June. Lis resents her sister's husband, a very traditional Hispanic, because he refuses to help his wife with the house and the children.

Lis spent most of her childhood in the rural flatlands of Guatemala. She and her sister's favorite pasttime was spending time with her grandfather, a construction worker, on his construction sites. Convinced that her grandfather was an engineer, Lis helped him carry sand and complete small construction jobs. She also enjoyed taking apart and putting back together household appliances such as irons and typewriters, an aptitude and interest she believes she acquired from her father.

Although Lis graduated from high school with a 4.73 grade point average and an award for outstanding achievement, she received no encouragement from her guidance counselors and teachers to pursue a college education. For that reason, Lis believes strongly that girls should be encouraged to go to college and build a future for themselves. Despite strengths in French and English and struggles with algebra II and trigonometry, Lis decided to pursue her dream of an engineering degree. Her parents instilled a strong work ethnic and the value of following through and completing any task one had begun.

Lis began her engineering studies at a local community college for two primary reasons: discouragement from family and financial limitations. While she pursued her associate's degree, Lis worked to support herself. She also continued to deal with the discouragement from her extended Hispanic family. Impressed by her motivation and finally convinced that an education was in her daughter's best interests, her mother provided the financial means and encouragement for her to transfer to the university after four years of study at the community college.

With the idea that she was defying her traditional Hispanic culture by choosing a non-traditional route, Lis felt somewhat ackward in that choice and, at the same time, even more motivated to pursue it. She found the environment in Electrical Engineering to be isolating and horrible in that students of various ethnic groups had formed their own exclusive groups prior to her admittance to the department. She was often the last to be selected for group projects, and her peers were, on many occasions, later surprised when they realized she had earned the highest grade on the project.

Lis attributes her persistence to realizing her dream of being a first generation college graduate, to setting a good example for her younger brother and sister, and, most of all, to providing merit to her mother for all the sacrifices she made on her behalf. She attributes her success to her faith in God and the support of the Project Success program. Lis completed her degree in December 1996 and plans to pursue graduate school in Electrical Engineering.

Narrative Four

A high school valedictorian discovers that having perspective and learning some things the hard way has contributed to her success as a Chemical Engineering student

A high school valedictorian from Chesterfield County, Virginia with strong interests in mathematics and science, Lynn grew up in a close knit family who enjoyed spending time together. She and her younger brother, a sophomore majoring in management and political science at Virginia Tech, spent most of their time playing outdoors and participating in a myriad of sports. Although she "hated" Barbie dolls, she loved the Lone Ranger and Tonto, Spiderman, and Superman. When Lynn would experience frustration or lament that she was incapable of performing some activity, her father's comment "well, a boy could do it" would provide all the motivation she needed to succeed. She grew up to become a motivated, determined, and disciplined perfectionist who loves a challenge and often pressures herself to succeed.

Lynn's stellar performance in mathematics surprised her father, a personnel manager, who had graduated with a degree in industrial psychology and loathed mathematics himself. Her aptitude for and love of mathematics and science, particularly chemistry, provided opportunities to attend the Governor's School for Chemistry and participate in a Boy Scout sponsored Engineering Explorer Program at DuPont. These experiences set the stage for her major in Chemical Engineering. An "awesome" guidance counselor was very helpful in the application and scholarship process prior to her admission to Virginia Tech.

Fortunately Lynn's experiences in the Engineering Fundamentals program were positive, and she learned to play the academic game well. Although she graduated number one in her high school class, she realized she would be competing with "smarter people." She was also willing to make the commitment to work hard, manage her time, and sacrifice going out and having fun during the week. Her assertiveness and outgoing personality have enabled her to ask questions in class, interact with faculty both in the classroom and at social functions, and form study groups with her engineering peers. Lynn has also provided an outstanding role model and support for young women in engineering at the freshman level.

The opportunity to work as a cooperative education student in a manufacturing facility has provided Lynn with an understanding of production and manufacturing work and a glimpse into the lives of production workers. Although she worked long hours and swing shifts, she was often put in charge of an entire operation. This invaluable experience led to both a decision about what she doesn't want to do for the rest of her life and an appreciation for her education. While on the job, Lynn also had a formal grievance filed against her by an employee. While many people would perceive such an incident to be the end of the world, Lynn learned from her experience and gained an interest in dealing with the business/people side of engineering, including union and management issues. Her ability to see the humor in life and unpleasant situations is one of her many admirable characteristics. She attributes her faith in God as instrumental in giving her the perspective to deal with both her engineering studies and cooperative education experience.

The engineering profession may not see Lynn enter their ranks when she graduates next year. Her love of chemistry is leading her to comtemplate graduate school in forenic chemistry or toxicology in graduate school. Although she knows it will be another one of life's challenges, Lynn also plans to combine a career with a family. Challenge is nothing new to this young woman. She can do anything she puts her mind to doing.

Narrative Five
A valedictorian from a rural town in Southwest Virginia transfers to the university to study civil engineering after spending two years in the local community college.

Suzanne was born and lived in the same small rural town until her transfer to the university. An all-around gifted student with a 4.0 grade point average, she ranked number one out of her graduating class of 216 students. The only academic subject that really challenged Suzanne was chemistry. She excelled in mathematics, english, and physics. In fact, she attended Governor's School for Physics in Williamsburg during the summer before her senior year in high school. Her only sibling, a sister who is a senior at the same high school, plans to study physical therapy in college.

One cannot help feeling admiration for Suzanne. She is a sincere, mature, and insightful young woman who has a great deal of understanding for life and the hand often dealt to unfortunate individuals in society. This understanding came about, no doubt, due to the trials and tribulations of her own life. Suzanne's mother worked as a secretary until she married her father. Her father, employed as a welder for years, served in the Vietnam War, and years later was diagnosed with Post-Traumatic Stress Disorder. For a period of six years, he did odd jobs such as digging roots and fishing worms to support the family. They now live on disability. Although they struggled financially and emotionally for a long time, their situation improved tremendously after her father's diagnosis.

Because her family could not afford the requirements for extracurricular activities such as music, band, and sports, Suzanne's childhood preferences centered on reading, board games, playing with dolls, taking care of their numerous pets and animals, and watching romance movies with her mother. From the time she was a small child, her mother read to her constantly and supplied her with all the books she could read. Suzanne's energy and devotion to her academics paid off in the end; however, her mother and father discouraged her from thinking about college because they didn't want her to be disappointed if the financial situation prevented that opportunity. Strong-willed and stubborn, Suzanne became even more determined to pursue her education.

Although studying engineering had not been a dream for Suzanne, it seemed a logical choice given her strong math aptitude, and she knew she didn't want to be a teacher. During her junior and senior years of high school, she formed friendships with her male math and science classmates, many of whom had plans to attend the local community college and major in engineering. These friends became a significant influence on her choice. Although she had been accepted at the university, a mix-up with financial aid contributed to her decision to begin her studies at the community college instead.

While a community college student, Suzanne worked almost full-time at the local MacDonald's. A straight A student in high school, Suzanne began to earn Bs for the first time in her life. Although her confidence in her abilities dimenished somewhat, her faith allowed her to keep her priorities in perspective. While one disadvantage of the community college was a poor foundation in engineering basics, that experience, in combination with the job at MacDonald's, improved her communication skills. Formerly very introverted and reversed, Suzanne became more out-going in her interactions with other people.

Suzanne transferred to the university as a junior and began her studies in civil engineering. She had heard many horror stories about engineering prior to her arrival. In addition to this intimidation factor, some of the courses, particularly statics and deformable bodies, have been very challenging due to the poor foundation she received at the community college. Somewhat unsatisfied with her performance during the first semester, she was determined to improve the second semester. She has since maintained a B+ average, quite a feat given her trips to a nearby town each and every weekend to work at Sam's Club. She finds that her non-engineering instructors are more approachable and enthusiastic; however, her experiences in engineering have not been particularly negative. A preference for individual effort and a strong work ethic have resulted in some discomfort with group projects, and she hasn't had a great deal of interaction with her instructors or advisor. Suzanne actually dealt with more negativity and bias in the community college classroom. One of her math instructors was very intolerant of women in engineering; only those women who were able to prove themselves gained his respect. Suzanne was and is one of those women. She has proven herself beyond any doubt.

Following graduation in the summer of 1997, Suzanne's interest in transportation systems gives her hopes of working for a state highway department. She actually participated in a shadowing experience with the Department of Transportation over the winter break. One reason for her frequent trips to a nearby town is her fiance whom she met on the job. He is a business major at another college with an interest in working in wildlife management. They plan to marry in the near future.

Narrative 6

A talented and comical young woman with creative and musical ability leaves engineering to pursue her first love - theatre and music.

Wendy's choice to major in engineering seemed logical for someone who had grown up in a family of "engineers named John" in Maryland. Her brother John, who completed his degree in Mechanical Engineering last year, was instrumental in her decision to attend Virginia Tech. Even Wendy's mother had graduated with a technical degree and worked as a cryptanalyst for the government prior to dropping out of the workforce to raise her family. Wendy's stellar academic performance in the public school system and her reputation as an "environmental green peace person" were also indicative of a bright and promising career as an engineer. Graduating number one (along with thirteen other valedictorians) among a class of 334, Wendy and her fellow valedictorians pushed each other and competed to succeed academically. Although expository writing was her only real academic weakness, Wendy preferred English and science, including biology and chemistry. To fulfill her parents' "math and science contingent," Wendy would later add biology as a second major.

A college education was always a given as far as Wendy's parents were concerned. Although her parents always supported her individuality, they both maintained that a mathematics or science degree was the key to the future, both professionally and financially. What they did not realize was that all of Wendy's musical and creative "hobbies" - piano, violin, jazz, tap, violin, ballet - during childhood would lead to her inability to put her creative energy aside to pursue a more practical major.

The freshman year experience in engineering was very frustrating and stiffling for Wendy. She had no idea what she was getting herself into, and she experienced the "worst imaginable" year. The rules on how to do things, the computer requirement, and visualizing 3-D objects and isometrics was especially difficult for Wendy. She felt embarrassed, intimidated, and scared, and she thought it was obvious to the whole world that she didn't fit into the "cookie cutter mold" of engineering. She compared her experience to "trying to fit a square into a round hole." At the time she was also auditioning for a play, and the world of performance was pulling at her. Her decision to leave engineering and major in theatre arts was the toughest decision she ever made; however, coming to terms with the change resulted in the weight of the world being lifted from her shoulders.

Wendy has no regrets about the time she spent in engineering. It helped her discover her own identity, the Theatre Arts Department, the New Virginians, and her voice teacher. After graduation, Wendy's dual career goals include "auditioning, auditioning, auditioning" as an actress for musical theatre and working for either a lab, hospital, zoo, or veterinary's office to provide subsistence. Some also plans to have a family one day, and although she doesn't like the idea of gender-specific roles, she does believe one of the parents should be a home with the children. If it weren't for her mother being home during her childhood, Wendy believes she wouldn't be where she is today.

VITA

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EDUCATION

Ph.D., 1997, Counselor Education, Cognate in Family and Child Development
Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA

M.A., 1988, Counselor Education, Virginia Tech., Blacksburg, VA

B.S., 1980, Sociology/Minor in Psychology, Concentration in Criminology, Virginia Tech, Blacksburg, VA

PROFESSIONAL EXPERIENCE

Academic/Career Counselor, Industrial and Systems Engineering, Virginia Tech, Blacksburg, VA, November 1989 - present

GED Test Examiner, Montgomery County Public Schools, Christiansburg, VA,
May 1991 - present

Counseling Intern, School & Family Counseling Center, Pulaski County High School, Dublin, VA, January - June 1996

Secretary Senior, Department of Statistics, Virginia Tech, Blacksburg, VA, August 1980 - October 1989

Counseling Intern, West Salem Elementary School, Salem, VA, August - December 1988

Intern, Probation and Parole, Department of Corrections, Roanoke, VA, September 1979 - March 1980

PROFESSIONAL DEVELOPMENT

Affiliations
President-Elect, Chi Sigma Iota Counseling Academic and Professional Honor Society International, Tau Eta Kappa Chapter, Virginia Tech, Blacksburg, VA, 1996-97
Virginia Tech Staff Senate, 1993-95
Virginia Tech Equal Opportunity/Affirmative Action Committee, 1993-95
Virginia Counselors Assocation (VCA)
American Counseling Association (ACA)
National Academic Advising Association (NACADA)

Awards/Honors
Robert M. Hoppock Memorial Scholarship, 1995-96
Dean's Award for Exemplary Service, College of Engineering, Virginia Tech, 1995
Virginia Tech Award for Excellence in Career Advising, 1994

Grants
Perceptions of Sexual Assault Among the Corps of Cadets (with Alma Rowland), funded by the Office of the Dean of Students, Virginia Tech, 1996-97

Presentations/Publications
Power and Exploitation in Hierarchical Organizations (with Alma Rowland), article in process, April 1997
Becoming a Teaching and Advising Olympian (with Ron Kander), Virginia Tech, September 1996
Holistic Advising: Merging Academic Advising, Career Advising, and Personal Counseling (with Sarah Wheeler), NACADA Regional Conference, Lancaster, PA, April 1995
TQM and Advising (with Sarah Wheeler), NACADA Regional Conference, Norfolk, VA, April 1994

Training/Seminars
Effective Teaching Workshop, Virginia Tech, April 1997
WEPAN Eastern Regional Training Seminar, Hampton, VA, December 1996
Family Mediation & Conflict Resolution, Virginia Tech, October 1996
Solution-Focused Brief Counseling, Wytheville, VA, April 1996
Counseling ADHD Adults, Virginia Tech, October 1995
New Directions in Family Therapy, Radford University, April 1995
SUCCEED Gender Sensitivity Training, North Carolina State University, November 1994
W. Edwards Deming Quality and Productivity Seminar, Charlotte, NC, October 1992

Volunteer Experience
New River Valley Hospice, Christiansburg, VA, May 1993 - present (inactive)
Women's Resource Center, Radford, VA, May 1989 - present (inactive)
RAFT Community Crisis Center, Blacksburg, VA, 1980 - 1982