How young women come to know the engineering profession

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How young women come to know the engineering profession

by

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A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Education

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This is to certify that the doctoral dissertation of

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has met the dissertation requirements of Iowa State University

Signature was redacted for privacy.

Major Professor

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For the Major Program
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ABSTRACT

As the United States transitions to a knowledge economy, information age, and unprecedented warfare, a diverse and technologically literate workforce is essential. Likewise, the contributions of women to science, engineering, and technology professions are vital, yet the number of young women considering these historically male-dominated professions remain at unacceptably low levels. The public and private sectors have invested millions of dollars since the 1980s to remove barriers and encourage and support women in the sciences and technological fields. Little or no advancement has been made in the representation of women in the technical field of engineering since the late 1980s (American Society for Engineering Education, 2001).

Still, employment prospects for women have increased dramatically in the late 20th century. Yet, in the engineering profession, a profession that holds promise and opportunity for one to positively impact society—the lack of women in the field seems baffling. Studies suggest the lack of academic preparation (in mathematics and the sciences, in particular) is not a feasible explanation for the low numbers of young women interested in majoring in engineering upon graduation from high school (ACT, 2003; Iowa Department of Education, 2002; National Center for Education Statistics, 2000).

This study, via a participatory action research methodology [academic researcher and adolescent females], documents the career exploration journey and analyzes how young women (10th-grade girls) came to know the technical profession of engineering. The study analyzed young women’s career exploration approach, the influences that dominated their
sense of the profession, and their views and feelings about the career option upon the
closure of the exploration experience.

Experiential learning themes dominated the exploration approach, while perceptions
of otherness and gendering quickly developed as the young women “came to know”
engineering. The extensive and opportunistic nature of the profession was appealing,
however, the messages were alienating. Personal choices of the young women evolved
around lifestyle and fit. The engineering profession they “came to know” had little in
common with their world or future.
CHAPTER 1. INTRODUCTION

The United States’ economy, social advancements, and national security depend more than ever on the talents of skilled, high-tech workers. At the onset of the 21st century, U.S. jobs are growing most rapidly in areas that require knowledge and skills stemming from a strong grasp of science, mathematics, engineering, and technology (BLS, 1999; 2003). Business and government leaders are predicting a critical shortage in skilled workers, which could threaten the United States’ ability to compete in the global marketplace (Larson, Rogstad, & Smith, 1998; AAES, 2000; CAWMSET, 2001; NCRW, 2001; NSF, 1997; U.S. Department of Education, 2000). According to the U.S. Bureau of Labor Statistics [BLS] Employment Projections, job opportunities in engineering for 2000-2010 continue to grow with varying rates by specialty (BLS, 2003). Employment in professional specialty occupations (which include engineering fields) is projected to increase 26%, or by 6.9 million (BLS, 2003) by 2010.

The Bureau of Labor Statistics reports the number of bachelor’s degrees awarded in engineering began declining in 1987 and this level was maintained through the 1990s with only slight increases in 2000 and 2001 (see also ASEE, 2002). The BLS report (2003) projects that the total number of graduates from engineering programs is not expected to increase significantly between 2000-2010. Pre-collegiate trends in course study selection reinforce the flat growth perspective. American College Testing (ACT) and Scholastic Aptitude Testing (SAT) suggest declines in engineering interest levels (ACT, 2003).

Leaders in government, business, and industry believe the United States, as a leader in the advancement of technology, is in jeopardy of maintaining its prominence due to the
lack of a skilled and trained workforce. Acknowledging this situation, a recent National
Science Foundation (NSF) directorate for engineering entitled *The Long View* (1997)
proclaims the federal government's vested interest in the engineering workforce by stating:

Besides the democratic imperative of equity, recent demographic trends
suggest that engineering will not have the appropriately educated human
resources to meet crucial societal needs, as well as help the Nation remain
globally competitive, unless talented persons from such groups [women,
ethnic minorities, & persons with disabilities] are vigorously recruited, fully
educated, and given equal access to career opportunities. (NSF, 1997, p. 10)

Another federally mandated report from the Commission on the Advancement of
Women and Minorities in Science, Engineering and Technology [CAWSET] entitled, *Land
of Plenty: Diversity as America's Competitive Edge in Science, Engineering, and
Technology*, states “Until our science and technological workplace reflects our diversity, we
are not working to our potential as a nation” (CAWSET, 2000, p.1). The report goes on to
stress: “…it is time to move beyond a mere description of the problem toward
implementation of a national agenda…. It is also time to establish clear lines of responsibility
and to define effective accountability” (p. 1).

A comprehensive report issued by the National Council for Research on Women
(NCRW) entitled *Balancing the Equation—Where are Women and Girls in Sciences,
Engineering and Technology?* (2001) echoes similar proclamations in addition to identifying
motivations for a diverse technological workforce. Themes from the report include the value
of diversity in thought stating that: “People who come to science from different locations, be
it because of gender or race or class, tend to ask different questions rather than accepting the
mainstream assumption” (p. 103); and “There are a lot of very sane people who are
beginning to understand that if technology and science are going to go forward with wild
creativity, we need the brilliance of more than a narrow group of people” (p. 108). Another theme involves commentary on research and development. “The future of our planet is going to be tremendously affected by technology. An important way to have an impact on people is to have an impact on technology” (p. 107). Finally, Shirley Malcom, professor and affiliate of American Association for the Advancement of Science, National Science Board and the President’s Committee of Advisors on Science and Technology comments on women and scientific and technological leadership. She is quoted as saying, “You’ve got to be in the boat in order to steer it” (Malcom, 2001, as cited in NCRW, 2001, p. 109). Women need to have a presence in technological fields in order to influence and guide the creation of the future.

These declarations outline a central issue of the engineering workforce crisis — the need for the employment pool to reflect the composition of society — diverse in gender and ethnicity. The work of a 21st century engineer includes tasks and responsibilities that require creativity, teamwork, communication, and problem solving skills (ABET, 2000; CAWMSF, 2001; Lipp, 1999; NSF, 1997). The U.S. economy is now global, women are considered primary consumers in many households, and ethnic minority populations are surpassing majority populations in many parts of the country. As a result, the engineering profession cannot advance by providing goods and services generated by the perspectives of a homogeneous group – Caucasian males. The collaboration of “different” thinkers is necessary to generate bright ideas as well as provide an intuitive and intimate understanding of how people in our multicultural society work, are influenced, and contemplate decisions. As stated in the aforementioned reports, business and industry executives believe they will compromise their prominence and existence if they do not incorporate divergent ideas and perspectives from a variety of people in the creation and delivery of goods and services
needed by a diverse society. They are very vocal about their need for not only a supply of
talented engineers, but also a workforce that is diversified (AAES, 2000; CAWMSET, 2001;

Unfortunately, when assessing the supply of new workers and the career aspirations
of high-school students, and females in particular, career interests do not fit the employment
projections in computer and technology jobs (including engineering). Of the half million
sophomores who took a national education assessment, PLAN — a standardized test of
educational development, which measures achievement and collects information about
educational plans and career interests — 28% of the females and 31% of the males indicated
an interest in the science-related career fields (ACT, 2000). Yet only 3% of the females and
16% of the males were interested in engineering (ACT Research, 1999). Given that the
employment demand in computer/technology-related fields (engineering) is expected to
increase by 21-35% by 2010 (BLS, 2003) and the number of females interested in
engineering continues to diminish (ACT, 2003), the need to further develop a pipeline of
interested and capable young women who will become the engineers of the future is not only
a challenge but also a necessity.

The need to appeal to young women who will become tomorrow's engineers is
widely acknowledged. Research in areas related to workforce issues and gender equity has
received more attention in recent years. As stated above, demographic data and interest levels
of females in technical fields are not encouraging; however, a review of youth culture and
feminist studies suggests a shift in adolescent perspectives and outlooks in regard to young
women's professional ambitions and contributions to society (Driscoll, 2002; Howe &
Strauss, 2000; The Lawlor Group, 2001; Lesko, 2001; Schneider & Stevenson, 1999;
Social science research also has made significant contributions to understanding the factors that work against young women when considering a non-traditional field like engineering (Barton, 1998; Belenky, Clinchy, Goldberger, & Tarule, 1996, 1997; Brown & Gilligan, 1992; Eisenhart & Finkel, 1998; Gilligan, 1993; Gilligan, Lyons, & Hanmer, 1990; Holland & Eisenhart, 1990; Young, 2000).

Since only 19% of the female population enrolls in non-traditional majors like engineering (NSF, 2000), a supposition could be that strategies to attract young women to a traditionally male profession are uniquely different. A multi-faceted, multi-dimensional, truth-seeking investigation of how young women learn about the engineering profession would benefit from knowledge produced as a result of modern psychology and social science. As previously stated, Gilligan (1993), Belenky (1996; 1997), Harding (1986; 1991), Hartsock (1998), Keller (1996; 1999; 2001a; 2001b), Smith (1987), Eisenhart (1990; 1998), Driscoll, (2002) and others have studied the way young women view the world, what they value, what is important to them, and how they “come to know” their world. These scholars have convincingly argued women’s viewpoints can be different among women themselves and hegemonic between genders. Therefore, related to this study, it is necessary to recognize this pluralistic view. Young women have unique career needs, interests, and perspectives in regard to the engineering profession, its value, purpose, and benefits. Understanding these perspectives and the complexities would begin to establish a knowledge base that currently does not exist.
Overview of the Study

Why are young women not considering engineering as a major in college? Women represent more than 50 percent of college undergraduates; however, the number of women majoring in engineering the past 15 years has remained unchanged (BLS, 2003). Why is this so? As a college admissions officer and K-12 outreach professional, I was fascinated by this phenomenon. Presumably, opportunities were plentiful and the nature of engineering work had changed (Lipp, 1999; McIlwee & Robinson, 1992). Contextualized, authentic data needed to be collected, originating in locations that only young women themselves could identify.

I began this investigative journey by conducting a preliminary study. This small-scale case study (two participants) revealed a lack of career awareness and information for 12th grade women who had solid aptitudes and a variety of extracurricular experiences in math and science. The young women interviewed in the preliminary study were attending an extensive science and technology summer program at a land grant university in the Midwest. Through the interviews, they expressed frustration when searching for information and answers about careers in engineering. They indicated that the information, specifically learning about what engineering is and what engineers really do, was difficult to find. For example, one of the girls associated her understanding of engineering with imagery of long math problems and working in a cubicle with a computer and calculator. The young women told me their mothers were the individuals who provided the most support and guidance through their career exploration journeys; however, neither mother knew about engineering. When the young women sought guidance and information about the profession, both mothers could only suggest sources for more information.
The dated image of engineering coupled with the fact that women constitute a limited, and even declining pool of prospective engineering students—albeit, their academic preparation and performance is superior to their male counterparts (ACT, 2003; U.S. Department of Education, 2000)—was troublesome. I wondered why capable women were not considering, nor were seemingly knowledgeable about a profession whose employment demand would exceed most occupations in the early decades of the 21st century. As a result of the preliminary study, I focused my inquiry on how young women explore high technology, male dominated [engineering] careers, and the perceptions that result from the exploration experience.

To this end, two groups of young women were identified who were beginning to think seriously about their future careers, who were not pre-disposed to the engineering profession by a family member or family friend, and who had average to above average grades. Together, the research participants and I (the researcher) set out, as co-researchers, to explore the engineering career field. The data collection started at an Engineering Career Expo held on the researcher’s university campus. At this event [data collection site] all participants’ tape-recorded their interviews with company representatives as well as their own personal comments and observations. Following the Expo, the participants expressed great interest in getting “more specific” information by visiting “on site” a company that was represented at the career fair to learn more about the engineering profession. They specifically wanted to spend more “one-on-one time” with female engineers to learn more about what they do and to job shadow them for a day. Together we visited engineering companies and job shadowed engineers.
We also used the Internet to explore the career field. As the researcher, I wrote an academic account of the research study that included checking with the participants. The participants completed journal assignments throughout the study and a reflection paper at the end of the data collection.

A detailed, descriptive account of the study is provided in Chapter 4.

**Organization of this Dissertation**

This dissertation is divided into six chapters. The following is a summary of each chapter.

Chapter 1 contains the research problem and provides: (a) background of the problem, (b) statement of the problem, (c) purpose of the study, (d) research questions, (e) importance of the study, (f) definition of terms, and (g) scope and limitations of the study.

Chapter 2 provides a review of current and foundational literature, including the following: (a) an examination of youth culture and girls' lives, (b) a comparison of Girls' realities and Math and Science careers, (d) women's science, and (e) a critique of science from feminist perspectives.

Chapter 3 provides the methodology literature review including: (a) critical ethnography, (b) feminist standpoint theory, and (c) adolescent career development theory. Research design, methods and data collection techniques are presented which include and reflect findings from the preliminary study and existing studies. Data analysis methodology, including rigor and trustworthiness, complete chapter three.
Chapter 4 provides a detailed description of the research approach, design and data collection methods. My background and experience as the researcher is provided in addition to a discussion on researcher reflexivity and bias.

Chapter 5 includes data analysis based on data collected from data collection sites and documents [journals, reflective essays, etc.] and provides an interpretation of the analysis. Chapter 6 summarizes the conclusions and outlines the recommendations for future action.

**Purpose of the Study**

The study sought to create a means for informing and envisioning new perspectives on how the [adolescent] “other” knows and understands the historically male-dominated field of engineering. To this end, feminist epistemology was employed as a means to detect and identify voices absent in career exploration in non-traditional fields like engineering. Ultimately, I hope the knowledge gained will be enlightening to those committed to diversifying the engineering profession. I hope the research methods and methodological framework this study employs will inspire further study with the purpose of identify new ways of reconstructing social structures to establish a comfortable and meaningfully productive space for women to consider professional lives in the engineering workforce.

Through this research, I sought to provide an insight to the thoughts, ideas, and interpretations of young women exploring the engineering profession. I hope the approach and findings impart a need for, and relevancy of, feminist thought within the engineering domain including the utilization of a feminist theoretical framework to inform policy and organizational communication. I expect this study will add to a limited, although, emerging body of knowledge and scholarly study related to female adolescent career aspirations in
engineering careers. Further, I hope that feminist methodology can be recognized as a respected and invaluable tool for creating new knowledge and perspective in a site which was once void of difference.

Topics the study explores included: What are the ways in which meaning and perspectives are gendered? What meanings and perspectives does engineering information create and convey? Is there correspondence and/or disjunction between the portrayal of engineering in college recruiting and career exploration communications? What piques a young women’s interest when researching careers or jobs? What are the sources of good information?

Research Questions

The research questions addressed three primary areas and serve to guide the study:

1. How do young women approach researching and learning about a non-traditional career field like engineering? — What is important to be known? What questions need to be answered? Where is the best information?

2. What do you see/hear? — What are the communicative underpinnings that influence young women’s images and perceptions which guide the decision-making process when considering non-traditional fields like engineering?

3. What is appealing or unappealing about a profession like engineering? — Do young women perceive cultural barriers or challenges? What opportunities do they envision?

Statement of the Problem

In this study, I intended to explore how young women come to know engineering by documenting their career exploration journey including an analysis of messages and language
they hear and see. The existence of studies that specifically examine the perceptions of young women when considering non-traditional career choices like engineering is limited. However, there is literature that examines: the social and psychological aspects of non-traditional career consideration specific to young women; young women’s experiences in formal and informal education that influence their perceptions and attitudes of scientific work; modern day feminism and how young women negotiate and make sense of their world; youth culture and professional ambitions; and why so few women are becoming scientists and mathematicians, as well as why women persist or leave the scientific disciplines.

This study fills a gap in career exploration and vocational preference research. It focuses on 10th grade young women as they explore the non-traditional field of engineering. Adolescents in 10th grade typically enter the career development phase when their interests in exploring careers heighten and their vocational preferences “crystallize” (Jordaan, 1963). The study is unique because the purpose is to capture the viewpoints and perceptions young women have in regard to engineering as they learn about it and how their contextual understanding develops.

The importance of this scholarship also arises from the fact that youth, in general, and women, specifically, have been a population whose authentic voice has been absent in formal research (Belenky et al., 1986; Collins, 1986; Denzin & Lincoln, 1998; Gilligan, 1982, 1993; Smith, 1987). Additionally, Gilligan’s landmark study in the 1980s demonstrated how the inclusion of women changes the paradigm of human psychology, realizing the need and importance of relationship and connectedness. Even critics of Gilligan’s work—those who advocate for respect and space for the ethic of relationship and caring—reinforce the need for adolescent feminist epistemological scholarship. Hearing, being cognizant, understanding,
and responding to the differences of voice, needs and values are paramount in a "male-centric" (NCRW, 2001, p. 91) profession like engineering. This is especially significant when there is immense pressure to diversify the employment ranks. Given the fact that the number of young women considering engineering as a career option continues to diminish, and that the private and public sectors are clamoring to reverse this trend, I believe it is important to examine and consider what young women are seeing and hearing as they contemplate this career option.

**Limitations of the Study**

This research is about perceptions. Communication elements influence perceptions, which ultimately frames how the participants come to know or learn about the engineering profession. This communication domain of research, in essence, constitutes media analysis—a familiar market research practice. However, market research is not the focus of this study. While it is necessary to acknowledge marketing as a persuasive discipline, which involves perceptions that encompass social, educational, and personal experiences, it is my desire to down play the media analysis aspect of "coming to know." It was my intent to focus instead on the exploration process, the general influences that dominate the young women’s sense of the profession, and their subsequent sentiments in regard to what they have “come to know.”

In regard to media and marketing influences including the biases and understandings that develop from these media sources, I chose to accept these influences as typical. When identifying participants for the study, I sought only to control for specific experiences via criterion-based sampling. The filtering conducted by the teachers and administrators prior to
the criterion-based sampling also controlled for preconceived notions and attitudes about engineering career options.

When selecting participants for the study, I selected an ethnically diverse group that included young women from an urban community in the Midwest and a group from a rural community. The notion of diverse ethnic backgrounds will be important to the value and the trustworthiness of the study.

Additionally, the number of participants was limited. At the conclusion of the data collection phase of the study six participants were still actively involved. A group this size is indicative of ethnographic studies, which tend to strive for greater insight to its participants points of view and a deeper understanding of the phenomena studied. Data gathered from participants in an ethnographic study are also “heavy” contextually, and these contextually rich data are ideal for analyzing and justifying findings. In the end, this study tells a story from the perspectives of six 10th grade young women (two discontinued participating in the study). Therefore, the findings from this study cannot be generalized to the entire U.S. population.

Finally, this study did not center on formal educational settings, the educational process, the influence of educators or curricula, or gender equity. Additionally, this study did not address the academic preparedness of young women in math and the science, other than pointing out that math and science scores have improved in the last decade with male and female students completing similar college preparatory curricula and receiving similar, and in some categories, higher grades and test scores (NCES, 2000a; Iowa Department of Education, 2001; ACT 2003). Instead, this study focuses on the career exploration process
and information that serves to influence the perspectives young women develop when learning about the engineering profession.

Definitions

There are a number of terms that call for descriptive meaning due to the significance they carry in the study. Frequently used, and sometimes, interchangeable terms in this study are “young women,” “girls,” “feminine adolescents” (Driscoll, 2002), and “participants.” Typically, the term “girl” is used for females in elementary and middle school. However, when discussing this terminology with the participants in the study, the young women often referred to one another as “girls,” but upon discussion, thought “young women” would also be acceptable. In educational and research circles, the term “young women” specifies females between the ages of 14–19.

Catherine Driscoll (2002), in her work on girls, feminine adolescence and culture, and Nancy Lesko (2001), in a similar late-post modern study of adolescent females, refer to this population as individuals “defined by puberty, chronological age or specific behaviors or identities” (Driscoll, 2002, p. 6), and individuals in “transition or in process relative to dominant ideas of Womanhood” (p. 6). I adopted Driscoll’s (2002) definitions of both “feminine adolescence” and “feminist” as categories for organizing knowledge about modern women. However, some older studies use the term women when discussing high school age females. Additionally, the term “participants” is used to denote the young women participating in the study. Participant, respondent, or informant, is to qualitative researchers like subject or sampling unit is to quantitative researchers.
In this study, I used the term feminism in a general sense to mean equality between sexes, including its pluralistic perspective. While feminism is often associated with women's issues, in this study and generally, Feminism, with a capitol "F", represents a political movement for social change. Feminism with a small "f" generally denotes a status of "other" (Lerner, 1977) as opposed to a dominant group. Stated differently, feminism seeks to be "inclusive" while recognizing and honoring difference—the essence of this study.

The words science, mathematics, and technology were used interchangeably when discussing topics or experiences in the scientific or technical domains. In part, this is because science is often viewed as a universal disciplinary term encompassing mathematics and technology content. Similarly, engineering is the application of science, mathematics, and technology; therefore, it too can be an inclusive term. Occasionally, the term "academy" is used referring to leadership and the decision-making body of the engineering profession.

Terminology that underpins this study included the terms problematic, standpoint, epistemology, location, and agency. I have adopted Canadian sociologist Dorothy Smith's definition of problematic and Patricia Hill Collins' (2000) definition of standpoint. Smith (1987), in her book, *The everyday world as problematic*, characterizes the concept in sociological terms directing "attention to a possible set of questions that may not have been posed...but are 'latent' or obscured in the actualities of the experienced world" (p. 91). In the contemporary world of female adolescents, problematics abound—due to uncertain contemporary times and a lack of voice.

Smith (1987) and Collins (1986) describe standpoint as a means to situate women's life experiences that are not captured in existing research. Standpoint does not mean all women "share similar positions or perspectives, but rather insists on the importance of
following the implications of women's (and others') various locations in socially organized activities" (p. 60). Further, Sandra Harding (1986; 1991) juxtaposes feminist standpoint theory and Western thought or science and problematizes the notion of objectivity.

Epistemology is also a term frequently used. Epistemology is "the study of knowledge and justification" (Schwandt, 2001, p. 71) — a term used to describe how the world is viewed and the relationship between knowing and being. Harding advocates standpoint epistemology as a means to produce stronger objectivity and generally more useful knowledge (Harding, 1986; 1991).

Location refers to the contextualized position of one's lived experience or experiences as they occur. Consequently, location is not static, but encompasses distinguishable characteristics or features. It also honors voice and perspective—it represents the individual. Agency is another term that signifies position. It "signals the capacity of individuals to perceive their situations, reason about them, consciously monitor their action, [and] form motives" (Schwandt, 2001, p. 4).

While not a dominant perspective at the onset of the study, it is important to define the cultural phenomenon of postmodern or postmodernism, and late modernism. Postmodern is a common, descriptive or theoretical term used in sociology, anthropology, education, and women's studies. It is also common in qualitative research circles and among feminist epistemologies. While an 'agreed upon' definition is still debated among scholars, I draw upon explanations provided by Schwandt (2001) and Lesko (2001). "Broadly conceived, postmodernism is an attitude toward the social world at the current stage of its historical development ... it is radically interdisciplinary in character and rejects conventional styles of academic discourse" (Schwandt, 2001, p. 201).
Postmodern perspective endorses “heterogeneity, difference, fragmentation” (Schwandt, 2001, p. 202), which is why it is closely related to feminist epistemologies, which embrace unique, distinctive, idiosyncratic, and individualistic knowing. In sociohistorical terms, modernism precedes postmodernism. It is a stance that in order to know and understand reality, it should be turned “on its head,” so to speak. What influences true reality is different than the “human-centered” [Enlightenment] influences of the past; thus, complexities abound.

Lesko’s (2001) work involving the cultural construction of adolescence is of the postmodern genre and is influenced by Foucaultian thought. This lens promotes the freedom to view knowledge or reality from a multitude of perspectives rather than “objectify all social life in order to explain how events really happened” (p. 9). Rather than studying children or adolescents, a Foucaultian and postmodern perspective studies childhood or adolescence in terms of “space and time of being” a child or adolescent. The perspective is not a point in time or a linear progression or historic roots, but rather is kaleidoscopic in nature.

When discussing feminine adolescence and youth culture in the context of cultural theory, Driscoll (2002) uses the term late modernity or late modern. This terminology denotes a time period that spans the late nineteenth century to early twenty-first centuries. This period is also marked by mass commodity production. The Modern period, as opposed to the classical period, is thought to begin with the arrival of the Enlightenment. This was a time in Western history when the focus of knowing began to originate in “the person” (p. 2). Driscoll (2002) suggests that “popular culture” in late modernity has always been equally if not more concerned with debating the forms and functions of feminine as compared to
masculine adolescence. Throughout the interpretive sections of this dissertation, these terms are used.

Scope of the Study

The focus of the proposed study was narrowed to examining specific elements—the career exploration journey and the resulting perceptions—that contextualize the engineering career field and provide meaning when young women explore engineering as a career option. This ethnographic study utilizes the findings of a pilot study and employs participatory action research methodology to draw data from six young women from one rural and one suburban community in the second semester of their 10th grade year.

Foreshadowed Issues and Importance of the Study

Drawing upon the perceptions and attitudes of modern youth culture and utilizing feminist theory, which by its nature is a critical framework, I expect the findings will render a traditional engineering image anchored by masculine nuances and traditional [Western] values of power and privilege. However, it is not known how or whether this gendered depiction is one that influences modern-day, or perhaps postmodern, young women. In terms of research methodology, at the onset of the study I was uncertain about the effectiveness and influence of a participatory action research approach to address the aforementioned research questions. As the findings reveal, this methodology was very suitable in “coming to know” how young women explore, and ultimately, view the engineering profession.

Traditional explanations for the shortage of women in engineering include lack of interest, lack of motivation, and inadequate preparation. As a result, educational communities, public entities, and private entities (for example, federal government agencies
including the National Science Foundation, American Association for the Advancement of Science, American Association of University Women, Girl Scouts, and business and industry) have worked in various ways to address issues embedded in these traditional explanations. This research provides a different perspective—a perspective experienced, felt, viewed, and told by young women themselves. This study examines how these young women interpret and perceive what it means to be an engineer. Understanding the meaning and perspectives of the young women should be of value to those interested in increasing the representation of young women in male-dominated career fields. Potential contributions include the development of improved, effective, and influential career communications, outreach programs, recruiting strategies, and discourse with professionals, leadership, and management.

I believe the findings from this study will create an impetus for dialogue and change. Through the authentic commentary of the participants, this research will provide a deeper and richer understanding of the gendered—and possibly, more broadly, contemporary youth culture—perspectives of the engineering profession including a patriarchal orientation and outdated core values. The findings of this study should be considered important information for policy makers, educators, career guidance professionals, engineers and professional engineering societies, as well as other influential adults, parents, and corporate leadership and human resource personnel.
CHAPTER 2. LITERATURE REVIEW

The review of the literature provides valuable insight to girls' lives and potential career decision-making factors. It is organized in two sections. The first section includes content theory that examines: (a) youth culture and girls' lives; (b) comparison of girls' realities and how math and science careers have been represented and received; (d) women's science; and (e) critique of science from a feminist perspective.

Section two includes methodological theory that examines the lenses used to analyze the phenomenon of how young women come to know engineering. These methodological lenses include feminist theoretical perspectives, specifically, utilizing standpoint theory, and career exploration theory. The chapter concludes by highlighting the contexts and theoretical models used in this qualitative study.

A National Science Foundation [NSF] report indicates that only 19% of the female college bound population enrolls in non-traditional majors like engineering (NSF, 2000b). Reports from The National Council for Research on Women [NCRW] (2001), ACT (2000), CAWMSET (2000), National Center for Education Statistics [NCES] (2000b), NSF (2000), American Institutes for Research (1998) convey concerns about the current participation rates and projected representation of women in science, math, engineering, and technology fields. Therefore, in order to increase the representation of women in these majors and the engineering profession, we must probe into how they are examining the career option and what they are learning as they research the profession.

This study is informed by an overview of youth culture and a deeper examination of modern female adolescents and their social and personal development related to career
exploration. It is useful to reflect upon adolescent and feminine epistemology (how the world is viewed and the relationship between knowing and being) to better understand the lenses young women use to bring meaning and perspective to what they read, hear, and see when contemplating an engineering career. Career development theory is included to provide an understanding of the adolescent career exploration process and the developmental stages.

Proceedings from conferences and symposia on youth culture, feminist inquiry, women in sciences, mathematics, and technology provide emerging thought on the topics informing this study. Reviews of existing studies document factors associated with women's choice of non-traditional careers (Eccles, 1994; Seymour, 1997); and aspirations attributed to the selection of scientific or engineering careers (Farmer, 1985; Harmon 1989; Seymour, 1997). Qualitative studies provide an insight to understanding women's decisions to enter male dominated professions like engineering (Chinn, 1995). Career preference theory describes identity types that persist within the system of engineering education (Dettinger, 1999). The aforementioned studies involved college students. No career exploration or engineering-related studies were found centering on youth or females in grades 9-11.

**Major Works and Scholars Informing the Study**

Eight scholarly works provide the foundation for the literature review. They include: *The science question in feminism* (Harding, 1986); *Educated in romance* (Holland & Eisenhart, 1990); *In a different voice* (Gilligan, 1993); *Women's ways of knowing* (Belenky et al., 1997); *America's teenager – motivated but directionless* (Schneider & Stevenson, 1999); *The everyday world as problematic* (Smith, 1987); and *Girls: Feminine adolescence in popular culture and cultural theory* (Driscoll, 2002). These scholars inform the
development of this study and provide an insight to scientific epistemology and the fundamental contextual framework within which this study is embedded.

Other prominent works of feminist scholars informing my understanding and providing a foundation as I constructed the study include Evelyn Fox Keller (1985; 1992; 1996; 2001a; 2001b), Helen Longino (1996), and Nancy Fraser (1989; 1997). Additionally, the career exploration research of Donald Super (1990), Albert Bandura's self-efficacy theory (1977, 1985), Holland's interest congruence theory (1973, 1985), and Betz and Fitzgerald's work on women and career development (1987), provide a contextual insight to career exploration and how young women may come to know engineering.

Youth Culture and Communications

Today's youth often referred to, as the Millennials, Gen Y, or Echo Boomers are very different from youth of previous generations. Current literature suggests youth culture is on the "cusp of a radical shift" (Schneider & Stevenson, 1999; Howe & Strauss, 2000; The Lawlor Group, 2001) with Gen Y's impact on society and American culture expected to surpass the Boomer generation in regard to influence. Millennials are a "do it yourself" generation marked by optimism, drive, social commitment, and strong work ethic (The Lawlor Group, 2001). They are not inclined to accept stereotypes as truth, and they are the least race conscious, most female-dominated, generation in American history (The Lawlor Group, 2001).

A 50-year longitudinal study funded by the Sloan Foundation considers Millennials the "most ambitious" generation since the mid-1900s (Schneider & Stevenson, 1999). They retain traditional social values, will push for higher standards in education, and embrace
honesty, caring, pride, and determination. Former “Boomer” causes are expected to fade (race and gender) with new “Millennial” causes focusing instead on class.

Marketing experts and communication professionals can be described as “intimidated” when writing and designing communication targeting Gen Y, states Buzz Leer of Lippincott and Margulies, Inc. (2001). Gen Y is a generation which has grown up with computers and the Internet. They have high expectations in the market place and are accustomed to information that is instant, entertaining, personalized, and current (Smith & Clurman, 1998). They are savvy, discerning, and critical consumers.

Michael Apple in his introduction to Nancy Lesko’s (2001) book, Act your age! suggests we sometimes see youth as the problem, and he, therefore, offers scholarly and insightful advice on behalf of modern day adolescents. Apple states that our interpretation of youth has powerful effects, and “the ways in which adolescents are treated during their teenage years can create tensions that last forever. Class, race, and gender identities are formed in interaction with institutions” (Lesko, 2001, p. xi). This suggests that youth should be considered part of policy development and viewed as part of the solution, rather than viewed as the problem.

Similarly, Driscoll (2001) claims:

Youth has been consistently important to cultural analysis because it presents a crucial point of cultural reproduction and cultural change. Youth names a field in which society reproduces itself and marks changes through the incorporation and exclusion of individuals and groups...twentieth-century cultural analysis has especially focused on how the world has changed—or...what parts of the world have not changed in the same way—and has also emphasized youth and adolescence as site for speaking about such change (or lack of change). (p. 10)
To this end, Lesko (2001) juxtaposes alternative theoretical frameworks with the dominant views of adolescence—the biological and sociohistorical perspectives. Lesko offers a thorough “deconstruction of our accepted understanding of youth. It causes us to rethink much that has been told to us about developmental psychology ... adolescence, about masculinity and femininity” (p. xii). She calls for participation in modern, scientific discourse about adolescence and poses new ideas about adolescence that are not opposed or inferior to adulthood. Exploring these postmodern ideas are the basis for Act your age! Lesko explores the “systems of ideas” that adolescents use to see, think, feel, and act upon. She asserts that to truly understand and influence modern youth “we must travel a greater distance toward disengagement and disenchantment with our current perspective than many critical analyses allow” (p.10). I adopted this line of reasoning in my study because it provides a psychosocial lens to investigate knowing and the making of “modern individuals for a changing nation-state” (p. 9).

Girls’ Lives

A fundamental attribute of this study is the importance of capturing and learning about the viewpoints and perceptions young women have of engineering, especially because they have been a population whose voices have been absent in formal research (Belenky et al., 1986; Denzin & Lincoln, 1998; Gilligan, 1982, 1993; Smith, 1987). Gilligan’s landmark study in the 1980s demonstrated how the inclusion of women changes the paradigm of human psychology, and ultimately, reframes society’s orientation from justice and separateness to the need and importance of relationship and connectedness.
While much of this research was focused on women, Gilligan’s group – The Harvard Project on Women’s Psychology and Development of Girls – also studied girls and found very similar tendencies in regard to voice and relationship. The results included familiar tendencies of pretending not to know what one knows, the challenges of hearing and listening to one’s voice, the conflict between thinking and knowing, and the phenomenon of using one’s voice to cover as opposed to convey one’s thought in the interest of a relationship (Gilligan, 1993).

Gilligan’s work has not been without criticism. Most feminist and sociological scholars embrace the theory of valued difference; however, critics of Gilligan, Noddings, and others argue that the inherent binary locations of “a different voice” continues to promote inequality. It also sustains the subordinate position that caring and nurturing has occupied in our political, social, and economic structures and culture (Faludi, 1991; Friedan, 1981; Wood, 1994). These critics express dismay in regard to the essentialist perspective of “a different voice” arguing that contemporary feminist epistemologies embrace pluralism, that women’s knowing is unique, distinctive, idiosyncratic, and individualistic, not one universal voice.

It is widely acknowledged that young women’s feminism is not one worldview, but multi-faceted. At an international conference, New Girl Order: The Future of Feminist Inquiry (2001), common concepts and research themes included the issues of voice, individualism, and the notion that dialogue is mutually heard. These themes were coupled with a desire to guard against the reconstruction of binaries. Studies on girlhood suggest a need for sense making; the importance of space (public and private); a strong belief about inclusivity in research (traditional academic research is viewed as alienating); and the need to
understand specificity and complexities in researching this population (New Girl Order, 2001). A significant concept emerging from contemporary research is that young women’s feminism is diverse, and a girl’s world and perspective is contextualized and should be honored.

Madeleine Jowett’s (2001) ongoing research asserts that young women are maturing in a time when popular culture is filled with debates on the relevance of feminism. Jowett suggests that within their perspectives, girls have seized equality, they choose to draw on history and their experiences, and they tend to evaluate conditions, while rejecting the negative. Jowett and others (New Girl Order, 2001) suggest that girls’ impressions of, and their interest in, being a part of a feminist “community” are mixed.

Corresponding with the theme of contextualized lives, Jowett’s research suggests that a fair worldview is difficult to accomplish; yet, young women look forward to what is possible. Emancipated identity themes also emerge, coupled with power relation criticisms of first and second wave femininists. Ednie Garrison’s research (2001) suggests that since the 1990s, young women have been ambivalent and sometimes hostile toward “feminism.” However, researchers (Baumgarder & Richards, 2000; New Girl Order: Young Women and the Future of Feminist Inquiry Conference, 2001) assert that this conservative backlash bestows a uniting power and that feminism is consequently being reconfigured as multi-faceted.

Another prominent young feminist issue involves the subject of labeling, especially in the academic domain. Again, following the “contextual” theme, Garrison and others (New Girl Order, 2001) caution researchers about using feminist labels because labels create boxes
and limitations. As a result, many studies suggest in one way or another the need for praxis and good power practices.

Various studies (Mazzarella & Pecora, 1999; New Girl Order, 2001; Walkerdine, Lucey, & Melody, 2001) also suggest that young women’s behavior is both conscious and unconscious in regard to feminism. Their investment and disinvestment in feminism, as it is more commonly known, is a complex phenomenon. They see themselves as individuals and are not driven to formally band as feminist groups have in the past. They realize as women they are going against “the tide,” yet they view themselves as beneficiaries of earlier women’s movements. They “know things have changed,” and realize “how far they [women] have come” in regard to living independently and pursuing non-traditional jobs (Walkerdine, 2001). Some researchers suggest that as a result, young women take a “cruising” attitude toward politics and activism (Jowett, 2001; Walkerdine & Heisecke, 2001).

Of special interest and concern to these researchers is the fact that these girls are maturing in a world full of contradictions (New Girl Order, 2001). A prominent contradiction involves female images in the media and the business world juxtaposed to young women’s “softer” side and the desire for relationships and to nurture. For these girls and young women, navigating a life course is work and confusing at a minimum. Research suggests that the existence of pervasive hegemonic relationships in popular press further contributes to the confusion (Walkerdine & Heisecke, 2001). The work of many researchers in this field attempts to create a space for interaction addressing and discussing these contradictions. Understanding these phenomena will aid in understanding the future of feminism, and advance the socialization of girls and young women (New Girl Order, 2001; Walkerdine & Heisecke, 2001).
Girls’ Realities Relative to Math and Science Careers

Linked in part to the debates about equity in science education, the women’s movement in the 1960s, and the civil rights movement, science education communities began to look at the education and opportunities available to young women and minority students (Barton, 1998). Studies conducted by Kalhe and Meese (1994), Mullis and Jenkins (1988), and Young and Fraser (1994) suggested that girls and minority students view science activity as dull, only for smart boys, and not connected with personal experiences. These studies also revealed external factors detrimental to interest in science. These factors included: (1) a lack of role models and after-school programs; (2) a view that scientific knowledge is objective, rational, masculine, and mechanistic; (3) home and family structures endorsed traditional roles for young women; and (4) boys’ performance in science was recognized more often than girls’ achievements (Barton, 1998, p. 3). The awareness of these phenomena spawned activism in the 1980s and 1990s that affected science education programs.

Second wave feminism in science education began to challenge the values and standards of science, and emphasized a need for multiple ways of knowing and doing science that reflect a variety of social contexts (Barton, 1998; Keller & Longino, 1999). Second wave feminism draws on the work of Hubbard (1986) and the problematizing of science that is separate and fragmented in its existence. Harding (1986) and Keller’s (1985) analyses also provide insights to the positivistic tradition of science.

Additionally, Harding (1986, 1991), Longino (1989, 1990), Smith (1987), Hartsock (1983), Rose (1983), and Millman and Kanter (1975) advanced second wave feminism in the sciences by questioning the nature of science and the white, European, middle-upper-class bias of scientific knowledge. These feminist scholars universally support the necessity for
equity so that women can contribute to and interpret science in contexts familiar to them. These “second wave” critiques introduced the third wave of feminism in science, by advancing the notion that science should embrace a reflexive orientation – an understanding of, and acknowledgement for multiple schools of thought and the situatedness of gender and knowledge (Barton, 1998; Keller & Longino, 1999).

Eisenhart and Finkel’s (1998) work in *Women’s science*, reflects the influence of second and third wave feminism in science and serves to inform this study by providing a foundation to examine how young women come to know, and are socialized, in the scientific domain. A prominent theory of science education reform focuses on giving girls the time, space, tools, and support to become aware of topics that interest them, and in contexts that intrigue them (Eisenhart & Finkel, 1998, p. 239). For girls to learn, it is important to engage them in activities they find meaningful. Further, learning and science can be enhanced with active collaboration of social science research and knowledge. I believe this approach can apply to learning about the engineering profession as well.

Socially and publicly meaningful science also serves to stimulate interest and advances the development of self-confidence and self-esteem (Eisenhart & Finkel, 1998). Knowledge of science enhances one’s identity within groups. Individuals who can apply science or use it persuasively can enhance their social status with an elevated sense of intellect.

From an educational perspective, inquiry-based, experiential or constructivist pedagogy provides experiences that pique interest and encourage sustainable curiosity. This pedagogy asserts that young people learn best when the learning makes sense to them. Constructivists also believe learning is a social process and learners construct knowledge for
themselves (Cummings, 2001). This type of learning is an active process and involves topics or concepts grounded in a context that students find relevant and engaging. These philosophical and pedagogical stances dominate the new National Science Education Standards (National Academy of Science, 1996).

Science as a Social Activity – Gender Constructs and Career Commitments

My study has also been influenced by the work of the anthropologist Dorothy Holland and educator/anthropologist Margaret Eisenhart. In 1979, Holland and Eisenhart directed a study commissioned by the National Institute of Education with the purpose of finding out why so few women were becoming scientists or mathematicians. Their study was an ethnographic study of high ability (academically-speaking), ambitious Black and Caucasian women attending two universities in the South all of whom had aspirations to major in math or science-related fields. Over the eight-year period of the study, Holland and Eisenhart’s findings suggested that the women’s lack of interest in math and science careers had less to do with “non-supportive socialization, gender-specific motivation patterns, and subtle forms of institutional discrimination, and more to do with “peer groups and their associated cultures” which play an “important – and relatively unrecognized – role in guiding women toward traditional positions in the work force” (Holland & Eisenhart, 1990, p. 27).

Holland and Eisenhart (1990) assert that the pull of peer culture, in part, a young woman’s desire to be a romantic partner, is stronger than a young woman’s personal commitment to academic work and career opportunities. As a result, I believe that in order to understand young women’s thoughts on schoolwork and careers, it is necessary to assess the
peer structure, its influences, and the ways gender is viewed. As Holland and Eisenhart’s study suggests, often, these cultural models – peer and academic life – were in conflict.

Another social and cultural dimension these findings revealed involved a perception of social prestige. When this concept was examined, Holland and Eisenhart (1990) found that women relied on romantic relationships for prestige more than their male counterparts. Men had several sources of prestige like sports and leadership positions (also see Horowitz, 1987). Additionally, young women struggle with decisions about choice of identity — for instance, to be a “bookworm” or a person who is known to “like fun,” or ideally, to manage both identities. The women in Holland and Eisenhart’s study who held their academic lives in high regard were challenged by the demands of both books and fun. “They viewed the work they did in college as a way of gaining recognition for their natural abilities and skills” (Holland & Eisenhart, 1990, p.31), but when they did not do as well as they expected to, their identity as a “good student” was in question. If the women spent less time with their studies and more time in romantic and peer relationships, the tendency to reduce academic aspirations and prioritize relationships with others affected academic and ultimately, professional aspirations.

There was a small group of women who Holland and Eisenhart (1990) tagged as committed to their learning and they were able to balance academic life and social activities and achieve the goals they set for themselves. A unique characteristic of this group was that they were goal-oriented and neither peer nor intermittent failure derailed them from their future plan.

Upon graduation and when these young women began their adult lives, less than one third had fulfilled their expectations. Many of these women were engaging in what critical
educational and feminist literature classifies as “practices” which sustain “women’s subordinate positions in the society” (Holland & Eisenhart, 1990, p. 4). Most of the women were committed to serious heterosexual relationships, chose marginalized career identities, and would likely be ill-prepared as breadwinners in their family unit. Holland and Eisenhart assert that the change of heart and mind for these women was attributed to what they coined the “education of romance” – a pervasive culture whereby one’s life choices are in response to peer pressure and the desire to be appealing to men which, ultimately, perpetuates long-standing patriarchy.

**Feminist Critique of Science: A Gendered Science**

Throughout history, the advancement of women in science has been filled with challenges. Historians, anthropologists, and sociologists suggest that the professionalization of science “may have been a device to preserve the direction of scientific inquiry for the elite, white men” (Harding, 1986, p. 80). Margaret Rossiter, in *Women Scientists in America*, (1982) documents women’s “historically subordinate ‘place’” in science. She writes:

Even as women’s educational level rose and their role outside the home expanded, they were seen as doing only a narrow range of “womanly” activities, a stereotype that linked and limited them to soft, delicate, emotional, noncompetitive, and nurturing kinds of feelings and behavior. At the same time, the stereotype of “science” was seen rhetorically as almost the opposite: tough, rigorous, rational, impersonal, masculine, competitive, and unemotional. Moreover, this conceptual element meant that much of the history of women in science would be worked out not simply in the realm of objective reality, specifically, what women could or did do, but covertly, in the psychic land of images and sexual stereotype, which has a logic all its own. (p. xv)

The lack of recognition for achievement, work force positioning (primarily field or lab work positions), and wages, have resulted in stereotypes and gendered symbolic meaning
in science which support cultural biases and docile social images. Cultural stereotypes of science and masculinity seem to be intertwined. They both can be described as tough, rigorous, rational, impersonal, competitive, and unemotional (Harding, 1986; Rossiter, 1983). Consequently, this results in equity issues of gender order and gender symbolism — a form of gender politics has served to advance scientific modes of knowledge-seeking, and likewise, science has advanced modern forms of gender symbolism (Harding, 1986) that can be associated causally with the low percentages of women in the sciences and engineering.

In the 1970s and 1980s many revolutionary and thought provoking feminist works focusing on women and the sciences were published. The work of these scholars and authors provide a historical and cultural perspective for this study. The scholarship I have utilized to develop a contextual understanding of women in the sciences include the work of Sandra Harding (1986, 1991), Evelyn Fox Keller (1978, 1985,1996), Helen Longino (1989,1990), Hillary Rose (1983, 2001), Marcia Millman and Rosabeth Moss Kanter (1975), and Dorothy Smith (1979, 1987). Today these scholars continue to lead discussion about the nature of science, women and science, and the social constructions of science disciplines.

Sandra Harding’s book, *The science question in feminism* (1986), is referenced in much of the literature relating to feminism, women, and the sciences. Harding identifies important trends in feminist critiques of science including tensions and conflicts in science fields, inadequate concepts that inform analysis, obstacles and gaps in research programs, and possible transformational tools for the construction of emancipatory meanings and practices. Harding believes these feminist science critiques can revolutionize modern Western scientific culture just like feminist critiques did for humanities and social sciences.
Equity imbalance

One of the foremost themes in feminist critiques of science points to studies documenting equity imbalances such as historical resistance to women getting an education, credentials, and jobs, and the psychological and social mechanisms through which discrimination is informally maintained (Millman & Kanter, 1975; Rossiter, 1982). Harding (1986) points to motivation studies where boys want to excel in math, science, and engineering and girls are not so inclined. One educational goal related to these studies is the desire to bring girls interest level up to that of their male counterparts. Relative to this goal, Harding in her book, *The science question in feminism* (1986) asks, “Do women want to become just like men in science?” “Why such a low goal?” “Why would women want to participate in programs, which are sexist, racist, and classist?” Harding (1986, 1991), Keller (1985, 1996), and many others pose the most earnest question, “Can the presence of women affect the nature of scientific inquiry and outcomes?”

Problematic assumptions

A prominent problematic assumption identified by feminist scholars is that science is pure and value-free. On the contrary, the literature suggests that identifying problems to investigate involves human perceptions and the selection and definition of problems always have social “finger prints” of the dominant group. Millman and Kanter (1975) regard this as a masculine bias in social and scientific inquiry and suggest the absence of women’s voice results in distorted meaning and reality.

Feminist scholars challenge the notion that scientific methodology and epistemology — what is said about science, its knowledge, and how it is conducted methodologically —
maintains value-neutral claims and practices. There is now much research to the contrary here as well. This includes literary criticisms of science, historical interpretations that are gendered, psychoanalysis of social meaning, and hidden symbolic and structural agendas (Harding, 1986; Keller, 1985, 1996, 2001a, 2001b; Rose, 1983, 2001). For example, consider the metaphors in the writings of the fathers of modern science – inferences that portray the strong, leading figure as male, and the caring, nurturing, weaker, dependent female figure.

Additionally, Harding (1986, 1991), Keller (1985, 1996, 2001a, 2001b), Longino, Millman, and Kanter (1975), and Smith (1979, 1987) cite the long-standing dichotomy between science and epistemology. The modern-day debate advocates masculine and feminine standpoints, with the masculine standpoint possibly attributed to Western and bourgeois needs and desires. Harding (1986) identifies some of these gendered standpoints: objectivity vs. subjectivity; the scientist as knowing subject vs. the objects of his inquiry, reason vs. the emotions, and mind vs. body.

Other scholars who recognize similar gender differences in scientific inquiry include: Dorothy Dinnerstein and Nancy Chodorow (see Mermaid and the minotaur, 1976); Nancy Chodorow (see The reproduction of mothering, 1978); Carol Gilligan (see In a different voice, 1993); and Lillian Rubin (see Intimate strangers, 1983). Harding (1986) argues that the social roles, marginalization, and oppression experienced by women positions them to be “reliable researchers” due their unique vantage point and their ability to identify male bias and to question conventional claims about nature and social life.

As a result of these gendered claims, epistemological inquiry is offered as an alternative lens to understanding how beliefs are grounded in social experiences and raises questions as to what beliefs women contribute to the construction of knowledge. The primary
differences in feminist inquiry include: (a) accounting for the relationship between knowing and being; (b) considering the epistemology (how do we know the world and what is the relationship between knowing and being); and (c) revisiting metaphysics (ultimate causes and nature of things).

The aforementioned themes outline, in a general sense, a feminist critique of science. There have been humanist critiques of science before feminist critiques were developed; feminist critiques have added the gendered dimension of science. Dominant scientific epistemologies were thought to be value neutral and methodologically pure and free from social influence. These criticisms are outlined because they are associated with the perceptions my participants have of engineering and the career “fit” they envision. Additionally, the literature contextualizes the nature of science [and engineering] as we have come to know it.

Methodology

I drew on feminist theory to inform this study, specifically standpoint theory within the spectrum of feminist thought, and a secondary theory, career development theory. Feminist and standpoint theories were selected because the origins of both theories are rooted in addressing a history of oppression and inequality, and in developing the silenced voice for the purpose of social change (Denzin & Lincoln, 1998). Career development theory intended to provide a framework for an adolescent’s career exploration progression.

Feminist theoretical perspective

Feminist theory acknowledges the gendered dimension of historically male-dominated professions. Harding (1986) writes about gender as an analytic category and tool
“through which the division of social experience along gender lines seems to give men and women different conceptions of themselves, their activities and beliefs, and the work around them” (p. 31). Mainstream feminist thought on the philosophy of science embraces Sandra Harding’s work that asserts scientific thought is dominated by traditions of Western thought, which “suffer[s] from the want of objectivity” (Hirsh & Olson, 1995, p. 1), as opposed to multiple ways of knowing (Baumgardner & Richards, 2000; Belenky et al., 1997; Eisenhart & Finkel, 1998; Goldberger et al., 1996; Luttrell, 1997; Mwangi, 2002; Smith 1987), a subjective or contextual orientation to knowledge production. Further, in a project supported by NSF entitled “Two-way Street,” science is promoted as a discipline that must be opened up to new perspectives of scientific knowledge, as well as being a discipline that should be embedded in other non-science disciplines (NCRW, 2001). “One must view science in context, and science in the making, rather than regarding it as a fixed body of knowledge with a certain authority behind it” (NCRW, 2001, p. 62) the report asserts. I draw upon a feminist perspective—standpoint theory—to raise awareness of gender differences, and to expose difference in thought and knowing. In this study, using a feminist lens to expand and enhance knowledge and perspective is central and insightful.

It is the definition and recognition that gender (as well as race and other dimensions of difference, although, not a focus of this study) is a legitimate social construct that provides structure and requires awareness in our social and natural world. Keller (2001) refers to this line of thinking as the “hallmark of contemporary feminist theory” (p. 133). It should be noted that it was not until the late 1970s that feminist theory pressed the natural sciences (Harding, 1986). Feminist theory asks new and different questions. I believe that in order to appeal to young women and their ways of viewing the world, and specifically, their view of
the engineering profession, it is constructive to employ feminist theoretical perspectives to
develop and apply different lenses to better understand the viewpoints of contemporary
young women. It is this perspective that serves as a lens through which this study is designed
and analyzed.

Most recently, Driscoll’s *Girls—Feminine adolescents in popular culture and
cultural theory* (2002) looks at the constitution of feminine adolescent/adolescence in
a range of discourses. Driscoll draws upon the work of French historian and theorist
Foucault who argues for the importance of viewing culture from a genealogical
perspective. Genealogy, a method of writing history, or historiography, does not use
cause and effect or points of origin in meaning making, but rather a mapping
approach connecting plausible ideas or rationales within a given context.

Similarly, Lesko (2001) advances this late modern, or post-modern view of feminist
theory, and adds the dimension of youth or adolescence. Lesko’s discussion of a
sociohistorical framework has direct implications for this study because its roots are found in
the economic and educational opportunities that have influenced the construction of youth,
and the “arrival” of girls in American culture. Based on this framework, Lesko points out that
adolescence was developed [in the U.S.] ”when child labor laws, industrialization, and union
organizing gutted apprenticeships, which had been the conventional way for youth to move
from dependence to independence” (p. 7).

Further, Lesko points out this economic view can account for the rise in compulsory
education, but “has not challenged the assumptions that adolescents are fundamentally
different, developing beings based upon their age…and the broad cultural transformations of
time, race, gender, and citizenship” (p. 7). This line of thinking is drawn from Foucault’s
discussion of postmodernism (see *Discipline to punish*, 1979), and leads to a more interdisciplinary perspective—a postmodern view—where Foucault suggests we study childhood rather than children, or more specifically, studying the “space and time of being a child that is defined, theorized, patrolled, and maintained by adults” (p. 9).

This approach can be applied to studying adolescence rather than youth, whiteness rather than whites, femininity rather than women, power rather than freedom, etc. Lesko (2001) advances this perspective and suggests the “social sciences and psychology helped make the inner, personal qualities of individuals visible and significant for building a modern society” (p. 9). She further states, “modern power operates in the creation of objective knowledge and of subjective realities (for example, we learn that to be successful we must understand and assess our strengths and weaknesses, based on sociological and psychological empirical science)” (p. 9). I adopt this line of reasoning in this study because it provides a psychosocial lens to the investigation of knowing and the making of “modern individuals for a changing nation-state” (p. 9). Additionally, a psychosocial framework involves economic and political influences; therefore, I believe it is befitting for a contemporary socio-economic problem to utilize feminist perspective and framework to analyze how young women come to know the historically male dominated field of engineering.

**Standpoint theory**

In order to further understand young women’s viewpoint, standpoint theory, a specific feminist perspective, is employed to capture the essence of how young women come to know the engineering profession. Standpoint theory, or as Harding (1986, 1991) refers to it, feminist standpoint, looks from the inside out, or encompasses a viewpoint that is one’s
own, as the individual (or research participant) looks out from within, to view the world

Dorothy Smith, a prominent social scientist and feminist scholar, described feminist
theory as the means to introduce discourse into discovery, which throughout history has been
controlled by the male perspective (1987). Smith (1987), and sociologist and African
American women scholar Patricia Hill Collins (1986), labeled these different “discoveries”
as “standpoint,” a term used to describe women’s life experiences that are not captured in
existing research (Belenky et al., 1986; Denzin & Lincoln, 1998; Gilligan, 1982; Smith,
1987). Both Collins (1986) and Smith (1987) through their work remind us of the powerful
and significant social contexts, political agendas, and economic forces that shape women’s
everyday lives and decisions. This “individual centered” approach is different from our
historically male, patriarchal, or Western intellectual tradition.

Smith (1987) describes standpoint methods of inquiry as an “exploration rather than
an account of a destination” (p. 106). It is a method that communicates in the present the
voice of the individual, not an “absent subject,” and a perspective “filled with the presence
and spoken experience of actual women speaking of and in the actualities of their every day
worlds” (p. 107).

In her book, *Feminism and social research*, Marjorie DeVault (1999) discusses
standpoint in terms of creating knowledge and knowing by talking and listening “as women”
[not exclusively gendered, but inclusive of Others] (p. 60). Women are accustomed to
translating their experiences into standard vocabulary, but by speaking and listening in ways
that “open the boundaries of standard topics, we can create a space for respondents to provide
accounts rooted in the realities of their lives” (DeVault, 1999, p. 63). For example, the
standard term or label of "self-defense," typically includes for women the meaning of classes and technical moves, as well as, living in safe neighborhoods, awareness when walking alone, non-suggestive dress, etc.

DeVault (1999) and Lather (1991) utilize research as praxis—where theory is both “relevant to the world and nurtured by actions in it” (Lather, 1991, pp. 11-12; see also Buker, 1990). This theoretical approach strives to create a theoretical understanding through the interplay between context, theory, and practice. Therefore, research as praxis is a methodological approach to reveal and probe the standpoint of the knower—a standpoint that is uniquely contextualized.

Standpoint focuses on the “ways in which gender is socially constructed, treating it as an analytic category in its own right” (Denzin & Lincoln, 1998, p. 241). This concept of standpoint is the focus of my research — to identify and analyze young women’s viewpoints as they explore and come to know the engineering career field. I believe this framework is fitting given the purpose of this study was to look at the engineering profession through the lens or standpoint of young women.

**Career development theory**

Career development theory was utilized in this study because the study was about the process of exploring careers and making decisions about employment after high school. Career exploration literature applicable to this study dates back to the 1950s. Over this period of time, the developmental phases of career exploration have remained fundamentally the same; however, ways to acquire career information have changed.
Contemporary career development theory continues to reference the work of Don Super (1990) and Jean Pierre Jordaan (1963) when identifying and theorizing the primary developmental task of high school students. This primary task is to formulate vocational preferences. The developmental processes involved in formulating a young person’s vocational preference involve three phases: (1) crystallizing a vocational preference; (2) specifying a vocational preference; and (3) implementing a vocational choice (Jordaan, 1979). Career exploration is a process an adolescent engages in when career options are investigated. The young person becomes less tentative about career options, and through experience, the passage of time, and by fantasizing about them. They also explore ideas and opportunities with family, friends, and other adults, and through research and eventually part-time, then permanent work.

Corresponding with learning about careers is self-knowledge development (Jordaan, 1979). This involves a more realistic appraisal of one’s interests, abilities, values, and personality traits, as well as an appraisal of one’s strengths and weaknesses. Self-concept and awareness becomes important when moving from the crystallizing thoughts on careers to implementing a course of action.

There are a number of key constructs and theories that have been found to influence young women’s choice of non-traditional careers. Young women who view themselves as self-reliant and independent have been found to be more interested in non-traditional careers (Betz & Fitzgerald 1987). Self-efficacy (persons’ beliefs about their ability to perform tasks successfully) has been found to be critical and is related to a variety of career outcomes (Bandura, 1977). More specifically, Betz and Hackett (1983) and Betz (1985) found that math self-efficacy was closely related to choice of science- and math-related college majors.
A longitudinal study by Hilton, Miller, and Brown (1991) involving 8th-12th graders found that adolescents whose parents who supported and promoted their interest in science were more likely to continue to be interested in a science or technology career. Farmer, Anderson, and Brock (1991) found that when women consider non-traditional science and technology careers because society does not give females clear messages about their roles in the work place, they are more responsive than males to supportive messages from significant others in their lives.

Two other constructs found to influence women’s career behavior are expectancy-valance (Vroom, 1964) and interest congruence (Holland, 1973; 1985). Expectancy-valance postulates that a person’s career selection choices are a function of both expectations and values. Women are more likely to place a high value on “people-related endeavors” (Lips, 1992) and they are more likely to avoid fields like engineering that are demanding in terms of educational commitment and number of hours worked (Betz, 1994). Holland’s work (1973, 1985) discusses interest congruence, which is the degree of fit between one’s personality characteristics and an occupation or environment.

An initial phase in the career exploration experience for young people involves the deliberate process of researching career information or crystallization. Often times this begins formally between the ages of 13-14 years of age when careers are introduced in civic or social studies curricula. Because my research is interested in how young women come to know the engineering career field, this research will involve girls (ages 15-16) beginning to advance through the initial stages of formal career exploration or crystallization.
Summary

This literature review provided the foundation for informing this study. A review of the literature introduces today’s youth as the “Millennials,” a generation that is coined the “most ambitious” (Schneider & Stevenson, 1999); a generation that has embraced more traditional values, but is not expected to adopt traditional stereotypes. Millennial females are thought to be the benefactors of the women’s movement, in terms of opportunities and the emergence of women’s psychology. Likewise, second and third wave feminism or late modern or post modern feminist thought have strived to contextualize science for a “girls world,” yet the historical underpinnings and philosophy continue to influence the discipline in ways that are thought to be alienating or challenging for the “other.” Many of these theoretical and philosophical threads form the interpretative section of this dissertation.

Theory used in this study serves to give “voice” to young women as they explore a non-traditional career field. The study, via feminist standpoint theory and participatory action research, seeks to raise awareness of gender differences, and perhaps, alter the status quo in terms of understanding how contemporary young women view the portrayal of the engineering profession. Additionally, insight to the career exploration and the career selection process suggests a definable activity, and one that has benefited from scholarly inquiry. Existing literature, however, does not specifically investigate young women’s perceptions resulting from an open-minded career exploration experience in the field of engineering; thus, my study provides new knowledge and insight to existing scholarship in this area.
CHAPTER 3. QUALITATIVE INQUIRY

Qualitative research is contextual, value-laden, and involves the lived experience of people. The methodology chosen for this study combines two qualitative research traditions: critical ethnography and participatory action research. Perhaps, from an epistemological perspective, these approaches could be viewed as contradictory. Participatory denotes involvement and the Greek root meaning of ethnography, means to write about others. Further, the critical dimension in critical ethnography takes on the additional task of raising the voice and level of consciousness on behalf of the research participants as a means of empowering them and giving participants more authority (Thomas, 1993). However, the combination of these approaches is thought to strengthen the quality of data collected and the findings that emerge.

Participatory action research became popularized as a research movement focusing on those traditionally oppressed (women and people of color), exploited, or abused in the research process (Denzin & Lincoln 1998, p. 335). As a result, the “subjects” traditionally observed became active participants, to some degree or another, in the research design, data collection, and/or data analysis phases of the research. As the researcher, I engaged the participants in data collection and analysis segments of the study. Collaboratively, the data were synthesized and “authentic” findings are presented in regard to how the young women in the study came to know engineering.
Critical Ethnography

Critical ethnography is a form of social research. Critical ethnographic research generally accomplishes three goals: (1) describes what exists; (2) interprets what is uncovered; and (3) explains how to use the phenomenon studied. These goals are related to the overarching research questions of this study as previously outlined: What is appealing or unappealing about a non-traditional career field like engineering? What is seen, heard, and understood about the engineering career field? What is appealing or unappealing about the engineering profession?

Jim Thomas (1993), sociologist and researcher, refers to critical ethnography as a "style of analysis and discourse embedded within conventional ethnography" (p. 3). It has emergent design attributes, and requires flexibility in methodology to allow for a shifting focus resulting from dynamic information flow. Thomas differentiates between conventional ethnography, which describes what is, and critical ethnography, which adds a political dimension, and asks, "what can be." In essence, critical ethnography differs from ethnography in that it seeks to speak on behalf of the research participant, to empower and give authority to his or her voice. Critical ethnographers aim to change a condition rather than describe it. Let us turn to the critical dimensions of critical ethnography and how it applies to this study.

Thomas (1993) refers to critical ethnography as a "type of reflection that examines culture, knowledge, and action" (p. 2), which deepens our awareness, and exposes "hidden agendas, power centers, and assumptions that inhibit, repress, and constrain" (pp. 2, 3). Using the participatory action research framework the study emerges due to the dynamic flow of information. Language and messages found to embody the contextual meaning of
engineering, provide perspective on how young women come to know engineering. I will attempt to describe systematic characteristics of the language and messages, and look for what LeCompte & Preissle describe as “unique and common patterns of experience, outlook, and response” (LeCompte & Preissle, 1993). As a result, this research can be expected to contribute critical social theory, while striving to provide insights about central psychosocial phenomena uncommon to other research approaches.

**Participatory Action Research**

Schwandt (2001) outlines characteristics of participatory action research (PAR), which is distinct from other social inquiry. These characteristics apply to my study. For example, in this study the participatory element includes cooperation and collaboration between the researcher and participants in the choice of methods to address the research problem, data analysis, and the interpretation of the findings. Various ways of participating include: participants-as-researchers, participants networked to share knowledge, participants as problem formulators, researcher-as-colleague, and researcher-as-participant (Denzin & Lincoln, 1998).

Action research is rooted mainly in Western industrial experience—or better known as the industrial democracy tradition or movement—and the work of Kurt Lewin (Greenwood & Levin, 1998). The label “industrial democracy” was used because the intent of action research was to “shape an alternative to conventional hierarchical organizations” (pp. 27-28). Lewin, a social psychologist is also credited with coining the term action research. His primary interest was in social change, specifically, questions about how to conceptualize it and how to promote it.
Lewin conceptualized change in a three-stage process: dismantling former structures (unfreezing); changing the structures (changing); and returning them back into a permanent structure (refreezing) (p. 17). In the words of Greenwood and Levin (1998), this experimental design of research established what today is called action research (AR) and "set the stage for knowledge production based on solving real-life problems" (p. 19). Themes of democracy and empowerment for workers and researchers were central to this emerging line of research methodology. Later, in the 1970s, participatory action research became the popular AR.

Given the focus of my study—the standpoint of the individual—I chose PAR as a research methodology. I set out to learn more about how young women come to know engineering. Drawing upon Lewinian tradition (Greenwood and Lewin, 1998), I sought to unbundle [unfreeze] the career exploration process(es) young women initiate and experience, through group and personal exploration. As the researcher or group facilitator, I drew upon my experience as a college and career advisor [for adolescents] as I participated in the research process. The research site was a natural setting and I did not take an expert or commanding role. Rather, my role was participatory and part of the research team. The young women were participants; together, we were co-researchers.

In my study, participation included participant-as-researcher, researcher-as-participant, and potentially participants-networked-to-share knowledge (Denzin & Lincoln, 1998). The participants-networked-to-share knowledge arrangement hinged on the type of information sought by the participants—for example, when they decided to explore the engineering profession as a group or some aspects of it together via pre-determined activities or conversations during formal or informal discussions.
Discussion of the science, epistemology, and practice of action research are befitting this action research project. It is a form of research that maintains a pragmatic tradition, a science that takes on complex and human-based problems. While conventional social scientists can view action research as “unsystematic, atheoretical storytelling” (Greenwood & Levin, 1998, p. 74), much can be learned from research that is placed in the present (naturalistic) and is contextually bound, action-oriented, and is connected to community (youth culture, in this study). This is the essence of pragmatic action research.

It is a way of knowing and learning that is oriented with the person, whereby, voice is elevated and research is “cogenerated” (Greenwood & Levin, 1998, p. 75) with researcher(s) and participants. As with critical ethnography, meaning constructed in the inquiry process intentionally leads to the creation of new knowledge or social action. Further, AR methods connect the development of knowledge with Friere’s concept of conscientization, an inquiry process that aims at “shaping knowledge relevant to action built on a critical understanding of historical and political contexts within which the participants act” (Greenwood & Levin, 1998, p. 77). Through the participant-as-researcher and researcher-as-participant relationship, knowledge gained has integrity because it is contextual, first person, including the interpretation and is grounded in scholarly practice.

Limitations of this inquiry design include the inability to transfer knowledge from one context to another. Linking is not impossible, but one must consider and understand contextual factors of the culture and environment before the application of knowledge can be suggested. Through this participatory research design, the research process can be empowering and the knowledge produced can be viewed as more authentic. A cautionary characteristic, however, is the tendency for participatory action research to be marked by
tension stemming from simultaneous understanding of “participant aims, social improvement, and knowledge production” (Schwandt, 2001 p. 187).

In the spirit of social research and social reform, this research—with an objective to produce knowledge and action, as well as consciousness-raising—focuses on Lewin’s first stage of the action research process (unfreezing). Recommendations from this study suggest thoughts to bring about change (Lewin’s stage two) regarding diminishing interest levels of young women in the engineering profession. Further [including broader] study is necessary to understand the career exploration experience of young women when exploring this male-dominated field before recommendations can be made to change structures (organizations) directly or indirectly involved in the exploration experience.

Analysis and Interpretation Methodology

Given the critical ethnographic design of the study, the analysis and interpretation “create[s] a vivid reconstruction of the culture studied” (LeCompte & Preissle, 1993, p. 235) and utilizes the narratives (audio taped data collection conversations and text from journals) to document information presented and subsequent meanings and perspectives the participants formulate or attach to things as they learned about the engineering profession. Through reflection, which is inherent in qualitative research and critical ethnography, we “examine culture, knowledge, and action” (Thomas, 1993, p. 2) and accomplish three goals: (1) describe what exists; (2) interpret what is uncovered; and (3) explain how to use the phenomenon studied.

The study employed Wolcott’s (2001) analysis approach with the research questions providing the framework. Answering these questions led to interpretation about meaning.
Data chosen for analysis was predisposed to the researchers’ subjectivity (reflexivity) and answered the following the research questions:

1. How do young women approach researching and learning about a non-traditional career field like engineering? — What is important to be known? What questions need to be answered? Where is the best information?

2. What do you see/hear? — What are the communicative underpinnings that influence young women’s images and perceptions which guide the decision-making process when considering non-traditional fields like engineering?

3. What is appealing or unappealing about a profession like engineering? — Do young women perceive cultural barriers or challenges? What opportunities do they envision?

To aid in analysis and interpretation, data from the field notes, audio taped transcripts, journal entries and personal e-mails were reduced using coding techniques based on their relational merit to the research questions. After the data were selected and coded based on association to the research questions, three coding techniques were employed to facilitate the development of patterns and subsequently themes or constructs for interpretation. Esterberg (2002) refers to the coding techniques as content analysis, semiotic analysis, and grounding analysis.

Content analysis is a systematic analysis of texts and meanings. I employed two types of content analysis in the analysis—manifest content and latent content. Manifest content is straightforward and involves counting occurrences. Latent content involves identifying the underlying meanings of the data. Semiotic analysis is also employed; it involves the study of signs and the “unpacking” of these signs.
Careful comparisons constitute the final phase of analysis known as grounding analysis. Did the data support the analysis? Were there shortcomings in the data? Were negative cases present? Finally, the trustworthiness in the analysis and interpretation was accomplished through triangulation (Denzin, 1978) utilizing multiple data sources and reviews by different researchers.

Through the voices of the participants and their data collection approaches, the analysis describes, "How the co-researchers came to know engineering." Relational patterns are identified using specified analytic categories that explain emergent themes or constructs, which speak to "how young women come to know engineering." This perspective is constructed through adolescent and feminine epistemology (how the world is viewed and the relationship between knowing and being). I offer this as a foundation for the development of standpoint theory for the group of participants functioning as co-researchers.

**Member Checking Reality**

To assure trustworthiness, member checking was a standard practice, and the member-checking exercises were also a part of the data. The purpose of member checking was to verify or affirm data, analysis, and interpretation, and thereby assuring the perspective of the participants was authentic and participatory action methodology was honored.

At the conclusion of the study I attempted to conduct a preliminary review of the findings, however, I was unable to re-engage all the participants in this process. (The rural group participated; the urban group did not.) I attribute this to the length of time between the final data collection and finalization of the analysis and interpretation, as well as the full and active lives of the co-researchers.
Ultimately, the young women came to the study interested in how to explore careers and learning about engineering. They accomplished this by the end of the data collection phase, and therefore, garnering their interest in analysis and interpretation was more difficult. I do, however, believe the member checking would provide further insight to how they came to know engineering and, in Chapter 6, I provide recommendations to sustain the participation of the co-researchers in future study.

Summary

As previously outlined, criticisms and failings of previous women’s and youth studies include claims that young women have not been “authentically” represented, and that they lacked voice. Current literature also suggests female youth are especially critical and cynical of scholarly interpretation in regard to them and their lives (A New Girl Order, 2001; Driscoll, 2002). Therefore, this study gives voice to the youth perspective, and PAR creates an awareness and understanding of standpoint that is an ethnographic account of “what is.”

This study sought to respect and honor voice through theoretical, design, and methodological frameworks. I attempted to provide “thick description” (Geertz, 1973), and tell an authentic story from the standpoint of the research participants. The remaining sections of this dissertation are an account of the experience and what was learned.
CHAPTER 4. THE STUDY

This chapter contains a factual description of the study: the original purpose, setting, participants and researcher, research sites, data collection methods, and data. Harry Wolcott (2001), in *Writing up qualitative research*, considers the study's description as the "most important contribution made" (p. 31). Wolcott asserts a good descriptive account allows others to theorize. Further, this study was written in a chronological format, reflecting the purpose of the study, to examine the career exploration journey of young women in the field of engineering and to learn about "how they come to know" the profession. An extensive review of the preliminary study follows and introduces the research. The preliminary study was instructive in formulation of research questions, participant selection criteria, and selection of method for further study.

Part 1: Preliminary Research Informs

The purpose of the preliminary study was to apply the knowledge gained, to a dissertation study. I hoped the preliminary study would provide a basis from which I would develop research questions and methodology for my dissertation study. As the preliminary study evolved, I was surprised by what I uncovered. I drew upon my experience as a college admissions and recruitment professional working with adolescents in career exploration advising and college choice decision-making. In my professional role, I was aware of the developmental stages a young person experiences as her interests in vocations develop, or do not develop. Behaviors and attitudes of adolescents are also unique. What adolescents say and how they behave are not always what they think and feel. Through my experiences, I have developed a "6th sense" in regard to understanding, coaching, and advising adolescents
through vocational aspiration development and the college selection process. As a result, my professional expertise enabled me to utilize the knowledge gained in the preliminary study to refocus research questions and alter the inquiry.

Over a span of 16 years, my professional life had involved counseling for college and career awareness work. I was well aware of the demand for women in high technology fields, such as engineering, yet perplexed by the lack of women in the field (AAUW, 1998), and the small number of high school girls considering engineering as a major in college (ACT 2000b; 2003). Upon reflection, I decided it would be useful to contemplate and investigate how and where young women sought information to make career decisions that included pursuing non-traditional fields like engineering. I wanted to know more about the meaning that young women gave their engineering or math/science-related encounters as they appraised their own suitability in technical careers. How did these experiences influence their decisions in regard to career selection?

The overarching research questions that guided the preliminary study were: How are young women being influenced to consider engineering as a career choice? Who or what are the primary influencers when considering engineering as a career option? and why aren’t more girls selecting engineering as a career choice? The findings and methodology informed the development the dissertation study. A brief account of the preliminary study follows.

Research participants and site

The preliminary study conducted at a Midwest university included two case studies. Two female soon-to-be-high school seniors, participating in a 6-week-long summer program sponsored by the university’s Women in Science and Engineering (WiSE) office, volunteered
to be part of the study. The summer program they were attending was designed to provide
science and engineering lab-based internships and an opportunity to design web pages on
science related topics for middle school children. The purpose of the program was to
courage the young women to enter science and engineering fields upon graduation.

I recruited research participants from the WiSE summer program because,
presumably, they were predisposed to the idea of engineering as a career choice. I expected
that research participants who attended a 6-week resident science and engineering summer
camp would have a sense of the career opportunities or some ideas about going to college
and studying subjects related to science, math or engineering. This background and
experience would enable me to probe further into how their vocational preferences were
influenced (Jordaan, 1963) and who influenced their thinking in regard to career exploration.

The two young women I interviewed, Jess and Elly (pseudonyms), were somewhat
similar, and yet, had different backgrounds and perspectives. Both participants resided in the
city they had lived in all their lives. Jess was a spirited, happy, and very positive young
woman from a major city in Pennsylvania. She was African American and attended a science
and engineering magnet school. Elly was more laid back, usually enjoyed experiences that
came her way, and was gifted intellectually, yet a "typical" teenager whose pastime was to
"hang out" with friends. She was Caucasian and from a larger city in the Midwest.

While I did not ask Jess and Elly for their academic record, from my conversations
with them, I concluded that both were exceptional students taking strong college preparatory
courses. Jess talked about having to "study hard," but doing well. Elly said mathematics
came very easily to her and occasionally she was bored in school.
Both participants generally liked school and were involved in school and extracurricular activities. They seemed to be typical teenagers, really enjoying time with friends and activities at school. Jess was the secretary of student government and would run for President in the fall. Elly was also involved in student government. She liked economics, followed the stock market, and was to be her school’s treasurer in the fall.

Elly was the youngest of three children and said her brother, who recently graduated from Yale with honors, had provided her a lot of insight to college through his experience. Elly’s mother was an art teacher, and her father was in business for himself.

Jess had grown stepsisters and a stepbrother who did not live at home. Her mother worked in an office and her father worked for the telephone company. Jess proudly stated she would be the first person to graduate from college in her family.

Both young women chose to participate in the WiSE summer program because they wanted to learn more about career opportunities in the sciences and engineering. It was Elly’s first time attending an extended, academic-based summer program. For Jess, it was a typical summer because she and most of her friends attended summer camps or programs like WiSE each summer.

I told Jess and Elly that one benefit of participating in the study would be that what they learn about themselves as they think about vocational preferences, college, and what to study or select for a major. I told them about my professional background. I offered my professional expertise as a college admission professional and I answered questions they had as the research experience caused them to think about their college options.
Methods of data collection

The data collection for the preliminary study included participant observation, written narratives, and two interviews. An initial, informal group interview was designed for the three of us to get acquainted. A second, individual interview with each participant was held in my office on campus. We discussed a location for the interviews and they thought my office would be most convenient. Each interview lasted an hour and was audio taped. The questions I asked were open-ended. To confirm trustworthiness, I provided limited triangulation. I asked each girl to write a narrative on how her career exploration has been up to this point in her life. (Only one girl completed this request.) Member checking was also conducted. I provided the participants an opportunity to read their transcripts and a draft of the study and to provide corrections or clarifications.

Findings

The interviews provided insight to the views these young women had about their future careers as well as who and what had influenced them along the way. There were similarities that emerged in their answers and some differences as well. The patterns included:

1. Lack of familiarity with the career field of engineering and what engineers do.
2. Difficulty when searching for information and answers about careers in engineering.
3. Primary influencers were their mothers; secondary influencers were people involved with their education and who seemed to take a genuine interest in their education.

Differences included how each girl viewed her understanding of her future career and her comfort level associated with this awareness or lack thereof.
Neither Jess nor Elly had a good understanding of what engineering was or what engineers do. When asked, “What does a career in engineering mean to you? Jess answered gasping. “I don’t know. I don’t know; it really doesn’t mean anything” (Jess, July, 2000).

Similarly, Elly said:

“Well, there’s two different ideas I have. One that I sit there and like fill things, or like make structures, I don’t know [inaudible]... I don’t know, like I am in lab all day, but not necessarily. But like I sit at a desk all-day and drawing on a piece of paper... I don’t want to be sitting there drawing on a piece of paper.

Later in the interview Elly talked about her friends’ perceptions of math and engineering:

“I have talked to a lot of my friends about it. Hmmm, they just don’t know what an engineer does, they don’t know what they would be doing on a day-to-day basis and they just kinda get scared off from that cuz they think they’ll be sitting at a desk saying -- so if I put this variable into this equation, what is this like, what is the, No, no, no. [chuckle] no more math (Elly, July, 2000).

Both were bright and had extensive exposure to math, science, and even engineering through school programs and projects. For instance, both young women participated in science, math, and technology-related extracurricular activities like the science fair. Each girl had experience with projects or programs that were engineering-based. They also took Advanced Placement Math and Science (AP) and advanced computer classes, participated in advanced math and science projects, and programs like the WiSE summer program.

When probing with Jess further because her ambitions were to become a computer engineer, I questioned, “Now, you said you think you’re going to do computer engineering or something like that. What does that mean to you, computer engineering?” Jess replied, “Ahh, [mumble] I don’t think it really has any like you see something, this means the world to me. It’s not like that, it’s just something I want to do and if it doesn’t work out, [I’ll] find something else to do.”
Both girls had interesting comments on the inherent challenges for girls who are considering engineering and how they learn more about non-traditional career fields. Jess pointed out a challenge when she said,

> Well, for one, is all you see is the male going into the field and you think they are taking over, so it looks, you think it's only them, so that doesn't give the women any confidence to go and go for it (Jess, July 2000).

Jess went on to say that she wanted to know more about what engineers really do on a daily basis. "What they really do," she emphasized. Elly reflected on a disappointing job shadowing visit that was coordinated through her school and a local engineering firm. She said, "Like they can't really find the people, they need to have to make those sort of connections—to do that kind of stuff—I tried to, but they don't really have the connections."

When trying to rationalize her disillusionment regarding the shadowing experience, she said, "It probably could have been fine but my problem is I need to see something to believe it."

Elly also talked about asking her mom questions related to engineering, she said,

> Sometimes I'll talk to my mom about it but she doesn't know everything, so, ah, she'll say well here's a sheet of paper you got in the mail, ah, I don't know there isn't a whole lot of people to talk to about it, cuz, ah, my family's not big on engineer[ing] (Elly, July 2000).

Influencers and people who care are important in the minds of these young women. Both Jess and Elly affectionately refer to their moms as a primary influencer. When asked, "Who has been a major influence in our life relative to your career exploration?" Elly replied:

> Hmmm... it would probably be my mother who helps me out when I am stuck. And I'm, like you know, I don't understand this, and don't understand what this career does or something. Cause she'll say, did you talk to one of your friends, did you talk to someone in the family? I would say, how my mom, probably that she has supported me, she was there. Sometimes my dad doesn't
care, he says, why are you doin’ that, why are you doin’ that (Elly, July 2000).

Jess also revealed a lot of positive reinforcement and this was manifested in her “can do” attitude. She said, “people always encouraged me and they don’t let you down.” Jess talked about a friend in class who said, “Go for it” when they talked about Jess’s dreams to have her own computer company. “[They [Jess and her friends] have all have big dreams, big dreams of being on top. Whatever the profession is,” Jess told me. She then added, “So I would say it is all confidence, whatever they want [for] themselves.” Elly’s views and attitudes were different. She described herself as anxious, and said, “I’m kinda excited but I’d say more anxious cuz I really don’t know what I’d like to do. Like more of, you know, if I do this, I will I end up, you know, not liking it. And can I get out of it? Or I don’t know. It’s more like scary.” As she thought about finding a career, the right job, and most imminent, the right college for her, she told me, “I’m trying to plot that all out.”

Analysis and interpretation

Although the number of research participants and contact time with the participants was limited, the intent of the preliminary study was to determine the importance and suitability of the research topic and the value of the questions posed. The purpose was to “peel away” and expose issues to probe regarding why more young women were not considering engineering as a career option.

Based on the findings of this small-scale study, three themes emerged. It was clear that the young women in this study, who had the benefit of intellect and formal and informal educational experiences, had limited knowledge about engineering. They also expressed difficulty when searching for information and answers about careers in engineering. They
said the information, specifically learning about what engineering is and what engineers really do was hard to find. Additionally, one of their primary sources of information and advice were their mothers and as they reported, their mothers did not know much about engineering. These circumstances and challenges make sense considering only 6% of practicing engineers are women (AAUW, 1998).

As I interpreted the findings, a logical approach and framework emerged for subsequent research and interviews warranting a critical theory methodology. The purpose would be to seek to analyze, critique, and transform the condition that young women lacked an understanding about the engineering profession, rather than attempting to understand why the condition exists and identify the influencers.

Refocusing the study

The preliminary study provided raison d'être for a dissertation inquiry that would probe the lack of knowledge about the engineering profession among young women. The findings of the preliminary study—or, the lack of information on the part of the participants when asked to describe engineering—caused me to reassess three fundamental aspects of a future study. I realized that a future study would need to employ a critical theory framework based on the disjunction I discovered between the scientifically gifted and talented young women in the study and their limited perceptions and lack of awareness of the engineering profession. Hence, three aspects of the study I felt needed to change involved the participants, methodology, and line of questioning.

First, it was clear that even scientifically gifted young women did not know what engineering was about. Therefore, in order to understand why more young girls were not
choosing engineering as a career option, I needed to examine the decision-making processes of young women as they were crystallizing (Jordaan, 1963) their vocational aspirations. Given the fact that so few women chose engineering as a field of study, one could hypothesize many women do not receive adequate career information to specify or implement a career decision that involved engineering. Further, I was interested in expanding the pool of young women who could consider engineering as a profession. Drawing upon career development theory (Jordaan, 1963; Super, 1990), I needed to involve 10th-grade young women who were beginning to contemplate [crystallize] what their vocational preferences and aspirations might be.

Second, the methodology needed to focus on the career exploration process young women employ when considering non-traditional careers. Therefore, a co-researcher framework would be appropriate for answering the prominent underlying research question—how do young women come to know engineering. The young women themselves needed to design the inquiry, specifically the data collection methods, which would guide the inquiry.

Third, the line of questioning needed to refocus on how young women approach learning about non-traditional careers, including what is important to know. Examining this issue through the “lens” of young women would enable the portrayal of an “authentic” perception of the engineering profession. The communicative underpinnings, derived from this depiction, could illuminate the disjunction between young women’s lives and the engineering profession, including cultural barriers and perceived challenges.
Part 2: How Young Women Come to Know Engineering

The researcher and the original purpose of the study

I was drawn to the topic of exploring the factors that influence or affect girls' choices of non-traditional career fields like engineering for many reasons. My professional career encompasses 18 years in college recruitment. As a college admissions and K-12 outreach professional, I have worked with young people and their families regarding career and educational opportunities in liberal arts, science, and technology fields. Currently, I direct the outreach and recruitment efforts in a College of Engineering at a flagship university specializing in science and technology in the U.S. Midwest.

One of my primary responsibilities is to increase the representation of women in the engineering college. Given these professional responsibilities, I frequently interact with young women considering post secondary education, as well as those who are in college or have recently graduated. We discuss ambitions, plans, and experiences related to life after high school or in college. I am curious about why only few talented and able girls pursue engineering majors, and stay in the field. I find it interesting and enlightening to step back to probe and learn more about how young women understand their experiences, and how this affects their actions and activity in regard to career exploration and selection of a non-traditional field.

I also have an interest in women's issues, specifically the psychosocial development of young women. As a result of my public administration background (professional experience, training, and Masters of Public Administration degree), I have followed the development and influence of the women's movement and youth culture, and how these two
phenomena are influencing the development of the information age. Therefore, coupling my extensive “field” experience and educational background with a research agenda that probes the underlying and influential factors affecting the way young women think about employment in the technical and male dominated profession of engineering was intellectually stimulating.

The ability to use one’s knowledge and experiences to interpret and understand a phenomenon is called “embodied subjectivity” (Mwangi, 2002, p. 66; Wolf, 1996, p. 13) in the qualitative research domain. It is a research tool common in feminist research. Sandra Harding (1987) refers to embodied subjectivity as the researcher and researched being on the same level (as opposed to objectivity where the researcher is the knower). Embodied subjectivity in feminist studies advocates the use of relationships, intuitions, emotions, empathy and experiences as data or knowledge, which speak to, and query the human experience (Mwangi, 2002). Given my role as a career advisor for young women, my professional experience, and position as a non-engineer in the engineering domain, I have a unique research position as a researcher. I have the ability to offer embodied subjectivity to the research study.

**Researcher reflexivity**

In qualitative research studies such as this, the influence of the researcher is paramount. The influence is called researcher reflexivity, and is considered the backbone of the study. Researcher reflexivity is the strategy, or methodology, which determines the perspectives that will influence a researcher’s assumptions about knowledge and how knowledge is gained. Guba and Lincoln (2000) label the strategy as the “researcher’s
position.” Researcher reflexivity involves the process of “reflecting critically on the self as researcher, the ‘human instrument’” (Guba & Lincoln, 2000, p. 183) or primary instrument for the study. Reflexivity clarifies the worldview, experiences, assumptions, and theoretical orientation of the researcher relative to the study. Therefore, to conduct this study, I drew upon my personal values and perspective, and 18 years of experience in the college recruitment profession, including seven years in the technology and engineering branches of the educational system.

In a broad sense, I have always been interested in issues that counter mainstream thought and lead to consideration of new paradigms of thought and action. I live my life in a non-conformist, albeit, “moderate,” manner. I embrace worthy and challenging social issues, which involve women, children, and the “Other.” The “other” or “otherness” is a term borrowed from anthropological and sociological studies and used to name the practice of understanding other “people and their language, culture, community, norms, values, beliefs, ways of life, traditions, and so on” (Schwandt, 2001, p.181).

My location, residing in an engineering college as a non-scientist or engineer, provides another unique research dimension. Patricia Hill Collins refers to this sociological location as the “outsider within” (Collins, 1986) and suggests this perspective or standpoint “enrich [es] contemporary sociological discourse” (p. S15). Its usefulness is that on one level, as an “insider,” I have a sense of the engineering culture having been a part of it for seven years. I also relate to the perspective of non-engineers (women investigating the engineering profession, in particular), being an “outsider,” as defined by training. Hill Collins (1986) asserts that “outsiders” occupy a special place. They are different and their perspective
sensitizes others to “patterns that may be more difficult for established sociological insiders to see” (Hill Collins, 1986, p. S29).

As a “human instrument,” it is also important to convey and reveal my feelings as a non-engineer in an engineering culture. I have observed that a mind-set prevails, which believes in the superiority of the scientific method. Further, the scientific method is presumed to be best understood by scientists (inclusive term including engineers and mathematicians) resulting in a closed system to “the Other.” For example, when describing the theoretical framework of this study to a professional engineering organization, I was advised not to describe the study using the “f” [feminist study] word. The purpose behind the well-intended comment was to assure that the audience would listen and not discredit my study based on personal biases and assumptions.

I also observed extensive gender bias within the engineering culture. Virginia Valian (1999), in her seminal work entitled, Why so slow? The advancement of women categorizes these gender biases and labels them “gender schemas.” Valian anecdotally and empirically confirms the detriment of gender schemas at work, suggesting men are often overrated and women underrated, therefore, the continued dominance of males in engineering. Often, women are devalued and their expertise is discounted, especially when stakes are high or power is in the balances. As a result, I was keenly aware of the hierarchy and the power relationships within the field.

Altogether, my location as an “outsider within” coupled with my experience, provided invaluable research reflexivity. This reflexivity offers a unique lens by which the data may be analyzed and interpreted. Tierney (1998) aptly acknowledges the value of this perspective by suggesting that reflexivity questions power and domination to “reclaim
representational space” (as cited in Mwangi, 2002. p. 69). In essence, to uncover or discover "how young women come to know" engineering will reclaim or introduce a critical knowledge-based dimension.

Assumptions

As I theorized the problematics surrounding how young women learn about engineering, I unknowingly allowed assumptions to develop in my mind based on my professional experience and background. As I looked at the presentation of engineering through imagery—pictures of cars, engines, machinery, and circuit boards, and the males who were portrayed along side these images—I believed that a major problem with how young women came to know engineering had to do with what they saw—the images. For most girls and women, car engines, machinery, or stereo and computer components are not of interest. Therefore, my assumption was that if engineering was contextualized in a feminine world, the interest level among girls and young women could improve.

The Land of Plenty (CAWMSET, 2001) congressional report dedicates a section to the public relations challenges of engineering, which includes how the field is described and presented. Related to this masculine imaginary are the constructs of constructivist pedagogy, a teaching pedagogy popularized in the late 1990s. This pedagogy is grounded in the notion that an individual learns best when concepts are contextualized in content that matters or has meaning to the learner. I theorized that a prominent reason young women were disinterested in engineering was due to the fact that what they saw and what was communicated about the engineering profession had little to do with what mattered in their world.
Original purpose based on my initial assumptions

The purpose of the original study was to build upon the current knowledge base within and across engineering, communication, and the behavioral sciences. I believed that exploring the role of language and imagery in developing a young woman’s contextual understanding of the engineering profession would begin to explain “how young women come to know” the field. In the end, the participatory action study emerged as research focusing on the influences of, and extent to which, the social and cultural aspects of engineering contributed to young women’s interest or lack of interest, rather than the images of engineering.

I provided this extensive self-reflection because it represented my epistemological stance in regard to this study, and was operational throughout the study. I adopted Bloom’s (1998) thoughts on the purpose and merits of self-reflexivity. Bloom (1998) states, “by disclosing and analyzing her identity and values [through reflexivity], the researcher asserts both that what she knows cannot be separated from who she is and that her warrants for making knowledge claims are subjectively situated and historically contextual” (p. 148). As noted earlier, self-reflexivity is the backbone of a study, and a benefit of feminist methodology. I have located myself through a description of my experiences, values [worldview], and assumptions, so that my position, like the participants’, can be understood, and critically evaluated.

Researcher role

Social researchers and qualitative researchers in particular face a unique dilemma, which Argyris and Schon (1991) refer to as rigor and relevance. The researcher conducting
qualitative research is closely interconnected and participates in the research along with the subjects or participants. What is learned from the inquiry is contextual and the researcher attempts to reconcile action with inquiry. The researcher, an instrument in the inquiry, strives to uncover multiple perceptions and beliefs and to make sense of them. This objective of qualitative research is also prominent in ethnographic studies such as this one.

At the first meeting when I introduced the study and its purpose to the potential participants, I introduced myself as a researcher and a graduate student in Educational Leadership and Policy Studies, who was seeking research participants for a dissertation study. I told them I had selected the topic of “how young women come to know engineering” because I was also a college admissions and K-12 outreach professional of 18 years. I was curious about how young women of today explore and consider career options, in particular the engineering profession, because of its importance in an information and high-tech era. I did not tell them I worked in the College of Engineering. I did not want this position to bias or motivate their responses. I told the young women that a benefit of participating in the study was that they would learn some career exploration techniques, which would translate into researching other career fields as well. I also told them they would learn about themselves and how to be a researcher.

We discussed their role as co-researchers and the value of the co-researcher model in exploring the research questions I identified. I told them I would support them as a co-researcher, and provide guidance and advice when needed. The “status” as co-researchers did not seem to influence or intimidate the young women. Their perspective was unknown and their focus was functional. For example, Amy’s thoughts were: “I am very excited.... I want to learn about engineering and the opportunities.... I have an idea of what we are doing now,
but still not very sure.... hopefully, Monday will help me figure that out” (Amy’s journal entry, February, 2002). Haley wrote, “I started thinking on Wednesday of what I really thought about this experiment thing.... what I really want to find out about is what jobs are out there and trying to find something for me” (Haley’s journal entry, February, 2002).

We discussed their responsibilities of providing written responses [journaling] following data collection and a reflection paper at the conclusion of the study. I offered to write the “scholarly” account of the study, with periodic member checks (Huberman & Miles, 1994; Maxwell, 1996; Merriam, 2002) whereby the participants reviewed and commented on the data collection and analysis. They were most appreciative of this offer, because their time was limited and they were intimidated by the prospect of “writing up” the research. We talked at length about “standpoint theory” and the importance of “voice,” their voice, as we wrote the study. This study would be sensitive to authentically presenting their experience.

A couple times during the study, I asked the young women to comment on my role as a researcher. I told them my intentions were to provide guidance when necessary, but not influence the study. They said they appreciated my role and presence. Following the job shadowing experience one co-researcher said, “it was good because you brought up some things that I hadn’t thought of” (Job shadow transcripts). In general, the co-researchers looked forward to our data collection meetings.

As the researcher, I wrote an academic account of the research study that included member checking with the participants. The research participants completed journal assignments throughout the study and responded to reflection questions at the end of the study. The participants determined if additional artifacts and documents should be included
for data analysis. I also included my observation notes and the audio transcriptions in data analysis.

Rigor and trustworthiness

Because ethnographic research can be considered “eclectic in its use of data collection and analysis procedures” (LeCompte & Preissle, 1993, p. 48), I have assured accuracy by employing four tactics that served to provide rigor and trustworthiness throughout inquiry and data collection. First, extreme caution was exercised when recording and analyzing data. Records, transcripts, and artifacts, were secure. Second, all meetings, activities, data collection, and de-briefing session(s) were audio taped and transcribed.

Third, observation notes, field notes, memos (Taylor & Bogdan 1998), journal entries and self-reflection essays provide triangulation. Triangulation refers to the “combination of methods or sources of data in a single [qualitative] study” (Taylor & Bogdan, 1998, p. 80). Denzin (1978) refers to this process of bringing together different sources of information and gathering techniques as “triangulation.” In qualitative research, triangulation enhances the findings and safeguards against error in interpretation.

Fourth, peer reviews (Taylor & Bogdan, 1998) or peer de-briefers provided invaluable input, insight, and commentary on reflexivity, in particular. As noted, research reflexivity can be desirable and can compliment the study. It can also hinder the process if the researcher’s role becomes controlling, biased, or involves some other undesirable influence.
Research participants

When doing critical ethnography, the data sources — people, artifacts, or documents — serve to ultimately shape the analysis. It is important to select those who possess the “insider’s knowledge” of the research domain (Yablonsky, 1969). To accomplish this, the study employed what Patton (1990) refers to as a purposeful sampling and LeCompte and Preissle (1993) call “criterion-based” selection.

Gaining access to suitable students was not difficult given the nature of my work and my professional network. I extended a call for participation to two colleagues, who could be viewed as gatekeepers. In qualitative research and working with student who are minors, the individuals who provide access and grant permission to interact and contact potential research groups are called gatekeepers (Becker, 1970 & Burgess 1991, as cited in Taylor & Bogdan, 1998). Gatekeepers in this study included one colleague who worked with teachers from larger urban schools, and the other, an administrator who represented a small, rural school district. Both were in the same Midwest state.

The urban gatekeeper was a program coordinator of an after-school program for under-represented minority students. Youth in the science-based after-school program were chosen for the program based on aptitude and ability in mathematics and science. This gatekeeper, however, identified two potential schools that had high participation rates in the program and directed me to contact the lead teachers. I subsequently contacted one lead teacher in one of the schools and was granted access. The basis for my selection was merely ease in scheduling as the after-school programs only met one night a week. As the study developed, this gatekeeper relationship (not as instrumental as compared to the rural
gatekeeper relationship) could have influenced the quality of the data collection for the urban group. A discussion of this implication occurs in the discussion in Chapter 6.

The second gatekeeper was a superintendent in a rural school. The superintendent was a classmate in my graduate program and we also collaborated on another research project. The second group of young women was selected due to the gatekeeper’s interest and commitment to career awareness for her students and the advancement of modern mathematics, science, and technology disciplines in the school district. This interest, and subsequent participation in the research, potentially influenced the quality of the data collected from the rural group.

The original research design called for six ethnically diverse 10th-grade young women (three at each site/in each research group). However, after the study was introduced at the informational meeting (see Appendix A-1). Note the graphic nature of the document; the fonts were used to create “interest” and highlight key aspects of in the project), two groups of four young women at each site self-selected to take the survey to qualify for the final selection. The selection criterion filter involved a survey (see Appendix A-2). The purpose of the survey was to identify 10th grade young women who were:

1. Beginning to think seriously about their future careers;
2. Not pre-disposed to the engineering profession by a family member or family friend;
3. Average to above average students (top half of their class and have a 2.8/4.0 grade point average); and
4. Did not have strong pre-conceived ideas about a major or career.

The survey results disqualified two young women from the urban group due to a strong preference for a major or career. Additionally, two young women attended the urban
group meetings and qualified but chose not to participate when the study began. One young
woman from the urban setting, whose parent completed the consent form, did not attend the
meetings and did not respond to communication about the study commencing.

Thus, the participant groups included two young women from the urban setting and
four young women from the rural site. The even number of participants in each group proved
to be beneficial as the study unfolded. The girls naturally divided into pairs. There seemed to
be a sense of comfort in having a partner to work with, learn from, and think with, as the data
collection stages of the study developed.

It also should be noted that as audiotapes were transcribed it was difficult to discern
between the participants voices. My ability to maintain, on a consistent and on-going basis,
the statements of each participant by name was impossible. However, when referencing
observational notes [field notes] or journal entries, I do identify the participant by name
(pseudonym).

**Urban group**

The participants, Alice and Joan (pseudonyms), were class acquaintances. Joan was
Hispanic and was in the after-school program. Alice was not in the after-school program, but
was in other school and social service programs. She was adopted and did not know her
racial and ethnic background. Alice took the initiative to volunteer for the research project
when she heard the announcement in school.

Throughout the study it was difficult to sense Joan’s actual feelings and thoughts. She
often seemed quiet, reserved, and possibly uninterested at first. However, she was the most
dependable (as compared to Alice, who occasionally encountered extenuating circumstances
and could not fulfill assignments). I often talked to Joan after our scheduled “research” time, and got a better sense of what she thought and how she felt. Joan continued to be the mainstay of the group and was responsive to probing questions and developing ideas for further exploration. I did not learn a lot about Joan’s background, other than she enjoyed the band and school year book. Joan seemed to be a diligent learner and her mother was quite involved in her education—talking to teachers and administrators when problems or “unfairness” seemed to interfere with Joan’s performance or ability to learn. She supported Joan’s involvement in the study as well.

I became quite familiar with Alice, the youngest of four grown children. She attended a science-based outreach program for girls when she was younger and enjoyed the “hands-on” activities and thought the “other” sessions were boring. Alice was interested in learning about exploring careers, and was most energetic at the onset of the study. Alice told me she had been involved in accelerated learning programs, and was attending the magnet school half days. She was enrolled in a Sylvan Learning program also. Alice liked athletics, was a peer helper, and also had a part-time job at a mini-mart gas station. With her savings, she was planning to buy a car.

Alice described her troubled home life openly. She had a social worker assigned to her in school, who provided support and guidance when necessary. During the study, Alice emailed often, and I worked with her to realize her own potential and the career opportunities available to her. When Alice took the selection survey, her answers indicated she was not receiving As and Bs in all her classes. However, due to school-based and social programs she was affiliated with, coupled with her interest and determination to be a part of this study, I chose to wave the grade criterion for Alice, and have her participate in the study.
My interaction with the lead teacher as gatekeeper for the urban group was limited after I identified research participants. It should be noted at the onset of the study I did not outline additional expectations of the gatekeeper other than providing access to students. Rather than working through with this teacher/gatekeeper for additional needs throughout the study, I worked independently. By working with the school staff, I negotiated meeting space, and investigated and complied with school policy for excused absences for field trips. I communicated with the research participants on my own.

**Rural group**

Interaction with the rural group and the gatekeeper was quite different. While the girls were interested in the topic and the study, they expressed apprehension. Prior to the Career Expo Jen wrote about the fact there would be many “important companies there with representatives” and “what if I start getting interested in the engineering field? Is that a good thing for me or do I want a more traditional job? And if I am interested, will I be able to stay close to home or not?” (Expo journal entry). Amy expressed her feelings about the Expo by saying “The Expo was educational at most. I felt really overwhelmed... I didn't really know what to ask” (Expo journal entry). One of the co-researchers observed that the college people did not talk to the industry representatives, but they “just walk by and take their stuff and leave. They don't even stop to talk to them...I take stuff after I talk to them at least because I didn't want to look dumb” (Career Expo transcripts, Rural group). They participated fully and enthusiastically. They completed writing assignments in a timely-fashion, and in general, were more dependable than the urban participants. The gatekeeper was very supportive. She made arrangements for meeting places, facilitated communication (including technical and
personal communication), and provided some transportation. As stated earlier, this interest level and involvement potentially influenced the quality of data collected.

The gatekeeper identified academically strong students for the study. One of the young women indicated she was not interested in engineering when she filled out the survey, but she wanted to remain in the study and said she would have an open mind. I did not sense or observe any bias from her throughout the study.

The four young women were friends, yet they paired up in twosomes almost immediately. Jen (pseudonym) was born and raised in the area. She had an older brother and sister and wanted to go to college—perhaps to study business or teaching. Jen was looking forward to the learning experience and was curious about engineering and the types of jobs it offered. (She was also the one who indicated on her survey she was not interested in engineering!)

Haley (pseudonym) had transferred to the high school the previous year. She had a younger brother and sister and a serious boyfriend. She did not know anything about engineering but was "interested in money and kinda materialistic" (Haley journal entry, February, 2002). She had "no idea" what she was going to study in college, but her family was stressing a teaching profession.

Henna, born and raised in the community, was the oldest of three children. Her father was a welder and Henna enjoyed her father's vocation. She was often in the shop welding. She told me customers would comment on a "girl doing welding work." She did not know about engineering and was open to a variety of careers. She seemed, however, to lean towards were physical education and art.
Amy had an older brother and sister. She commented on the limited exposure and awareness young people from the area had, especially in regard to engineering and other professional fields. Amy had “no idea” what she wanted to do, and wanted to learn more about engineering.

Research sites

In accordance with participatory action research, the participants selected the research sites. These included their school, home, business, restaurant, and the campus of the researcher. I told the research participants I would identify the first research site to “kick the study off” and they would determine the remaining data collection sites. A decision as to whether the group would meet as a unit or individually was reached using a participatory approach. At a minimum, the participants chose to work in pairs.

I selected the Spring Engineering Career Expo held on the university campus as the first research site. The career expo was, in essence, a career fair, which exposed the young women to all the engineering fields and allowed them the opportunity to observe and question. Following the Career Expo, the two groups (rural and urban) chose different research venues. Among the group members, there was consensus regarding the approach to data collection.

Data collection: Mode of inquiry and data sources

Information and decisions covered at the initial meeting with the research participants included: (a) an introduction to research and research methodology; (b) discussion of participant and researcher roles; (c) sharing the objective of the research – to identify how girls explore and come to know the engineering profession (what is seen, heard, and
While exploration was encouraged, a timeframe and general timeline was agreed upon.

Soliciting participation

As previously described, locating and gaining access to the participants was different for the rural and urban groups. The rural gatekeepers identified potential research participants, introduced the study with the parent letter and consent form (see Appendix A-3) and instructed the girls to bring the letter home describing the study. Parental consent forms were required to participate in the study and all participants returned them promptly. The gatekeeper also administered the selection criteria survey. When I arrived at the rural site for my first meeting, I reviewed the surveys (four of five girls qualified and the four qualifying were in attendance). The purpose of the first meeting was to commence the study. (The participants were aware they could withdraw from the study at any time. I communicated this verbally and in the parent letter.)

The first meeting at the urban school involved a meeting with the after-school coordinator for the science-based program—a program that was offered at multiple schools. He was enthusiastic about linking me up with the teacher responsible for the after school program at that particular school. The coordinator also submitted an announcement to be read on the PA system the day of my meeting, announcing the study and informing students of the location of the meeting. From this information source, two additional girls inquired about the research opportunity.

A second gatekeeper, the teacher for the after school program, was less interested in encouraging the students to consider this research and learning opportunity. When I arrived
at the school for my scheduled meetings he did not offer assistance in locating students or suggesting meeting places. The impression I developed throughout the study was that he was not very interested and committed to the after school program in general. I did not observe any meaningful or educational dialogues between the teacher and students. The students confirmed my observations. The group showed little respect for the teacher as well. He was usually in casual conversation about weekend plans, summer work at a golf course, or sports. As a result, he did little to facilitate or encourage the girls’ participation in this study. I found this odd because the purpose of the after-school program was to encourage and support minority students in the sciences throughout high school, so they would have the skills and confidence to pursue a science-related discipline in college.

The first meeting with the urban group involved introducing the study, expectations, parent letter, and consent form. The students completed the selection survey and I informed those who did not qualify for the study. For those who did qualify, I impressed the need to return the parent consent form at the meeting the following week as the study was going to begin at that time and people could not join after the study had commenced.

**Initial meeting**

The initial meeting with both groups was similar. I met briefly with the gatekeepers. The rural gatekeeper had reserved a room for us—the conference room with a conference table connected with her office. She had also arranged for laptop computers per my request. (I used them as instructional tools in preparation for the Career Expo and to introduce them to a university web site and all its information.) At Urban High, the gatekeeper/teacher suggested I take the students to the teacher’s lounge (where we meet for the first meeting)
and meet there, if it was available. It was. We sat in lounge chairs and discussed the research project. Our conversations were audio taped and I kept extensive field notes including observations. (This practice was standard throughout the study. I will not repeat mention of this practice at each collection site.) I followed an outline of key topics (see Appendix A-4) at the meeting. Taylor and Bogdan (1998) refer to this outline as an “interview guide” (p. 105; as cited in Kvale, 1996). The guide serves as a reminder of topics to discuss, allowing the researcher latitude while questioning or within discussion.

We commenced the study with introductions. I shared my background as it related to this study (my college admissions experience) and why I was doing the study. As I presented “who I was,” I was cognizant of the importance of the students liking me and on-going challenge of maintaining their interest in the study. They were volunteers and were not being paid.

Having worked extensively with teenagers this age, I knew they led very busy lives and their perspective was “about them.” Consequently, I needed to appeal to “them.” I was upbeat, somewhat youthful in my approach (common language; dress was business casual; and attitude was light-hearted), and flexible (timelines, ideas regarding the study). This approach was not out of character for me and it seemed to be effective. I continually emphasized the applicability of this information as they made decisions about their future, and provided a literature base involving contemporary youth studies and identity development (see Appendix A-1: Career Exploration Research Project. Note the text and design of the document).

The young women were fascinated by the characteristics of Gen Y (Howe & Strauss, 2000; The Lawlor Group, 2001; Schneider & Stevenson, 1999) and the development of a
young woman’s ‘voice’ (Belenky et al., 1986; Denzin & Lincoln, 1998; Gilligan, 1982, 1993; Smith, 1987). Standpoint theory (Fraser, 1989; Harding 1986, 1991; Hartsock, 1991; Hirsh & Olson, 1995; Smith 1987) was a concept we discussed and Don Super’s (1963; 1990) developmental stages of career exploration also made sense to them.

I also introduced participatory action methodology (Denzin & Lincoln, 1998; Greenwood & Levin, 1998; Schwandt, 2001). We discussed the roles of the participants and the researcher, and the options to research as an individual or in groups. I emphasized my role as a facilitator and advisor when necessary. The girls were familiar enough with one another that this arrangement was acceptable and seemingly developed effortlessly.

We brainstormed ideas for data collection and methods. I underscored the importance of “authentic” youth research given the lack or limited nature of current qualitative youth inquiry. I also discussed future workforce issues (demand for engineers) and why women were needed in the high tech professions. We talked about the importance engineering had placed on encouraging women to enter the workforce, and how, in this study, we were going to document this exploration journey—from young women’s perspectives.

I introduced the methods for data collecting, which involved the audiotapes, my field notes and observations, their journal entries reflecting the data collection experience and thoughts that transpired. I encouraged them to research on their own and keep a record. When we brainstormed places and ways to learn more about the career of engineering they mentioned the library, talking to engineers, newspapers, the Internet, email, newsletters, university web pages, books, and talking to companies (Urban group, February meeting, 2002; Rural group, February, 2002). Both groups had similar lists. Appendix B-1 outlines the
data collection dates, sites, research topics, and assignments, which subsequently evolved as a result of the participatory action methodology employed in this study.

The last task at the initial meeting was to prepare for the Career Expo trip. The rural group used the laptop computers to log on to the university website for the information about the Career Expo—the companies attending, the types of engineers they employed, and a map of the floor [booths] so the young women could anticipate the magnitude of the event. We brainstormed questions to ask the company representatives. Half of the questions they formulated related to work as a woman or a mother (see Appendix F-2 for Career Expo Questions). The first four questions included topics such as pay, benefits, maternity leave, childcare, and working through a pregnancy, if you are a chemical engineer, for instance (Rural group, February, 2002). They also inquired about “women being accepted into your company;” “have women worked in your company before, and if so, how long were they there?” “What was it like [having women present in the workplace]?” “Did the male and female engineers get along?” (Rural group, February meeting, 2002). The urban group did not have time to create original questions, but they reviewed the rural list and liked the questions. They decided to use the same list (see Appendix B-2).

We closed the meeting after making transportation plans to attend the Career Expo and discussing the journal writing assignments. The writing assignment included thoughts about the study, and a reflection on what the girls learned, thought about, or realized. They were asked to email or fax the assignment to me within the week.

The journal entries reflected a genuine interest in the study and learning more about exploring career options, in general. The young women were optimistic about their futures and finding something right for them. For example, Henna wrote, “I am really interested in
this study.... I chose to be in this study to learn more about careers and why most women are not choosing careers that they can [Henna underlined] succeed in” (Journal entry one).

Another wrote, “It is true that you can be whatever you want to be but I think that you need the right tools and setting too” (Haley, journal entry one).

Career Expo – February 19, 2002

Transportation to the Expo differed for the two groups. The rural group, who lived 90 miles away, drove with the gatekeeper (superintendent). They were released for a half-day of school so they could attend. The young women from Urban High did not have transportation, so I provided transportation to and from the Expo. The participants lived 40 minutes from the university. I also provided box meals for both groups to enjoy as they traveled to or from the Expo. The rural gatekeeper was most appreciative.

The Communications and News Service office at the university where the Expo was held learned about the study and asked if a reporter could interview me and photograph the group. I contacted the gatekeeper, who asked the young women if they would be interested in this type of publicity. They were flattered and thrilled to be asked, and the interview and photo session was granted (see Appendix C for a copy of the March 1 news article).

The day of the Expo was rainy. In my field notes, I recorded the following as I sat at the entrance to the Expo awaiting the arrival of the first group (rural group),

...traffic looks pretty good here for the career fair [expo]. We've got young people, primarily college students here, dressed, most of them in interviewing apparel, many carrying umbrellas and portfolios and others are dressed a little more casually.... the companies attending today...are not only looking for summer employment, and coops and interns, but also for fulltime employees. (Bruning, Expo field notes)
The young women arrived at the Expo with their list of questions. I gave them hand-held tape recorders to record the question and answer conversations with the company representatives. We practiced using the tape recorders to assure the girls knew how to operate them. We also discussed the importance of telling the representatives the conversation would be audiotaped and why. One company representative expressed concern about this practice. The girls divided into pairs and started negotiating the crowd and the booths—including 250-plus companies.

After 45 minutes of walking through the booths and interviewing (including audio taping conversations) the company representatives, I told the girls to re-connect with me at the present location. Following this rendezvous, the rural group requested more time to interview (15 minutes). The extra time was granted.

The urban group was prepared to leave at the end of their first 45-minute interviewing period. Their interview time was the last hour of the five-hour Expo. Consequently, the later minutes of the urban group's data collection also coincided with the closing of the Expo. I observed a "letting down" of excitement in the building as company representatives started to disassemble their booths, and focus on leaving rather than visiting with Expo attendees. The girls said they would have liked to have had another hour, and suggested arriving earlier next time to allow for another hour.

As I talked to the participants following their interviewing, they said most company representatives were interested in talking to them. All of the participants noted the imbalance of men and women—in both college students attending and the gender of the representatives in the booths. They all agreed they liked talking to women representatives better, one young
woman reported, "we like ladies better than we did the men. The men were very...they didn't know how to answer the questions" (Bruning, Expo transcripts).

The biggest surprise for one urban participant (and the other concurred) was "that they're [men] not sexist" (Bruning, Expo transcripts). She was reflecting on the attitude she encountered when talking to males representatives. Additionally, she found this attitude affirmed by the women representatives she discussed professional advancement with. "It was basically your effort and how you did your jobs. I was surprised that a lot of young women said that" (Bruning, Expo transcripts). I then probed further by asking what the men said, and the participant replied, "the men said, yeah, it's totally how you did your job...that didn't surprise me much. I just thought it was interesting how many women said that" (Bruning, Expo transcripts). The urban groups also noted the amount of college it would take to become an engineer. They had not thought about that, they said.

The young women also said they were amazed at the "huge variety" (Haley Expo Journal) of engineering options, and many they did not know existed. One young woman said to me "if I can't find something I like in engineering, something is wrong with me" (Bruning, Expo field notes). They liked all the "free stuff," and found themselves exhausted, yet amazed, by the experience (Urban group Expo transcripts; Bruning, Expo transcripts; Rural, Expo Journals). I also made note that they really did not know where to start. They needed more guidance from me than perhaps a participatory research project should ask for or require (Bruning, Expo field notes). Without question, I knew that attending the Expo and the exposure, gave them a real feel for what engineering had to offer currently. The experience also provided a good jumping off point for purposeful career exploration.
Upon leaving the Expo, I asked the girls to reflect on: what they saw (displays, ways the companies presented themselves); what a company was about and had to offer; what they learned about the engineering field; what they read on the displays or materials they took home; or what they looked up on the web sites. They wrote about these questions in their journal writing. I also sent a reminder email reiterating the request.

Third meeting – March 1 & 7, 2002

Following the Expo, the participants' expressed great interest in getting “more specific” information by visiting a company or people they visited with at the career fair to learn more about the profession “on-site.” I coached them on using the materials and “free things” they had collected at the Expo to further explore the companies they learned about on the Internet on their own. All the young women wanted to spend more “one-on-one time” with female engineers to learn more about what they do and to job shadow them for a day. A time was scheduled to carry out this task via data collection. In fact, while driving the urban group home following the Expo, they started to name companies they wanted to visit and explore the opportunities with engineers first-hand.

As I traveled to Rural High for our third meeting, there was much excitement surrounding the study. I felt this based on the enthusiasm the girls expressed through their e-mails and journal entries. I arrived early, so I decided to explore the downtown area to get a feeling for the community. Advertisements, local attractions, and the city's web site suggested this was a German community and with a rich heritage. It was a community of 1500 that was proud of its health care facilities, progressive educational system, and state-of-
the-art telecommunications systems. It was a well-kept community, with cobblestone streets in the downtown area.

I had prepared an outline for my meetings, and used it as a guide (see Appendix B-3). Together with the participants, we reviewed the purpose of the study and the role the young women had in this participatory action study. I brought the transcripts from the Expo for our review. We also discussed the journal entry topics (what they saw, heard, read, felt; what they learned about the profession and what was appealing/unappealing; and future plans). I met with the participants in pairs—the same twosomes from the Expo.

Journal entries from the Expo expressed amazement in regard to the Expo experience. The participants used words like “cool experience” (Alice Expo journal) and “very impressed” (Jen Expo journal) with the Expo and the profession. These comments were not without a critical or concerned observation[s], however. For example, “I also noticed that most of the guys were really not interested in talking to us about women in engineering...not all guys but most of them” (Henna, Expo journal). Jen wrote, “The booths that caught my eye the most were the ones with food...and free stuff, pictures, and bright colors. I was surprised to find some not even having 2 pictures and their name” (Jen Expo journal). Amy’s journal said, “I also kind of realize why women don’t usually enter the field. “I don’t know if I would be able to work through school. The intimidation of men all around would make me uncomfortable.” The urban group reported, “I didn’t like that guy at all” and “I think that guy didn’t think we were serious” (Bruning, Expo transcripts). The only negative comments they made resulted from interactions with male representatives.

The urban group had chosen to accelerate their data collection. As I drove them home from the Expo, we discussed the possibilities of plant visits—which included three or four
different industries. The young women hoped one company visit could be Polaris because they said they loved the Jet Ski display at the Expo and jet skiing (Bruning, Expo transcripts). (I was unable to arrange this due to the transportation logistics; the company was 200 miles from their homes.) Another desirable company visit was food related, Italian food, specifically. The girls wanted to visit the companies the following Friday, March 1, which, was a vacation day for them.

The decisions and logistics involved with the company visits were numerous. The participants expressed their interest in types of companies they wanted to visit and that they wanted to talk to some women. The urban group wanted to visit several companies. The rural group wanted to job shadow. As a researcher, I was sensitive to "biasing" the visit, in that I wanted the participants to experience the engineering company like others would if they called for a visit or job shadowing experience. Therefore, I was consistent in stating the request for a company visit with the staff person responsible for coordinating our visit. I explained verbally and in writing. The e-mail request read:

This is a research project involving 10th grade girls. The research involves exploring the engineering profession and learning about how these girls come to know the engineering profession. We would like a tour and learn about how engineers are involved in your operation. If possible, the girls really appreciate hearing from and asking questions of other females involved in the operation. (Personal e-mail, April 3, 2002)

The metals plant (site visit for the urban group) was an exception to the standard request for a company visit. Prior to our visit, I learned that the tour was going to be given by retired male engineers. I did not believe this would be of benefit to our research, so I contacted a former engineering student who was employed at the plant. She was in management and took over the plans for the visit at that site. The wood and construction
plant was a smaller organization, so I contacted a woman engineer who had been very active in the Society of Women Engineers professional organization and had worked in my office while she was in college.

However, between the Expo experience and data collection at the selected companies, a number of significant events occurred conflicting with our scheduled company visits. As a result, I postponed the originally scheduled visits. Most of the company representatives understood and eventually we identified new dates. Due to re-scheduling, one food processing company (an urban group company) needed to cancel due to visiting dignitaries. Another change involved wood and construction company visit (rural group). The woman who was going to host our visit transferred to a different location, which left one female engineer in the plant. She hosted us (she was the former staff person of mine while she was in college).

**Urban group's rescheduled Company Visit and Job Shadow – April 8, 2002**

As mentioned previously, the urban group wanted to see a variety of companies, so the plans for the April 8 visit included four different engineering-based companies. (See Appendix B-4 for April 8 official schedule). Appendix I also includes details about each company visit not included in the schedules sent to each company visit coordinator.

The day of the company visit was again dreary, but I was looking forward to the experience with the girls and I hoped they would share in my enthusiasm. I called them both the previous evening to remind them about the shoes (closed-toed shoes were mandatory on factory floor), which actually was a cause for concern because one girl only had tennis shoes.
I could not loan her a pair of my shoes because her foot was too large, so we hoped her tennis
shoes would pass inspection.

Problems developed throughout the day. These were primarily due to a hectic
schedule resulting in timing-related issues. Departure from the first site was timely, however,
the location of the second site was unknown because I had never visited the Center and I was
unfamiliar with the parking availability. This caused a delay, and was complicated by the fact
that one of the participants insisted on locating her cousin who attended the university. This
request caused a strain between the young women and myself. They were interested in
locating the cousin, and I was interested in assuring that the girls arrived at their
appointments on time. The focus on locating the cousin seemed to affect their interest level.
Later, following intense probing, I learned that one of the reasons the young woman wanted
to see her cousin was to get a tampon from her. We stopped at a convenience store, and the
concern was remedied. We arrived at the metals plant 30 minutes late causing the organizer
of the visit to shift the schedule, which involved seven other engineers.

Each participant arranged permission for absence from school. In one situation, I was
asked to provide a social worker a letter describing the study and reason for the absence of
one of the participants. I provided transportation for both groups. The urban girls requested
Italian food for lunch, so “carry-out” Italian sandwiches were picked-up following the ice
cream making activity. The woman who organized the wood and construction company visit
arranged a “rap session and pizza” over the lunch hour with other engineers for the rural
group. Dress for the both visits included casual apparel, however, closed toed shoes and hair
pulled back was mandatory.
Rural group's rescheduled Company Visit and Job Shadow – April 9, 2002

Kelly (pseudonym; an engineer and former student of mine), who coordinated the visit to a wood and construction company, developed a detailed schedule for the young women and myself (see Appendix B-6). Details of the visit are also included which were *not* part of the official schedule. Overall, the organization resulted in a nicely paced and educational day. The job shadowing provided the “real experience” that the young women were seeking. We coined it the “show me” experience. For example, they valued the opportunity to stand in front of a machine while its uses or problems are described, or to look at auto CAD prints to better understand the role the engineer had in developing and using them (Bruning job shadow transcripts).

Both groups were assigned the task of writing up the Top Ten things they thought would make an educational job shadow or company visit and the Top Ten things that make a bad experience. This seemed to be an easy assignment for everyone. They completed them in a timely manner and with little prodding or explanation.

Final data collection meeting – April 22 and 23

Like the other data collection meetings, I prepared an outline to guide our discussion (see Appendix B-7). We reviewed the Top Ten assignment and the status of the research project—the data collection was complete and I would be drafting the preliminary findings. We set tentative meetings to review and comment on the findings in early June. The primary data collecting activity on this day was to utilize the Internet to search and research college information and professional or occupational information.
The meetings in both settings were similar in content, but differed dramatically in terms of discussion and analysis. The difference stemmed from the fact that one of the urban participants did not attend the final data collection meeting due to a death in the family and the visitation was being held that afternoon. Her departure left only one participant and myself. While we were comfortable with one another, the data collection lacked dialogue because my role was to guide or assist in locating Internet sites, not reacting or critiquing them. Another anomalous dimension was that the remaining urban young woman present had been barred from using the computers at the high school because she had violated a school policy for appropriate use. I met with the principal about the matter, and he allowed the young woman to use the computers to complete the data collection activity on the Internet, in my presence.

The Internet exploration involved logging on to a series of engineering related web sites and reviewing them for content, applicability, and educational value. A list of the sites included www.engineeringirl.org, www.girltech.com, www.nasa.gov/women, www.asee.org/precollege, www.aauw.org, and a university site. The Internet activity and dialogue with the rural group was lively and interesting. They spent most of the time exploring the sites I suggested, and less time exploring on their own. The young women were interested in the fun facts, the gadget section, and the games. They also found the information about specific majors interesting, as well as the admission requirements to get into college and how to prepare for an education in engineering, for example.

The topics for the final journal entry were based on questions I formulated after reviewing the data already collected. The questions posed were intended to fill potential gaps in the data (see Appendix B-8). We discussed the questions and I sent them to each co-
researcher via e-mail. I emphasized that the purpose of this research was to articulate how young women come to know engineering. Specifically, articulating through their voices. Therefore, the final stages of the research—the analysis and the writing—were as important as the data collecting. I thanked each of them for their time, told them our next meeting to review the findings would be at a restaurant of their choice, and I hoped they had a little more they could give the study.

**Members checking the preliminary data analysis – June 10**

We sat in a booth at the restaurant of their choice. During our time there, friends and even family stopped in for something to eat or just to meet others. We decided we would order something to eat when our “work” was done. After catching up on how the prom went (two of the girls attended), how summer jobs and summer fun were developing, we launched into the work for the morning. Like past sessions, I had an outline of topics to cover (see Appendix B-9). We planned to review the charts (see Appendix B-10, Chart A; Appendix B-11, Chart B; and Appendix B-12, Chart C) that I had developed. The intent of the charts was to provide a visual depiction of “how they had come to know engineering.” We also discussed the metaphors I chose to describe the phenomenon of “coming to know.”

We decided I would “talk them through” the charts [findings] after they had reviewed them on their own. The young women decided they would make notes on the charts if they needed to remind themselves of a thought. Following, my explanation of the meaning behind each chart (Chart A: Capture and Learn; Chart B: Career Exploration Approach/Process; Chart C: Communicative Factors), together, we elaborated further on the findings and changed, edited, and expanded the data.
Finally, we explored three issues: (1) what was meant by a “traditional view of engineering;” (2) commentary on the influence of the young women’s math and science experiences in school; and (3) whether they wanted to be referred as “girls” or “young women” in the study. After a long contemplation, they said they did not care (Bruning June 10 field notes) what label “girls or “young women” was used. Unfortunately, I was unable to schedule a similar meeting with the urban group. Both participants started Driver’s Education the week I traveled to Rural High for the final data collection, and after driver’s education they were unavailable.

Summary

I chose to provide an extensive description of the study given the nature of the research. As stated previously, the purpose of the study was to create a means for informing and envisioning new perspectives on how the young women “come to know” the historically male-dominated field of engineering. To this end, feminist epistemology was employed as a means to detect and elevate young women’s voices and perspectives as they explored the engineering profession as a viable career option. The epistemology of the participants’ was captured through a participatory action research methodology. A detailed account of the study and the exploration process, as it unfolded, provided the content for Chapter 4 entitled “The Study.”

The knowledge and perspective gained from the study was extensive. As a result I chose to focus primarily on perspective, rather than the career exploration journey. In Chapter 5, I identify prominent epistemological themes based on and supported by the data. A discussion of these findings follows in Chapter 6.
CHAPTER 5. ANALYSIS AND INTERPRETATION

Overview

Analysis and interpretation of the data collected constitutes this chapter. In a qualitative research study, the data refer to "the essences of people, objects, and situations" (Huberman & Miles, 1994, p. 182). Data, therefore, are in the form of words based on observations, interviews, or documents. Data collection activities were described in Chapter four and outlined in Appendix B-1. The data are in the form of my field notes (observations), audio transcripts from data collection activities (interviews, site visits, and meetings), and journals the participants kept when reflecting upon data collection activities (documents). Personal e-mails are also included as data.

Through careful and intentional analysis of the data, I reconstructed the information gathered and provide an account of the viewpoints and perceptions young women develop in regard to engineering as they learned about it. I also offer an interpretation of their contextual understanding as it develops. The analysis and interpretation of the young women’s "discoveries" are told through their words and from their standpoint.

Wolcott’s (2001) analysis approach was utilized with the research questions providing the framework. Answering these questions led to interpretation about meaning. Data for the analysis were selected according to the researchers’ subjectivity (reflexivity) including the co-researchers’ standpoint, and answered the following the research questions:

1. How do young women approach researching and learning about a non-traditional career field like engineering? — What is important to be known? What questions need to be answered? Where is the best information?
2. What do you see/hear? — What are the communicative underpinnings that influence young women's images and perceptions which guide the decision-making process when considering non-traditional fields like engineering?

3. What is appealing or unappealing about a profession like engineering? — Do young women perceive cultural barriers or challenges? What opportunities do they envision?

**A Central Discovery — Refocusing of the Original Research Questions**

While the overarching research topics remained consistent throughout the study, the focus on the communicative underpinnings as it related to media and imagery shifted. The original purpose of the study included documenting the career exploration journey, specifically the messages and language that the young women heard and saw. As the leading researcher, my original assumptions were focused on aspects of messages and language. I sought to identify the meanings and perspectives the engineering information created and conveyed, and determine if there was correspondence and/or disjunction between the portrayal of engineering in college recruiting and career exploration communications. Further, I believed and assumed messages in the form of graphic imagery would be a central analytical category in the "coming to know" process.

As the data collection phase of the research began with the participants attending the career expo, I realized my focus and assumptions were not in sync with what was important and influenced the young women. The young women arrived with a list of questions (an interview guide) they had developed at an earlier research session. These questions represented their interests and guided their inquiry. As they looked out onto the floor of the
coliuseum filled with 150-plus piped and skirted company booths, I directed them to pay attention to the company displays where the representatives were positioned.

The [original] purpose of the study was to examine the influential communicative factors that had an impact on or affected young women as they learned about the engineering profession. I expected the study to focus on the career exploration process, but more specifically, the understanding and perceptions that developed about the profession as influenced by the media imagery. I assumed that imagery would be a primary data point and would constitute the young women's contextual understandings of the engineering profession.

At the Expo, my line of questioning for the young women was "What did you see?" "What was interesting to you?" "What was uninteresting?" (Bruning, Expo transcripts). I suggested that the participants pay special attention to the composition of the booth [imagery depicting the company] by observing the design and graphics in the booths. Only two participants responded to my specific journal question asking for a "reflection on what you saw" by commenting on the displays and ways companies presented themselves following the Expo experience.

This a priori analytical category was potentially problematic for participatory action research methodology and qualitative research. Asserting my assumptions in the research process violates the role of the qualitative researcher, and could have jeopardized the trustworthiness of the study if gone unchecked or corrected. Ashworth (as cited in Merriam, 2002) defines the action of suspending presuppositions as "bracketing or the process of epoch," and allowing "the experience of the phenomenon in terms of its own intrinsic system of meaning, not one imposed on it" (p. 94).
After listening to the young women’s responses to my “graphic imagery” line of questioning, and probing the impressions they had related to the images they observed, I realized my bias and assumption regarding engineering imagery did not exist in the minds of the co-researchers. I subsequently, bracketed, or consciously removed these ideas from my thoughts, in order to not further interfere in or influence the research process. The young women then moved the data collection in the direction of experiencing the world of engineering.

**Imagery Re-focused—The Approach and Source Focuses on the Human**

The participatory action study emerged as research focusing on the social and cultural characteristics of engineering as evidenced by the nature of the questions the young women created for the Career Expo. Additionally, Henna was “curious about why only few talented and able women pursue engineering” (Journal entry one). This statement characterized the underlying question most participants had at the onset of the study.

The data collection started in earnest at the Career Expo and the co-researchers’ line of questioning consisted of lifestyle and experience-based inquiry (see Appendix B-1). As we were preparing their interview guide at an earlier meeting, Haley said that she was looking for a job with “good money, satisfaction, time...” so she could raise her family comfortably and provide her children with “all the possibilities in the world” (Journal entry one). Each girl had different hopes and ambitions for herself and her life, although the common thread was a good life and job, and the ability to care for others comfortably. All of the young women arrived at the Expo somewhat nervous and apprehensive about being around all the
college students, but genuinely excited about beginning to explore career options for their future.

Common questions and prominent themes in their interview guides were related to lifestyle and work environment. Routinely, the participants asked questions about whether the workplace [company] was supportive of women. The data provided an insight to the first research question: How do young women approach researching and learning about a non-traditional career field like engineering? — What is important to be known? What questions need to be answered? Where is the best information?

**Approach to Researching and Learning—The Who**

A prominent pattern that emerged for all participants was the preference of who to seek information from—women or men—when inquiring about the profession. Observations like “*We like ladies better... men were very... they didn’t know how to answer the questions*” (Rural group Expo transcripts) quickly emerged. The first questions on the interview guide revolved around topics concerning family and equality. Answers from men about maternity leave and childcare seemed to be inadequate or disappointing. “*We had some really smart alec guy from this company... we are asking about what their maternity leave is like and he’s like, ‘of course, we have maternity leave. ’ We were like, okay, we’re going to go now*” (Rural group Expo transcripts).

Another company representative responded to a question about maternity leave and childcare while working by saying, “*there is this short-term disability program they can participate in that will give them compensation while they are off*” (Urban group Expo transcripts). Disability, as it relates to child bearing and childcare was not a familiar term to
this generation nor did it sound “friendly” when learning about company attitudes and policies. Another data point was the use of the pronoun “they.” A discussion concerning this occurs in the section entitled, Engineering—complex and hegemonic.

The atmosphere at the Expo was a busy one, and the fact that many men were brief and had little to say about work and family, left the young women feeling uneasy. The young women thought that some of the older men they talked to at the Expo were macho...the participants generalized by saying that the older men really didn’t have time for them and thought their questions were stupid and made them feel stupid. They said the “younger guys” were a little more willing to talk and not quite so macho but made them feel “little” and “inadequate” and “intimidated” (Bruning, Expo field notes) and didn’t take them seriously (Urban, Expo journal). By the end of their time at the Expo, they reported feeling “exhausted,” from all the activity, as well as the expenditure of nervous energy trying to “fit in.”

Conversely, the participants felt a kinship with women. They were able to “connect” with the women because they were interested in what the co-researchers had to ask and say. Both groups enthusiastically told me about exchanges with female engineers. The female engineers expressed common interests and concerns with the co-researchers when they [professionals] were younger and explored career options. The girls were encouraged; one co-researcher reported, “she was like ‘I was asking the same questions [when I was your age] and if you have any other questions, you can contact me’” (Urban group Expo transcripts). They were flattered that the professionals offered to communicate with them in the future, and at several data collecting meetings a co-researcher talked about contacting one woman engineer working in Kansas City. We discussed visiting this woman’s company, but distance
was a deterrent. At the end of the study, the co-researcher had not contacted the professional, but she still had her business card.

Maternity leave, childcare, and life styles, were prominent topics in the minds of the participants. I believe this was one reason the young women preferred talking to female representatives—the responses from male representatives lacked details and concern. The “experience” of combining college life and later a career with “life” was a concern of the co-researchers. The female representatives talked about balancing school, hanging out with friends, and current careers of college girlfriends. One engineer spoke about the level of responsibility with her job as “sometimes scary” (Urban group Expo transcripts). The professional women willingly offered advice and encouragement. The young women appreciated this.

Balance in one’s life, socializing with friends, and insecurity in regard to professional demands were not issues men in the study discussed. In the minds of the young women, these exchanges gave a sense of “realness” to the profession. One co-researcher summarized “but I like the woman (compared to the man at the job shadow site)...she seemed to be a little more down to our level and listened to our questions and answered our questions and that type of thing. I liked that” (Rural group job shadow transcripts).

It should be noted, however, that when I asked the co-researchers about this preference for women engineers over the men when learning about the profession, they denied the partiality (Expo field notes, second meeting transcripts, company visit field notes and transcripts). I attribute this viewpoint to youth culture and contemporary feminist thought. Generally, today’s youth embrace individual accomplishments (The Lawlor Group, 2001), and therefore, would not support this theoretical dichotomy. Additionally, many
modern feminist theories and studies do not purport separateness or difference (Driscoll, 2002; Lesko, 2001; Mazzarella & Pecora, 1999; New Girl Order, 2001; Walkerdine et al., 2001; Woods, 1994). The young women co-researchers did not either.

Two of the rural participants told a representative “we have not had much luck talking to women engineers” (Rural group Expo transcripts). The representative immediately pointed out another female close by. The point being, however, the limited number of women present was observed and noted by all co-researchers. During the final member checking meeting the co-researchers concluded the “field was synonymous with ‘MEN’ “ or “men only” (Rural group fourth meeting field notes). Again, feelings of exhaustion from trying to work (research) and assimilate to the culture which clearly was gendered began to emerge, even at the early phases of the study.

**Role of graphic imagery**

Pictures (imagery) were considered an important learning resource also, although these data could be in response to my probing before I bracketed the presuppositions. Nonetheless, graphic imagery was a source of good information, however, secondary to the human dimension. One group reported, “Pictures really helped us to understand.” They noted people [engineers or company representatives] that just talked—their words “can be hollow and uninteresting,” but if the representative had pictures and also demonstrated a clear interest in the participants as young people, it was much easier to learn (Bruning, field notes).

Journal entries conveyed that they found bright colors appealing and Jen expressed surprise “to find some not even having two pictures and their name [on the Expo booth]”
(Expo journal entry). They also liked the “give-aways” (free promotional items) from the companies. The urban co-researchers, in particular, appreciated seeing and receiving the multitude of promotional pieces. These articles included hand-held calculators, visors, CD carriers, stress balls, candy, pens, etc. Several young women noted the web address imprinted on the articles and would use the information to further research the company or keep it as “memorabilia” from the experience.

The women also asked and learned about the various engineering fields and what engineers do on the job. These data are presented and discussed in response to the second research question—“what did they hear” and is found in the Communicative Underpinnings section.

“Up close and personal”

A second prominent theme, although the young women stated it was the most important learning experience, was the opportunity to “get up close and personal” (Rural group, second meeting transcripts) when learning about the profession. Experiential learning with the co-researchers going to the job site and seeing engineers actually doing their work was considered a “BIG factor” (Rural group, job shadow transcripts) and viewed as compulsory for “coming to know” the profession. The need to experience it first hand was paramount. “Let me know it myself,” “do I like it?” were their comments (Bruning, fourth meeting field notes).

The rural group reported that the job shadow day was “awesome,” “real good,” and one young woman appreciated the opportunity to “coming in here [visiting the company] and see what you do compared to regular stuff at [home town]. There’s more out there and
bigger things and bigger problems to solve than what we think of mainly” (Rural group job shadow transcripts). They marveled at the expansive nature of the profession and the fact that engineers work all around them, they just had not realized it. “Coming here” was also appealing to the rural group. They seemed to be much more place bound than the urban group. At the conclusion of the study, the company visits were a highlight and provided a conceptualization that was vital.

The urban group experienced four engineering settings and reported similar sentiments. One site visit included a tour of a facility that was not in operation. When I asked the young women if they found the facility not in operation interesting, one young woman said, “it was boring. All he did was show us a bunch of machines.” And the other added, “Yeah, no one was actually there doing anything. In the beginning we didn’t even know what he was talking about.” “Just looking at a machine doesn’t really do anything for me. I’m sorry, but...”(Urban group company visit transcripts). They compared the tour without activity to a company visit and tour earlier in the morning. The young women noted:

*They had all their people doing things [at the first company visit] and we could see them doing their jobs and what they do. But, when you’re explaining that this machine does this and it goes like this really fast...so can we see it go really fast?*

Another site visit included learning about food production by means of making ice cream. When I asked the young women about this learning experience Alice said “it was fun. We just made ice cream.” Joan agreed, “We got to do something.”

Clearly, the urban group needed action, activity, and entertainment to enjoy their learning. “Seeing it go really fast” was an example of entertainment as well as understanding the applications. When we visited the metal company they knew the company utilized robots
to paint machinery. During our visit, we did not see the robots or "Martians" as they referred to them, in action. This was very disappointing to them. Additionally, during the website review, the gadget, games, and trivia-related sections received the most attention.

Academic preparation for engineering

Throughout the investigations at the Expo, company visits, and job shadowing, the co-researchers asked questions about classes to take to prepare for engineering and how the company representatives came to the conclusion that they should become engineers. The young women learned that math and science were the most important classes and also the reason why the representatives they talked to got interested in studying to become an engineer. In fact, some engineers referred to strong math and science backgrounds as the "obvious" preparation and skill base for a potential engineer.

By the end of the study the co-researchers were asking, "is there anything else [types of classes to take in high school]?" One response was "you should probably work on...like your communication classes like speech. I don't even like those classes...but your job involves so much communication other than written..." (Rural group, job shadow transcripts). Most of the girls had a preference in regard to their feelings about, and confidence, in their math and/or science abilities. None of them felt they had strong abilities in both areas. They saw this as problematic. From my perspective, however, given my experience, all of them were capable and could do well. However, the influence of self-efficacy (Bandura, 1977) was evident, in addition to the socialization Eisenhart and Finkel (1998), and Holland and Eisenhart (1990) discuss in their research on adolescent women.
Finally, in reference to "Who," all co-researchers commented on the importance of learning about the profession from someone who cared and was interested in them [young people] and the engineering work (Urban group Expo transcripts; Top Ten journal entries). During the final member checking exercise, I labeled this the "You Care, I Care" phenomenon. The co-researchers agreed wholeheartedly. Many of them included these sentiments in their Top 10 Things that make a Good/Bad Job shadow or Company Visit journal entries as well.

**Communicative Underpinnings—What was Seen and Heard**

All co-researchers marveled at the expansive nature of engineering—"almost everything takes some kind of engineering"—summarized a universal understanding. Midway through the Expo interviews, both groups checked in with me and concurred, "if I can't find something I like in this field, something is wrong with me" (Bruning, Expo field notes). They also became knowledgeable about the types of work engineers do and that the work involved management, creativity, and "came to know" that it was a very, very demanding profession. Typical perceptions were "it would be a hard job... with all the math and all that" (Alice company visit transcripts).

Put differently, Haley thought, "if you really wanted to be devoted to your job it would be the way to go, but you don't really get to deal with your customers and you're so busy that I don't know that you would even be able to have a family" (Reflection journal entry). Thus, the "demanding" perception of the profession was also problematic. While youth culture literature asserts that today's youth are ambitious and hard working (Howe & Strauss, 2003; Schneider & Stevenson, 1999), and these young women demonstrated similar
attitudes and characteristics, they were either intimidated by the perceived demands of engineering work or sought a work culture that promoted a more balanced lifestyle and familiarity or comfort.

Another prominent issue was that “the work” was too complex and the employment ranks were very male dominated. At one point during the Expo inquiry, Alice asked for an explanation of a specific type of engineering work in “simple terms.” Often, descriptions of engineering work were vague or riddled with jargon and topics unfamiliar to the common person. For example, “I work with municipalities...on their infrastructure needs,” or we “are really into the industrial side of things,” or “we do a lot as far as distribution transmission lines...” When the explanations were comprehensible, the young women occasionally reacted with statements like “that sounds boring” or “I can’t see myself doing that.” In Jen’s final reflection entry, she wrote: “turn offs: male dominant[ed], seemed hard for women to get ahead, most of jobs not for me.” These thoughts were common among many young women.

The co-researchers expressed concerns about becoming lonely on the job. One rural co-researcher, when reflecting on the prominence of men in the profession, said, “If I didn’t go into the field, it would be because I’m a person who likes to have other people to talk to (interpreted as I need to be with more people like me). I think if I were to go into this, I would like, whoa, enough of this” (Rural group job shadow transcripts). This perception aligns with youth culture and contemporary feminist thought that suggest current youth “travel” en masse or groups and belonging, membership, and relationship is important while still remaining independent, special, and unique (Baumgardner & Richards, 2000; Driscoll, 2000; Gilligan & Brown, 1990; Howe & Strauss, 2003; Lesko, 2001; Yankelovich MONITOR, 2000).
A prominent theme and observation I made, though the young women did not recognize this characteristic as such, involved the genderedness of the profession, or what Harding (1986) and Rossiter (1982) refer to as gendered symbolism. Gendered symbolism was discernible in the descriptions of the engineering field and the experiences the young women had during the study. For example, male engineers described the work in mechanistic or logical language. Answers to questions were brief, and their descriptions involved labels or titles which were not part of everyday vocabulary. Because answers were often brief, and a hegemonic tenor accompanied actions and explanations, the engineering culture, as described by men primarily, did not appeal to the co-researchers.

Gender schemas (Valian, 1999) were also copious throughout the exploration, although, the young women were only subconsciously aware of their influence. Valian (1999) defines gender schemas as a “set of implicit, or nonconscious, hypotheses about sex differences [which] plays a central role in shaping men’s and women’s professional lives.... gender schemas affect our expectations of men and women, our evaluation of their work, and their performance as professionals” (p. 2). Gender schemas are not intended to oversimplify or infer oppositional traits, but they do refer to “our intuitive hypotheses about the behaviors, traits, and preference of men and women, boys and girls” (p. 11). The lack of female representation, the cultural bias’ inherent in a male dominant workplace, and the subordinate social positions women occupy as a result of these factors warranted numerous gender schemas operating during the data collection.

Descriptions from female engineers, however, were more thorough and multidimensional. They related the work to “real life,” and had a “recruiting” tone to their “pitch” about the field. However, “otherness” and gender schemas dominated descriptions and
explanations of the work experience, and while it was predominantly evident in explanations from male engineers, it was not inviting or familiar to co-researchers.

**Engineering—The Work**

Various descriptions of “the work” populated the data collection. This line of questioning was second in popularity to the “how will I be treated as a woman on the job” type questions. Conversations the young women had with female engineers were received with enthusiasm; those with males were not as positive. Women were generally talkative about their work and usually encouraging. The following exchange was with a female environmental engineer.

Co-researcher: *what exactly do you do?*

Company representative: *Actually, I’m an environmental engineer. I mean, water, wastewater, sewers, water and wastewater plants.*

Co-researcher: *Doesn’t sound like it’s much fun.*

Company representative: *It’s exciting.*

Company representative: *I told the other girls, that if you ever need any information or anything, you can always email me. If I can answer any other questions. I know it’s difficult to really know what engineering is. There’s a lot of different kinds of engineering, and what I did was basically my first couple of years, just in general, take the basic classes and then from there decided, ‘oh, I want to go environmental’. You don’t have to decide right away.*

Co-researcher: *So, like, prior to college, you really didn’t know...any idea?*

Company representative: *No, no idea. But I liked math and science, so okay, let’s try engineering and it worked out. Don’t be scared.*

Another female engineer, in response to the question “*Can you give me a description of a typical day on the job?*” said:

*A typical job day, well, get to work, get on the computer, or come to a career fair! When I get to work I get on the computer, and review what I need to do*
for that day and then basically what I do is make all the contacts with people
that I will need, I might need to go out and survey the building project to make
sure that everything is ready to go. Engineers are the first to problem solve.
So that's what we do.

The women engineers reminisced with the young women about their career decision-
making experience. They also shared and contextualized their work life experiences for them.
This awareness on behalf of the women engineers, attempted to address apprehension the
young women felt in regard to suitability and fit. This “value-added” knowledge (and gender
schema) left an impression and was as important as factual information. Henna reflected in
her journal entry, “I think it was cool that it's not a women dominated career, but a lot of
women now a days are thinking about it and getting better jobs out of them being a woman.”

Engineering—complex and hegemonic

Interview dialogue with male engineers at the Expo was often brief or vague or overly
complex. Discussions often lacked depth and concern for issues and questions important to
the young women. The behaviors and attitudes of the engineers could be interpreted as
hegemonic and exemplified in the form of superiority, arrogance, difficulty or controlling
cultural attributes (Denzin & Lincoln, 1998; Driscoll, 2002; Lather, 1991). These traits are
often associated with masculine gender schemas. Male hegemony also was manifested in the
phenomenon of “otherness,” through the frequent use of the pronoun “they” when discussing
women or referring to females in the company. Evidence of these hegemonic behaviors and
attitudes, and gender schemas are drawn from the transcripts and include the following
exchanges:

Co-researcher: How did you get interested in engineering?
Company representative: I started when I was young... trying to take apart
different things. Always checking the mechanics.
Co-researcher: *What type of classes would you have to take in college?*
Company representative: *Math, Physics...I don’t remember the specific ones...it was a grueling five years.*

Co-researcher: *Can women go ahead and work through pregnancy?*
Company representative: *Yeah. There’s no reason why they couldn’t.*

Co-researcher: *What are the benefits of being an engineer?*
Company representative: *The benefits...proud of the work that you do. The engineer is the highest person on the job.*

Co-researcher: *Can you work through a pregnancy if you were say a chemical engineer for instance?*
Company representative: *Yeah.*

Co-researcher: *What is the representation of women?*
Company representative: *They are actually more and more...right now, three to four work in the office.*

Hegemony was epitomized in the brief, non-descript answers, the word choice of “grueling” when describing an accomplishment, and in the hierarchical description of the engineer being the “highest person on the job.” These are examples of hegemonic social order which is not a perspective youth culture and feminist thought ascribe to, or embrace (Driscoll, 2002).

Therefore, this version of hegemony was another cultural condition of engineering the young women found problematic.

“Otherness” was amplified in the frequent use of the pronoun “they.” Throughout the transcripts, male engineers refer to female colleagues as “they” as if to say women are not a central part of the organization, rather an addition. A sense of “otherness” also became apparent when discussing the numbers and the representation of women in the engineering companies present at the Expo. In several instances, company representatives told the young
women "more and more women" are entering our company's employment ranks, and they would complete the statement by saying "there are about three or four [now]."

Another example of hegemony centers around an exchange about hours spent working on the job.

Co-researcher: *What kind of hours do you have to work as an engineer?*
Company representative: *Typically, I work about between 45-60 hours a week.*

Co-researcher: *Is that a lot?*
Company representative: *Is it a lot? I guess. The average workweek is 40 hours, of course.*

Co-researcher: *So can women work during their pregnancies, like a chemical engineer?*
Company representative: *Yeah. The woman that works with us worked through her pregnancy.*

The engineer gives the impression he was proud of the fact he works 45-60 hours per week when he informs the co-researcher the "average work week is 40 hours, of course." He also teeters on insulting her intelligence with his rhetorical question, "Is it a lot?" and "I guess" statement. Further, the underlying principle was that successful and important people work long hours. When asked about working through one's pregnancy, he states the woman he works with did. (Note the reference to one person.) These attitudes are also incongruent with a generation that the values family and desires balance in one's life (Howe & Strauss, 2003; Schneider & Stevenson, 1999; The Lawlor Group, 2001)

Other examples of hegemonic or indifferent passages are:

Co-researcher: *What are some of the benefits of being an engineer?*
Company representative: *The ability to be involved all the way through a project.*
Co-researcher: Can you give me an idea of a typical job day?
Company representative: A typical job day? The manufacturing engineer is just left alone...talking with people under you.

Co-researcher: What kind of engineer are you?
Company representative: Mechanical engineer, in the manufacturing world.

Co-researcher: How did you get interested in engineering?
Company representative: Some interest in math and science in school. I started in engineering and decided on mechanical engineering.

Co-researcher: Are there a lot of women in mechanical engineering?
Company representative: There are women engineers in all fields.

Co-researcher: What kind of classes did you have to take to become an engineer?
Company representative: In college or high school?
Co-researcher: Both.
Company representative: In high school, you have to take the prerequisites to get into college. The first two years of college, they are pretty standard. Mechanical engineering...

As previously mentioned, the young women were concerned about the culture for women in the workplace. Below is another interview regarding these topics.

Co-researcher: What type of jobs do you have?
Company representative: What we're here for today is primarily engineering type of jobs. We're basically energy... We're pretty good sized [emphasis is mine].

Company representative: What we're here for today is primarily engineering type of jobs but of course as a company, we do run our own revenue system and run our large computer type equipment with computer people running them. We have a very large customer service...over 200 people answering phone calls and stuff. We also have a lot of technicians and union people. We do a lot of our own construction as far as distribution transmission lines so we have a lot of people, union laborers that do construction.

Note that the representative says they are looking for engineers “today” and yet, he responds to the question by explaining the non-engineering jobs...customer service [phone bank],
technicians and laborers. Valian (1999) would consider this biased assumption that the young women would not be interested in or could not do "engineering" as a gender schema—which breeds lower self-perceptions that are subordinate, and thus, maintaining the social order.

The representative does not answer the co-researcher's questions which focus on engineering jobs very thoroughly, however, the co-researchers maintain their line of questioning. They ask:

Co-researcher: Do you have a lot of women engineers?

Company representative: Well, no. Because we haven't had that many opportunities to hire them. We do have more than Rochelle [colleague present in the booth]...she's not the only one, but I don't know how many. It's not a lot. Because generally, you don't see that many, particularly in the electrical and mechanical [areas]. You see a lot more women going into the computer side. We are interested in hiring more if we have the opportunities. I'd encourage anybody who has talent from the high school level...that was interested in more of the logic side concepts to go ahead and go into engineering. It's a very good place to get a job. Our full time jobs are limited right now.

Notice that the representative indicates "not a lot of women" work at his company, but, earlier he referred to the company as "good sized." He also references one woman, Rochelle, as not the only one, but obviously one of very few. Gender schemas are operating when he claims that not many women go into electrical and mechanical engineering, but more women are going into the "computer side." Because electrical and computer engineering are closely related and sometimes classified as one and the same, it is reasonable to assume his reference entails women going into computer processing, a less significant position and profession. Additionally, the supposition that engineering requires more "logic side" skills or interests is another example of gender schemas.

Co-researcher: If a woman would go into engineering with the mechanical and all that, would you hire her?
Company representative: *Well, it all depends on what’s available. We don’t have the freedom to say...you actually have to have a job that’s authorized by the company and then you go out and look for the best candidate, but we do have the concept with diversity. We are instructed to be concerned with that and promote diversity in the hiring which means that we know we’re highly white, male dominated here in the Midwest and we are instructed to do our best to look for good candidates.*

The non-committal language about hiring, the passage regarding the “concept” of diversity and “instructed to be concerned,” are clear evidence of “otherness” and a hegemonic way of thinking.

Again, these are forms of superiority, arrogance, “otherness” or gendered symbolism, and gendered schemas (Driscoll, 2002; Harding, 1986; Lather, 1991; Rossiter, 1982; Valian, 1999). Given the value of family and “fit” that these young women attach importance to, the engineering culture seemed uncomfortable, foreign, and unappealing. This is because, in part, contemporary young women do not envision a world where family or nurturing and professional lives are mutually exclusive (Driscoll, 2002; New Girl Order, 2001; Woods, 1994). They envision an integrated world.

Other extensive examples of “what the co-researchers heard and saw” are included in Appendices D-1 and D-2. Appendix D-1 includes the transcript from the urban group’s visit to the wood and construction company. The dialogue occurs after our tour of the floor of the plant. Most notable in these transcripts was that the dialogue was one-sided. The young women did not converse with the men like they did with the women engineers. Appendix D-2 includes excerpts from the rural group’s job shadow experience. These conversations were with a female engineer. The text exemplifies the manner women engineers contextualized the profession for the co-researchers.
Following the data collection experience at the Expo, Amy wrote in her Journal:

*I also kind of realize why women don't usually enter the field. I don't know if I would be able to work through school. The intimidation of men all around would make me uncomfortable. I know that the businesses are looking for women, but I just don't know. I felt uncomfortable even approaching people to talk to them. I guess you could say I felt dumb, confused, and little all at the same time. I would rather find information about engineering other ways (e-mailing).*

As evidenced throughout, the young women found the engineering culture to be foreign and uncomfortable. Still, Alice wrote, "*I used to thing [k] it [engineering] was a really boring job and what I learned it is actually a lot of fun.*" Sentiments about engineering based on the final reflection journal entries, however, suggested that most of the co-researchers did not find the engineering profession appealing or suitable for them.

**Engineering—The Appeal and Lack Thereof**

The appeal or its lack was largely influenced by the Expo and company visit or job shadow experience. Prominent themes included the complexity of the field in terms of difficulty and relatability. The rural group focused on suitability for family life and professional opportunities close to home. The urban group focused on employability after graduation. Cultural factors were viewed as troublesome, but the young women were told and believed that the representation of women in the field was improving.

**Nurturing**

The questions the young women developed for the Career Expo clearly suggested the importance of family and nurturing. Throughout the data collection, these topics seemed to remain important, especially with the rural group. Not only were they concerned about
benefits for women of childbearing age and childcare, but also they were interested in a supportive environment for themselves and their future families.

Both groups heard women engineers discuss supportive work environments and the opportunity to “have your life” (Women engineer, Metals Plant), however, at the end of the study Henna’s journal described the sentiment of many. She wrote, “I see engineering as being very demanding and wouldn’t be very all around family friendly because you’d be busy all the time.” Similarly, Amy talked about “wanting to have a family and not having to be moving around and being able to provide a stable environment for her children” (Bruning, rural group second meeting field notes).

Location and proximity to family was also important to the rural group. Early in the study Jen was concerned she would become interested in engineering and wondered if she “would be able to stay close to home or not?” One of the reasons one of the rural participants was excited about visiting the nearby wood corporation was that “since [wood corporation] is around our area it could be very helpful to get to know what it’s all about and it could be something to look forward to in the future” (Rural group job shadow transcripts).

Engineering—lack of context

Eisenhart and Finkel (1998) discuss the importance of contextualized instruction for women when exposing them to non-traditional fields. When the young women could relate to the descriptions of the engineering field, they became excited. For example, one of the rural participants made a special point of telling me engineers who work for Tyson Foods “have stuff to plan, stuff to order, engineers order.” Another told the Peace Corp female representative “thank you. Those are good answers” when she detailed the work an engineer
does as it relates to water and sanitation or teaching girls about math or science in third world
countries, as well as describing personal health policies of the Peace Corp.

An example of "lack of appeal" occurred at the Renewable Resource Center site visit
with the urban group. For example, they considered the multi-purpose discussion of manure
as "sick." At the end of the study, however, Jen said she "definitely knows more about
engineering. It's not just trains anymore. It's still very complicated to me, which may be the
reason it doesn't spark my interest." She went on to say it was a learning experience she
would "never forget" and still would have "done it even if I still can't completely understand
it."

Another prominent theme that related to engineering being too complex was the
perceived dependence on one's math and science skills. Many found "all the math
discouraging" (Expo journal entries; Rural group job shadow transcripts; Urban group
company visit transcripts). Henna wrote in her final journal, "Again, I really didn't think it
would be for me because I'm not into the science stuff. I am pretty good at math but all that
other stuff kind of confused me."

They also heard about the "discipline" necessary to study all the time [while in
college] from the company representatives. Most co-researchers concurred that engineering
was "a lot of tough work" (Jen, reflection journal entry). At the end of the company visits, I
noticed Alice was losing interest in the study. I asked her if this was accurate and she
commented "I can't do all that stuff." I asked, "all what stuff...the math?" And she replied,
"Math, all the computer stuff, the only thing I get out of the computers at school is the
Internet." Haley believed she had "a pretty good understanding of engineering," but didn't
think it was for her. She said, "I'm looking for a job that deals with people more and I really
don't think that engineering would be personally fulfilling to me. Right now I'm looking more at optometry, but that will probably change” (Final reflection journal entry). These comments are similar to what Vroom (1964) and Holland’s (1973; 1985) found in their studies related to expectancy-valance and interest congruence as they apply to women’s career behavior.

Cultural barriers

The lack of women in the field was clearly a prominent psychosocial barrier, although, the rural group was more vocal about the representational differences than the urban group. The culture seemed to be void of context, behaviors, and values familiar to the young women. Percentages of 20-25 % did not represent a critical mass and single references to women in the company became bothersome to the young women. Haley, when thinking about her presence in the engineering culture stated outright that she “didn’t want to become a tomboy, didn’t want to be a flirt, and wanted to be herself and wanted to be in a place where she could be herself” (Bruning, second meeting field notes). As previously acknowledged in numerous ways, but frankly stated by a young woman during the wrap-up conversation at the conclusion of the job shadow experience, the co-researcher reflected, “I’m a person who likes to have other people to talk to.... if I were to go into this [engineering], I would like, whoa, enough of this” (Rural group job shadow transcripts).

Summary

Voices of these young women provide candid insights and responses to the engineering profession as they came to know it. The findings reveal how the young women considered, processed, reflected upon, and ultimately, associated with, or discarded, the
notion of a career “fit” with engineering using their “feminine adolescence” lens (Driscoll, 2002). This feminine epistemology was defined as a category for organizing knowledge about modern women who are in “transition or in process relative to dominant ideas of Womanhood” (Driscoll, 2002, p. 6) and connotes a shift between “dependence and independence” (p. 52). It is a process facilitated by linking knowledge and education.

Throughout the study, the young women (co-researchers) were eager to learn and determine whether engineering offered a “fit” for them in terms of their skills, abilities, interests, and ideas they had for their futures. To discern this, they focused on the social and cultural aspects of the profession by learning from those who were “living the life.” They set out to “get up close and personal” (Haley reflection journal entry) and experience the “real thing” (see Appendix b-12) by asking professional engineers about their work and life. This experiential learning was central as they young women visited work sites and engaged in job shadowing as “they came to know engineering.” Their vision of adulthood included a good life and job, and the ability to care for others comfortably.

Several prominent themes emerged as the co-researchers embarked on their experiential career exploration journey. One was the preference of who to seek information from. The unanimous preference was other professional women. Another significant observation was how expansive the engineering profession. Everything in the world “was engineered” the co-researchers learned. Problematic themes dominated the “coming to know” experience from the young women’s standpoint and disjunction almost immediately emerged between the feminine adolescence perspective and the gendered engineering culture.
The young women came to know engineering as a complex, demanding, and intimidating work culture. They recognized the gendered dimension of the culture, and, were not comfortable with the space and support women had in the workplace. A sense of "otherness" dominated the learning experience and the young women realized values of family, nurturing, and relationship were limited within the engineering culture. Most foreign and unappealing in the subconscious minds of the young women were the hegemonic attitudes (closely related to the "otherness" phenomenon), gendered symbolism, and gender schemas present in the culture and exhibited in the workplace.

Hegemony was evident in language, social order, and cultural underpinnings of the profession. Harding (1986) and Rossiter (1983) assert that the cultural characteristics of—tough, rigorous, rational, impersonal, competitive, and unemotional—result in equity issues of gender order and gender symbolism that can be associated causally with the low percentages of women in the sciences and engineering (Harding, 1986).

Additionally, the gender schemas were operational throughout the inquiry; they were seemingly of one variety—masculine. Valian (1999) like others including myself, believe "differences exist, but the sexes are more alike than they are different" (p. 13), and a balance or a blend of gender schemas are necessary and expected in the minds of contemporary young women.

I believe this statement alludes to the disjunction the young women encountered. They live in a world that is more or less androgynous and integrated and, therefore, they expected or at least sought equality in the workplace and among workers. To a large extent they experienced a culture of difference, where gender was asymmetrically organized (gendered symbolism) and gender schemas were not operating. Female engineers tried to
provide and present a balance, but due to their minority status, their voices and perspective were too limited to instill a lasting impression. Between the gendered attitudes of many within the engineering profession and the contemporary or postmodern positions of the young women, the gender schemas and the abundance of gendered symbolism were found to be foreign, unappealing, and alienating.

To advance the representation of women in the engineering ranks and in colleges of engineering across the country, we need to explore the phenomena of genderness and “otherness” as perceived by feminine adolescence. We need to recognize, understand, and work through the epistemological issues young women present in regard to “what they come to know about the engineering profession.” Finally, as Clewell and Burger (2002) recommend in an article entitled “At the crossroads: Women, science and engineering,” future research calls for an “intensive, qualitative look at the decision-making process girls engage in when considering their career paths” (p. 249).
CHAPTER 6. DISCUSSION

Future Study

The analysis of this study serves to inform and encourage further study of feminine adolescence, career exploration, and technological career fields like engineering. Michael W. Apple (as quoted in Lesko, 2001) asserts that our interpretation of youth has powerful effects, and “the ways in which adolescents are treated during their teenage years can create tensions that last forever. Class, race, and gender identities are formed in interaction with institutions” (p. xi). Apple suggests that youth be considered part of policy development and viewed as part of the solution. The findings of this study, which indicate that young women develop a lack of interest when exploring the engineering profession, support Apple’s perspective.

As the findings imply, feminine adolescence finds social and cultural structures in engineering to be foreign and unappealing. Kiluva-Ndunda (2001, as cited in Mwangi, 2002) suggests social and cultural structures are influences seldom dissected, not to mention, discussed. Smith (1987) concurs in the *Everyday world as problematic*. According to the experiences and perspectives of the young women participating in this study, the engineering profession would be well served to investigate the issues of lack of critical mass and representation by exploring gendered symbolism, the manifestation of “otherness,” and the cultural dominance of hegemonic attitudes within the professional structure and ranks.

This study demonstrated the importance of acknowledging “girls’ reflexive process” (Lesko, 2001) by using the feminine adolescent voice as an instrument to gain perspective.
Given the lack of interest on the part of the participants which developed in regard to engineering in this study, it would be instructive to explore the young women's unwillingness to counter the social dynamics within the profession. The insight would be central to understanding and addressing the negative issues related to culture and attitudes.

Mwangi’s (2002) work on African women in pursuit of an advanced education in African culture discusses the phenomenon of “cultural silence” (pp. 51-52). I believe this phenomenon may have been operating among the ethnic minority women in my study as they explored engineering as a career option. Given the limited number of ethnic minority participants in the study, exploring the “cultural silence” phenomenon was not warranted; however, I believe it existed. These concepts and others should be explored in future study with a larger and more diverse population of young women.

**Method and Methodology Comments**

The participatory action framework addressed the research objectives exceptionally well. The participant selection criterion-based filter facilitated identifying ideal research participants. Discretion was also exercised when implementing the selection filter and I would encourage this practice again. The timing of the study—young women in their 10th grade year—was optimal. Including rural and urban groups from similar regions produced good comparative data. It also assured efficient use of time and financial resources. Research groups with even numbers were advantageous and I recommend at least two academic researchers per research site and approximately eight participants per site. This number will allow the academic researcher to facilitate and nurture researcher/co-researcher relationships
and assure that the researcher “gently guides” exploration and data collection as deemed necessary.

Identifying gatekeepers who have an interest in career opportunities for the young women is very important. Identifying and outlining responsibilities of all adults involved with the project (parents included) is also advisable. In regard to the project, while young women are generally interested in exploring careers at this age, a time commitment of this magnitude needs additional incentive other than “learning about career exploration and a ‘fun’ factor.” I would recommend monetary incentives in the form of college scholarships. Scholarships could assist in the tracking of the research participants when they enroll in college as well.

Closing Comments

It is interesting to note the traditional perspective and approach the engineering academy has taken to address the lack of gender and ethnic diversity in the profession. The Long View (NSF, 1997) and other similar instructive visionary documents identify primary strategies to address gender and ethnic diversity. They include: (1) educational preparedness, (2) visibility of the career option, (3) new educational paradigms for enhancing student attraction and retention, (4) support services while pursuing the degree, (5) career opportunities and advancement upon graduation including graduate education and research, and to “allow underrepresented groups to compete more fully in their chosen engineering careers” (NSF, 1997, p. 10).

These approaches focus on aspects external to the profession or doing something different to the “other” to improve the condition without looking within the profession to
examine the issue with an inward focus. Dating back to the 1960s and 1970s, feminist critics of the sciences have denounced the patriarchal, prescriptive nature and perspective of the scientific community, and the conventional approach to increasing the enrollment of women (and the underrepresented people). Phrases such as “allow underrepresented groups to compete” or “give equal access to” are classic examples of the innate, hegemonic, and exclusive power structures embedded in the engineering profession. It is my observation that these approaches will not change the lack of representation and is woefully out of sync with contemporary youth and feminist thought.

Therefore, I hope the findings from this study will create an impetus for dialogue and further study. Through the authentic commentary of the participants, this research has provided a deeper and richer understanding of the gendered nature of the engineering profession from a feminine adolescence perspective. The knowledge gained from this study should be considered important information for corporate leadership and human resource personnel, policy makers, educators, career guidance professionals, engineers and professional engineering societies. The research will advance through collaboration among and between these entities. The study should also be conducted on a national scale to substantiate the findings and secure endorsement from the scientific and engineering communities.

A Call to Action

The issue of lack of interest between young women and the engineering profession requires urgent action. Driscoll (2001) and others purport the transforming influence of
today’s youth on trends and societal norms. Driscoll summarizes the influences of youth culture when she writes:

Youth has been consistently important to cultural analysis because it presents a crucial point of cultural reproduction and cultural change. Youth names a field in which society reproduces itself and marks changes through the incorporation and exclusion of individuals and groups...twentieth-century cultural analysis has especially focused on how the world has changed—or...what parts of the world have not changed in the same way—and has also emphasized youth and adolescence as site for speaking about such change (or lack of change). (p. 10)

While feminine adolescent scholarship was non-existent until the end of the 20th century (Driscoll, 2001), reports like Balancing the Equation (NCRW, 2001) identify diverse characteristics among individuals and assert that traditional practices and approaches to appeal to those absent in the workforce are not theoretically, nor pragmatically, effective. Research and reports produced by NCRW, AAUW, and other agencies outside the engineering domain focus on a psychosocial perspective. Educational pedagogy aside, this perspective is absent in most mainstream science and engineering diversity reports and action plans.

The findings of this study also argue that if the engineering profession wants women to achieve equality and have a presence in the workforce, the profession must evaluate, analyze, and re-design institutions so that they are open and appealing to all people. The profession must also examine perceptions of institutional climate, barriers, and incentives to becoming an engineer, as seen through the eyes of youth and expressed from their standpoint. The ultimate reconstruction must be based on authentic voices and different values in order to alter the existing culture and eliminate the “male-centric work environment” (NCRW, 2001, p. 90).
APPENDIX A. DATA COLLECTION PREPARATION

A-1: Career Exploration Research Project

“How Young Women Come to Know Engineering”

February 11, 2002

Research Project of:
Monica Bruning
112 Marston Hall
Iowa State University
Ames, IA 50011
Tele: 515.294.9963  Fax: 515.294.9963
Email: mbruning@iastate.edu

Note: This outline was used as a teaching tool to introduce the study, create interest, therefore, the design and content of this outline serves these purposes.

Purpose of the study: The purpose of the study is to examine the influential communicative factors that have an impact or effect young women when considering a non-traditional career field like engineering. Specifically, this study focuses on the career exploration process and the perceptions, a reflection of language and imagery, which constitutes young women’s contextual understandings of the engineering profession. The goal of the research is to enhance understanding of the thought and decision-making processes young women employ when making career decisions that involve these non-traditional career choices.

Literature Review: Today’s youth, often referred to as the Millennials, Gen Y, Echo Boomers, et al., are very different from youth of previous generations. Current literature suggests youth culture is on the “cusp of a radical shift” (Schneider & Stevenson, 1999; Howe & Strauss, 2000; The Lawlor Group, 2001) with Gen Y’s impact on society and American culture expected to surpass the Boomer generation in regard to influence. They are a “do it yourself” generation marked by optimism, drive, social commitment, and strong work ethic (The Lawlor Group, 2001). They are not inclined to accept stereotypes as truth, and they are the least race conscious, most female-dominated, generation in American history (The Lawlor Group, 2001).

A 50-year longitudinal study funded by the Sloan Foundation considers Millennials the ‘most ambitious’ generation since the mid-1900s (Schneider & Stevenson, 1999). They retain traditional social values, will push for higher standards in education, and embrace honesty, caring, pride, and determination. Former “Boomer” causes are expected to fade (race and gender) with new “Millennial” causes focusing instead on race.

A fundamental attribute of this study is the importance of capturing and learning about the viewpoint and perception young women have of engineering, especially because they have been a population whose true voice has been absent in formal research (Gilligan, 1993; Smith, 1987; Belenky, Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1982; Smith, 1987, Denzin & Lincoln, 1998). Gilligan’s landmark study in the 1980s demonstrated how the inclusion of women changes the paradigm of human psychology, realizing the need and importance of relationship and connectedness.

The Harvard Project on Women’s Psychology and Development of Girls – also studied girls and found very similar tendencies in regard to voice and relationship. The results included familiar
tendencies of pretending not to know what one knows, the challenges of hearing and listening to one's voice, the conflict between thinking and knowing, and the phenomena of using one's voice to cover as opposed to convey one's thought in the interest of relationship (Gilligan, 1993).

Studies on girlhood suggest a need for sense making; the importance of space (public and private); a strong belief about inclusively in research (traditional academic research is viewed as alienating); and the need to understand specificity and complexities in researching this population (New Girl Order, 2001). In essence, dominating concepts emerging from contemporary research is the idea that young women's feminism is unique, and a girl's world and perspective is contextualized.

Theory: In order to understand a girl’s viewpoint, standpoint theory is used to truly capture the essence of how young women come to know the engineering profession. Standpoint theory looks from the inside out, or encompasses a viewpoint that is one's own, as the individual (or research participant) looks from within out, to the view the world (Fraser, 1989; Smith 1987).

The work of Don Super (1963) and Jean Pierre Jordaan (1979) identified the primary developmental task of high school students is formulate vocational preferences. The developmental processes to formulate a young person's vocational preference involve three phases: (1) crystallizing a vocational preference, (2) specifying a vocational preference, and (3) implementing a vocational choice (Jordaan, 1979). Career exploration is a process an adolescent engages in when career options are investigated. The young person becomes less tentative about career options with experience and the passage of time; by fantasizing about them; through discussions with family, friends, and other adults; through research, and eventually part-time, then permanent work.

An initial phase in the career exploration experience for young people involves the deliberate process of researching career information or crystallization. Often times this begins formally between the ages of 13-14 years of age when careers are introduced in civic or social studies curricula. Because my research is interested in how young women come to know the engineering career field, this research will involve girls (ages 15-16) beginning to advance through the initial stages of formal career exploration or crystallization.

Method: The study will be a participatory action research study whereby the participant (student) plays a role in developing the research methods and in conducting the research under my guidance. I am a researcher, graduate student in Educational Leadership and Policy Studies – College of Education at Iowa State University, and have been in the college admissions profession for 18 years.

The research is a dissertation study involving 10th grade girls who are beginning to consider careers and college plans after high school. After the potential research participants have been identified, they will be asked to complete an online survey www1.eng.iastate.edu/mbruning/careers

The Study: The specific career field the research involves is engineering. The study will include up to 6 participants. The participants may collaborate on data collection techniques and analysis with advisement from the researcher. The initial meeting of the participant and researcher to get the study underway will occur the week of February 11, 2002 at a location determined by the participant. At this meeting the following information will be discussed:

1. Overview of the study and its objectives
2. Roles of researcher and participant
3. Brainstorm ideas for data collection
4. Plan data collection
5. Introduce Spring Career Expo* scheduled for Tuesday, February 19, 2002 and discuss data collection techniques for the Expo
6. **Outline general timeline** for the study (All research, analysis and writing will be completed by July 1, 2002. Most of the research and analysis will occur between February and May 2002.)


Transportation logistics to ISU will be determined in advance with the participants and their families.

**Data Analysis** Data will be transferred to computer-assisted qualitative *data analysis* software (CAQDAS) – NVivo for coding. The data will be sent to, or discussed with the participants for categorizing and theme development. Member checking, de-briefing, and theory generation will be conducted once the data are compiled and dispersed.

**Findings** Following member checking and de-briefing, I will write-up the findings, summary, and recommendations for further study.

**Benefits to the participants:** Participants will learn career exploration techniques, research methodology, and could advance their own research agenda beyond the scope of this project.

**Research ethics:** Iowa State University’s Institutional Research Board approved the research on February 8, 2002. The parent information and consent forms are provided and parental consent forms were obtained.
A-2: Survey for participation in a Career Exploration Research Study

Research project of:
Monica Bruning
Iowa State University
515.294.9963  mbruning@iastatee.edu

Your Name: ____________________________
Telephone: ____________________________
Email address: _________________________

Circle the answer that best describes you and fill in the blanks where requested.

1.  I want to go to college. Yes No

2.  I am taking a college preparatory curriculum (4 years English, math; science, 3 years social
    science.) Yes No.

   (If yes, continue to question 3.)

3.  I get grades of As or Bs in English, Math, Science, and Social Science. Yes No

4.  I would describe my ideas or thoughts about what I would like to major in at college as:

   Uncertain

   Some idea – I’m thinking about ____________________________

   Have definite plans – My plans are to _________________________

5.  I have a family member relative or close family friend who is an engineer. Yes No

6.  I would like to learn more about careers in preparation for going to college. Yes No

7.  Engineering might be a career I would be interested in learning more about. Yes No

Thank you. You will be contacted about participation in this study soon.

Return to: Monica Bruning or Monica Bruning
Fax: (515)294-8993  112 Marston Hall - Iowa State University
       Ames, IA  50011
A-3: Parental Consent Letter and Form

"How young women come to know engineering"

Your daughter has volunteered and was selected to participate in a research study examining how young women approach exploring the career option of engineering and the perceptions they develop when investigating the profession. The study will be a participatory action research study whereby the participant (your daughter) plays a role in developing the research methods and in conducting the research under the guidance of Monica Bruning, Ph.D. candidate and researcher. Ms. Bruning is a graduate student in Educational Leadership and Policy Studies - College of Education at Iowa State University. She has also been a college admissions officer for 18 years.

The research is a dissertation study involving 10\textsuperscript{th} grade girls who are beginning to consider careers and college plans after high school. The specific career field the research involves is engineering. The study will include up to 6 participants. The participants may collaborate on data collection techniques and analysis with advisement from the researcher.

The initial meeting of the participant and researcher will occur the week of February 11, 2002 at a location determined by the participant. At this meeting the following information will be discussed:

1. Overview of the study and its objectives
2. Roles of researcher and participant
3. Brainstorm ideas for data collection
4. Plan data collection
5. Introduce Spring Career Expo* scheduled for Tuesday, February 19, 2002 and discuss data collection techniques for the Expo
6. Outline general timeline for the study (All research, analysis and writing will be completed by July 1, 2002. Most of the research and analysis will occur between February and May 2002.)

*A primary data collection opportunity will be at the Spring Engineering Career Expo held at the Hilton Coliseum on the Iowa State University campus the evening of February 19, 2002. Transportation logistics to ISU will be determined in advance with the participants and their families.

Participation in the research project is voluntary. Participants will learn career exploration techniques, research methodology, and could advance their own research agenda beyond the scope of this project. Students may decline to participate at any time, even after starting the study, and may choose to not explore some of the data collection opportunities.

Although some research activities explore personal preferences and opinions, there are no known risks to the participants and all answers will be treated with strict regard for confidentiality. Names will not appear on any documents and will not be connected with any part of the information coming out of the research. Answers are strictly confidential and responses will be grouped with others to analyze data and findings for analysis and publication. Nothing in the data analysis will identify participants as individuals. Nonetheless, this study is a dissertation study and the general views and findings may be shared with Iowa State University, business and industry, and the educational community.

In order for your daughter to participate in this focus group, we are required to obtain your informed consent. Please indicate your approval by signing and returning the bottom portion of this sheet to the address listed below. Timely receipt of the form below is imperative; if unable to fax, please inform via email below or by phone and mail signed form below.
For more information about the Career Exploration Research Project please contact Monica Bruning at the same address.

Monica Bruning, Researcher  
112 Marston Hall  
Iowa State University  
Ames, IA 50011  
515 294-9963 Fax: 515 294-8993  
mbruning@iastate.edu

Dr. Larry Ebbers  
Major Professor  
N221A Lagomarcino - ISU  
Ames, IA 50011  
515 294-8067 Fax: 515 294-4942  
lebbers@iastate.edu

I give my consent for my daughter to participate in the research study named and described above:

Student's Name: ___________________________ Date: ______
Signature: ___________________________ Date: ______
Parent/Guardian Name: ___________________________ Date: ______
Signature: ___________________________ Date: ______
Researcher signature: ___________________________ Date: ______

Please fax to (515) 294-8993 Attention: Monica Bruning or mail to the address above.
A-4: Initial Meeting – February 8, 2002

1. Introduce myself
   a. Why I am doing this project
   b. My career
   c. Why I developed this research project
      i. More opportunities that ever before females. Some fields and professions actually target women for workforce because of their skills and abilities, and because they are under-represented in the ranks.
      ii. Careers and career exploration has changed a lot
      iii. Studies on youth up until the last 10 years or so was limited. Studies for young women/girls, really limited.
      iv. Findings and reports really didn’t capture the essence of the girl’s real experience.
      v. I design a study, where by we do this together. It’s our study.

2. Participant doing research - Where the idea came from
   b. Possible Selves and Pasteles Study (hand out and read document)

3. Describe How YW come to know engineering research project (hand out and walk group through the proposal)

4. Discuss primary tasks
   a. Roles of researcher and participant
      i. Group work and/or individual work
   b. Brainstorm ideas for methods and data collection
      i. Journaling
      ii. Reflection paper
      iii. Website
   c. Engineering Career Expo (map of floor and description)
         1. How to check out companies
         2. Map of the floor
         3. Questions to ask
         4. Audio tape
**APPENDIX B. DATA COLLECTION DOCUMENTS**

**B-1: Data Collection Calendar and Outline**

<table>
<thead>
<tr>
<th>Date</th>
<th>Group/Site</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 12</td>
<td>Urban HS Teacher Lounge</td>
<td>SOLICITING PARTICIPATION Met with lead teacher/new gatekeeper. Gatekeeper distributes research description and consent forms to parents. I introduce study to potential research participants.</td>
</tr>
<tr>
<td>Feb 13</td>
<td>Rural HS Gatekeeper</td>
<td>INITIAL MEETING Met with gatekeeper and research group. Introduced study. Discussed and planned Career Expo trip. Developed questions. Journal entry assignment: Reflection on thoughts about the study, our discussion.</td>
</tr>
<tr>
<td>Feb 18</td>
<td>Urban HS Teacher Lounge</td>
<td>INITIAL MEETING Met with research group. Collected consent forms. Discuss and plan Expo trip. Adopt Manning questions for Expo. Journal entry assignment: Reflection on thoughts about the study, our discussion, what was learned. Assignment: Additional questions for Expo forward to Monica.</td>
</tr>
<tr>
<td>February 19</td>
<td>Rural HS State University</td>
<td>CAREER EXPO Attended Expo. Interviewed company representatives. De-briefed. Journal entry assignment: Reflection on thoughts about the study, our discussion, what was learned.</td>
</tr>
<tr>
<td>March 1</td>
<td>Urban HS</td>
<td>COMPANY VISITS to Metals and Wood companies. POSTPONED afternoon 2/28.</td>
</tr>
<tr>
<td>March 4</td>
<td>Urban HS</td>
<td>COMPANY VISIT to Food company. POSTPONED 2/28.</td>
</tr>
<tr>
<td>March 7</td>
<td>Rural HS HS Library</td>
<td>THIRD MEETING - Career Expo de-briefing. Status of research. Planning future data collection</td>
</tr>
<tr>
<td>March 28</td>
<td>Rural HS</td>
<td>COMPANY VISIT AND JOB SHADOW (Wood Corporation) POSTPONED 2/26</td>
</tr>
<tr>
<td>April 4</td>
<td>Urban HS</td>
<td>Food processing company visit CANCELS 4/8 visit</td>
</tr>
</tbody>
</table>
### B-1: (Continued)

<table>
<thead>
<tr>
<th>Date</th>
<th>Group/Site</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 8</td>
<td>Urban HS Companies</td>
<td>COMPANY VISITS (Wood Corporation; Center visit; Metals plant)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Journal assignment: Top 10 list - Great learning experience/Bad learning experience.</td>
</tr>
<tr>
<td>April 9</td>
<td>Rural HS Company</td>
<td>COMPANY VISIT AND JOB SHADOW (Wood corporation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Journal assignment: Top 10 list - Great learning experience/Bad learning experience.</td>
</tr>
<tr>
<td>April 22</td>
<td>Urban HS (one absent) HS Library</td>
<td>FIFTH MEETING - Review Top 10 assignment; review status of research; Website exploration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Journal assignment: Reflection on the study.</td>
</tr>
<tr>
<td>April 23</td>
<td>Rural HS HS classroom</td>
<td>FIFTH MEETING - Review Top 10 assignment; review status of research; Website exploration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Journal assignment: Reflection on the study.</td>
</tr>
<tr>
<td>June 10</td>
<td>Rural Group Local Café</td>
<td>SIXTH MEETING - Member checking – Graphs, charts, findings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Outstanding questions.</td>
</tr>
<tr>
<td>Early June</td>
<td>Urban Group – Local Restaurant</td>
<td>Member checking – Graphs, charts, findings. Outstanding questions. UNABLE TO SCHEDULE.</td>
</tr>
<tr>
<td>November</td>
<td>Urban &amp; Rural Groups</td>
<td>Emailed status of study.</td>
</tr>
<tr>
<td>February 2003</td>
<td>Urban &amp; Rural Groups</td>
<td>Emailed status of study and timeline for review.</td>
</tr>
<tr>
<td>March 2003</td>
<td>Urban &amp; Rural Groups</td>
<td>Sent copy of study. Review and respond to text of study.</td>
</tr>
</tbody>
</table>
B-2: Career Expo Questions

What is beginning pay for women engineers out of college?

What are the benefits?

What is the maternity leave and childcare while working?

Can you work through your pregnancy, if you are a chemical engineer, for instance?

What type of engineer is in highest demand?

What kind of hours do you work?

What kind of job would I be doing?

Can you give me a description of a typical job?

Would women be accepted into your company?

Have women worked in your company before?

If so, how long were they there?

What was it like? Did the male and female engineers get along?

What kind of colleges do you like to hire your employees from?

Specifically, what college do you recommend students go to for engineering?
B-3: Rural High School Meeting – March 6

Two groups:
- 7th period Haley & Amy (class periods: 45 long)
- 8th period Henna & Joan

(Use Overview of Study document)

1. Review purpose of study:
   - Examine the influential communicative factors that have an impact or effect young women when considering engineering.
     o Develop a career exploration plan and the perceptions:
     o Reflect on language and imagery, which creates an understanding constitutes young women’s contextual understandings of the engineering

Goal of the research is to enhance understanding of the thought and decision-making processes young women employ when making career decisions that involve these non-traditional career choices.

2. Review PAR: Participatory action research study whereby the participant (student) plays a role in developing the research methods and in conducting the research under my guidance.

Data Collected to Date:

Journals:
1. Journal #1- Jen, Haley, & Amy
2. Journal #2 – Amy, Haley

Attended Career Expo:
1. Review Expo transcripts
   a. Reflect upon:
      i. What you saw, heard, read, felt
      ii. What did the companies have to offer?
      iii. What did you learn about the profession?
      iv. What is appealing or unappealing about what you saw, heard, read, felt?
      v. What else do you want to know about the profession?

2. Journals:
   a. Haley:
      i. Exhausted? Good, bad? Why
      ii. Overwhelming – why?
      iii. Variety in profession – what does this mean for you? Do you want to know more? How might you get this info?
   b. Amy
      i. Educational – right kind of education? Timing good (education is a development process, where you ready?
      ii. Realize why women don’t enter the field. Expand?
      iii. Work through school comment?
      iv. So many men – how feel, how handle, want to handle
      v. Find info other ways – ideas?

3. Final Phases of the research
   a. Wood and construction company visit
   b. Web sites
      i. http://www.engineergirl.org/
      ii. http://www.girltech.com
   c. Brochure review
   d. Other
B-4: Urban Group Company Visit Schedule – April 8

7:45 AM  Depart from Urban High

8:30-10:00  Wood and Construction Corporation
Operations involved the wood and construction industry employing agricultural, civil, construction, computer, electrical, industrial, and materials science engineers. Visit coordinator informed me five engineers were employed at the site and all were male. He arranged a tour “with a couple of the younger engineers that can actually show their projects on the floor” (Personal email, April 3, 2002).

10:30-12:00  Ag Recycling and Biotech Center
Replaced food production facility just prior to the visit day. Center research involved developing technologies for producing food and industrial products from agricultural materials; developing agricultural substitutes for petrochemicals; and exploring and modifying properties of crop-derived materials through applied biotechnology.

Visit and interactive activity “Making Ice Cream” with Society of Women Engineers President (see Appendix J for experiment description)

Carryout lunches eaten while driving to metals corporation

1:00-3:00  Metals and Equipment Corporation
Operations involve metals industry and heavy and large equipment. The visit included meeting with seven women engineers. Jobs included: Supply management (mechanical engineer); design engineer (mechanical engineer); facilities engineer (civil and electrical engineers); quality and manufacturing engineering (industrial engineering, and managers (chemical and mechanical engineers).

3:30  Return to Urban High. Transport Alice to Sylvan Learning Center
B-5: Ice Cream Experiment

Iowa State University
Department of Chemical Engineering Ice Cream Experiment

Plastic Bag Ice Cream

Overview: In this activity students will learn how to lower the freezing point of water and how ice cream forms as a solution freezes. This activity works best when students are directed to follow the instructor's step-by-step demonstration.

Materials: Needed for a class of 30 students.
- 4 qts. (1 gal) Milk (2% or reduced lactose will work)
- 4 qts. Whipping cream (Rich's non-dairy coffee creamer works well)
- 8 cups of sugar
- 1 bottle vanilla
- 30 small plastic Ziploc bags
- 30 large plastic Ziploc bags (1 gal size)
- 30 plastic spoons
- Crushed ice
- Rock salt or food grade salt

Materials needed for each student:
- 1 small plastic Ziploc bags
- 1 large plastic Ziploc bag (1 gal)
- ¼ cup sugar
- ½ cup (120 mL) milk
- ½ cup (120 mL) creamer
- 1/4 teaspoon vanilla
- 1 plastic spoon
- ½ to ⅛ of a cup of rock salt
- ⅛ cup of crushed ice

Pre-lab Preparation: Use a permanent marker to mark each plastic cup at the ¼, ½ and the 1-cup levels. This will help the students when they measure the ingredients.
**Procedure:** Use the plastic cup to measure \( \frac{1}{4} \) cup of sugar by filling it to the first mark from the bottom of the cup.

Transfer the sugar into the small bag.

Fill the plastic cup to the \( \frac{1}{2} \) mark with milk. DO NOT TRANSFER IT TO THE BAG.

Add enough creamer (1/2 cup) to the milk to bring the total volume in the cup to the one-cup mark.

Add approximately \( \frac{1}{4} \) teaspoon of vanilla to the milk/creamer mixture. With smaller children the teacher may want to assist the student.

Carefully transfer the contents of the cup into the small bag, which contains the sugar. Close the bag securely.

Place the smaller plastic bag inside the larger plastic bag.

Surround the smaller bag with several cups of crushed ice.

Pour \( \frac{1}{2} \) to \( \frac{3}{4} \) of a cup of salt over the ice and seal the larger bag securely.

Knead or roll back and forth on a table or desktop. Be careful not to put too much pressure on the bags.

After 10 minutes, check the mixture to see if it is frozen. If it is not, continue kneading.

When the mixture is frozen, simply remove the smaller bag and eat ice cream directly from the bag. (Add toppings if desired)

**Purpose and Background:** Ice keeps things cold because it absorbs heat energy from its surroundings. The freezing point of a liquid is the temperature at which it turns into a solid. In this activity the salt is added to the ice; it lowers the freezing point and the ice begins to melt.

In order for the ice to melt it must absorb heat energy from its surroundings (in this case the ice cream mixture). This causes the temperature of the mixture to drop and the mixture freezes.

**Reference:** This activity was adapted from a pre-high school chemistry activity presented by Kimberly Granatire and Phillip Murry at an ICE workshop at Miami University, Middletown, Ohio in July 1991.
B-6: Rural Group Job Shadow Schedule

April 9, 2002

9:15 AM  Depart from Rural High School

10:00  Overview of products manufactured at the plant provided by Kelly

10:15  Tour of facilities by Kelly

11:00  Shadow an engineer. Group divided into two sets. One pair shadowed Kelly, a Continuous Improvement Engineer. The second pair joined a male Process Engineer

12:00  Lunch (pizza) in the conference room with three engineers (two men and Kelly)

12:45  Groups rotated. Pair one joined the Process Engineer. Pair two joined Kelly, a Continuous Improvement Engineer

1:30  Society of Women Engineers (a professional organization) presentation by Kelly who was very involved at state, regional, and national levels, followed by question and answer session

2:00  Departure
B-7: Data Collection Meeting – April 22 & 23

Rural and Urban Research Groups
Final Data Collecting Meeting
April 22 & 23, 2003

1. Top 10 journal entry
2. Status of research project
   a. Data collecting complete
   b. Analysis and write-up findings
   c. Calendar set for preliminary findings
   d. How to respond to preliminary findings
   e. Timeline for responding
3. Web site research
4. Researching college information
5. Q & A
**B-8: Final Journal Questions**

1. Did you feel the activities we did - career fair, visits/meetings with me, job shadowing, and web research helped you get a better idea of engineering as a career option? If yes, why/how? If no, why not.

2. If you did some thinking about or 'investigating' the engineering career option on your own, tell me about what you did and what you thought about or realized.

   If you didn't think about the research (exploring the engineering career option), why do you think you didn't think about it?

3. What does a career as an engineer mean to you? Identify with an * those thoughts you think resulted from participating in this study.

4. As we explored the engineering career option, what piqued your interest? What was a turn-off?

5. When you explore another career field, how will you go about it to get the best information?

6. How do you feel about the depth of your understanding about engineering careers now? What is your future plans relative to career exploration?
B-9: Member Checking Meeting – June 10

Rural Research Group
June 10, 2002
10:30 Deb’s Corner Cafe

Materials and supplies:
Tape recorder & tape
Research notebooks
Software article
Charts & copies
  o Capture and learn viewpoint
  o Career exploration process
  o Communicative factors

Update on status of research project

Plan for the hour

  □ Review charts
    o What kind of line between communicative factors and perceptions
    o Note other arrow ends
  □ Comments on charts – make notes on chart
    o Agree with categories? Add/Edit/Eliminate
    o Speculate meaning
    o Connections and/or relationships among categories and incidences
    o Metaphors – accurate description

Outstanding questions
  □ Anchor the meaning “traditional view of engineering”
  □ How refer to you in writing – girls or young women
  □ Influence of math and science experiences in school
B-10: Analysis – Chart A – Capture and Learn
Capture & Learn Viewpoint

Communicative Factors

perceptions

meaning

viewpoint

Career Exploration Process

Traditional View of Eng. View

External Factors

Relational & Nurture

Career Ideas Crystallizing

"Do It Yourself"

Identity Choices

Savvy & Discerning

Ambitions Self-efficacy

Self-efficacy
B-11: Analysis – Chart B – Career Exploration Approach/Process
Career Exploration Approach/Process

"Quality Counts"
"Tomorrow"
"The Real Thing"
"Family Ties"

"What (young) Women Want"

Relational
Nurture
Social Commitment
Income
Personal Fit

Legend
- Analytic units
- Conceptual categories
- Adolescent feminine
- Epistemology
- "metaphors"
B-12: Analysis – Chart C – Communicative Factors
How Young Women come to Know Engineering

Communicative Factors

The "How"

"Fun Factor" & Pragmatic

"Show me" "Do it"

"The Zen"

"Fun Factor" & Pragmatic

"What (young) women want"

Relational

Nurture

Social Commitment

Income

Personal Fit

Legend

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Getting through to girls

by Debra Gibson

It's official -- your daughter doesn't want to be Britney Spears when she grows up.

Once you've breathed a sigh of relief, don't assume your job is done. Daughters in particular just may be getting short-changed when it comes to career exploration.

Monica Bruning, director of outreach and recruitment for the College of Engineering, is in the business of convincing boys and girls to study at Iowa State. But when half of Iowa's college population are women, and less than 20 percent of ISU's engineering students are female, she wonders if some students simply don't hear the message.

"I began thinking a lot about how young women's perceptions of careers develop, and in particular what they know about engineering," Bruning explained. "In many of the smaller Iowa communities, these girls may not even know any engineers.

"I was amazed when I did an earlier pilot study on campus with very high-achieving girls here for six-week summer research internships (Program for Women in Science and Engineering, or PWSE). These were very strong science students whose impression of engineering still was sitting in a cubicle all day long plugging numbers into formulas."
So in conjunction with her doctoral dissertation project, Bruning currently is conducting career exploration research with 10th-grade girls from [deleted] High School in western Iowa and [deleted] High School in Des Moines. As part of their exposure to career opportunities, the girls attended the recent College of Engineering Career Expo in Hilton Coliseum, where they visited with dozens of professional engineers. Armed with tape recorders, the girls asked the tough questions.

"They felt especially good about the conversations they had with female engineers," Bruning said. "They wanted to know if there is sexism in the workplace, and if they'll be able to take maternity leave and still have a career. Overall, they came away with the perception that engineering is very cool.

"They just had no idea what all their options are," Bruning continued. "Their eyes have been opened up, and they're more curious now than ever. As one girl said, 'Everything is engineered.'"

Bruning will continue to track the girls as they conduct research on specific companies and plan field trips to those sites. Job shadowing with engineers also may be an option for the research subjects. And throughout the process, they are recording their opinions and aspirations in journals.

"I want the girls to ask themselves the tough questions like, 'Do I want a career in a field that is very nontraditional for women?'" Bruning said.

**Influences on girls**

She also is studying the career influences that exist among girls' peers, as well as inside their homes.

"Research tells us that girls in particular look to their mothers for guidance in making career decisions," Bruning said. To that end, she is planning a "Mother-Daughter Camp" for summer 2003, geared to inform moms of career options and to aid girls in personal development and leadership skills.

"Let's face it -- some moms are asking, 'Do I want my daughter to go into a fast-paced, rigorous field? If so, there go my grandchildren,'" Bruning said. "Positive encouragement within the family is important, and especially for girls."

Bruning's interest in exposing girls to technological careers led to an invitation last fall to moderate a session at "A New Girl Order -- Young Women and the Future of Feminist Inquiry," an international conference held in London. That experience was a turning point for the long-time admissions professional.

"I truly found my intellectual home there at the conference," Bruning said. "I've been a higher education practitioner for so many years, and now I'm learning all those underlying theories that have supported these systems. It was a great place in which to understand and learn from so many women scholars and researchers."

Bruning's own career path started with a student-teaching stint at a private
boarding school in Surrey, England. After graduating from North Dakota State with degrees in home economics and physical education, she was a substitute teacher in Minneapolis "until I got tired of all the discipline issues," she said. "I decided I wanted to work with kids who actually wanted to be at a school."

She moved west, and spent the next 11 years working in admissions for the Western State College of Colorado, Gunnison. With the advent of the Internet, she became interested in technological career possibilities and joined the staff of Montana Tech of University of Montana, Butte. On her first day of work, she halted the production of the school's admissions viewbook because "it was painful to read," Bruning remembered with a laugh.

"I was reading all this copy written by engineering professors, and all I could think was, 'How could any 17-year-old find this interesting?' And I've been saying it ever since -- we have to show these kids how engineering affects their lives and the things that mean the most to them. That's how we get them to become engineers themselves."
D-1: Urban group's Conversation with Male Engineers at Company Visit

The following transcripts detail a discussion with the engineers following the tour of the plant floor. The transcripts comprise a conversation between the two male engineers who conducted the tour, the young women, and the lead researcher.

Engineer: Did they answer your questions out there? Did you have anything else? Any other questions?

Young women: ...inaudible...

Engineer: What I thought we could discuss if there weren't any other questions, was I was going to talk about getting into engineering. Some of the terms that we were using like 'IE.' and 'ME' and...are you aware that there is engineering and there are different disciplines in engineering.

Are you aware of that or do you want me to talk about the different areas that you could go into? In engineering, there are several different areas and depending on what you like you could go into that. It isn't all the same. There is Industrial Engineering, Mechanical Engineering, Chemical Engineering, Electrical Engineering, Computer Engineering, Ag Engineering, Construction?, Civil, Material, is there still Nuclear? So, there's what...8, 9, 10 different areas.

Mechanical engineering, you think of someone more working on a computer and designing things. Purely design kind of work and working with CAD. We do heating and ventilation design. A mechanical engineer would have had to figure out how big a sawdust pipe had to be in order to carry...if I'm going to carry anything up to a three pound of chunk of wood, how fast does the air have to be going through there? Stuff like that.

I got through mechanical engineering and decided that I didn't like the numbers well enough to do that all the time and that's one of the reasons I lean toward the people side

I had material science classes required, electrical engineering classes required and then all my core industrial engineering classes, but I came in with a little knowledge of everything. I wasn't an expert and I couldn't go and crunch the numbers and figure out how to pick up a three pound chunk of wood through the sawdust, but I had that knowledge in the back of my mind that there was more to it than just picking it up.

Then we also have the more of the people side, like the ergonomics and how do people interact with their workstations and psychology and time studies. A lot of the more human piece of engineering and to integrate those.

So now, working here at the wood company, I have to build a machine, I have to have this machine fundamentally sound, but also how is that operator going to be able to reach for that button or how are they going to interact with the product while it is sitting on that piece of equipment.

Electrical engineers...are the guys that...that stuff gets over my head quick! Those are the guys that design like the electrical distribution systems. You think of engineers as some of them being "nerdy"
and that type of thing...that’s the electrical guys. (laughter) You think of engineers as some of them being “nerdy” and that type of thing...that’s the electrical guys. (laughter)

Chemical engineers are doing like the paint and working with materials. Reactions and that sort of stuff. You could probably say...I don’t know, when I was in school that was the most...that was almost 50/50 men and women in Chem E. and...Is that right?

Monica: Um-hum.

Engineer: That was something that they were really good at...I wasn’t very good at chemistry. Computer engineers. I’m not too familiar with that, but I suspect that they design systems of computers and how they interact with our inventory systems.

Ceramic or glass. One of our line managers now used to be a ceramic engineer and she actually worked at a place that made the glass. She would work with the composition or what she called the mix of the batch in order to make that glass clearer or less voids in it or whatever she thought was best.

Civil that does building design and road design and that’s real close with construction engineers too. It would be like the department of highways, you know the state DOT.

A construction engineer I know actually worked for the company that built this [building]. He wasn’t on this project but all the concrete work and steel work...they’re a lot about schedules and also on how to interact with the workers to keep everything moving forward and knowing when the orders are going to come in and how to arrange everything and how to get it built as quickly and efficiently as possible.

As you go to other companies, too, you might keep in mind and ask maybe how do they use their engineers and like some...I’ll go to places and buy equipment and they have engineers they just put in a cube and that’s all they do is work on auto CAD and design equipment. They crunch the numbers like I was saying. That’s all they do is work on that. That’s not for me. I couldn’t sit behind a computer for that long...you know, 8 hours a day and do that. I like to be able to get out on the floor and do different things and do a people project this day and a machine project and do that different kinds of stuff.

If this is interesting to you and you like math and science obviously...you got to have a lot of knowledge of math and like working with that type of thing. If you don’t...engineering may not be where you want to go.

I would encourage you to get involved with it and take a look at it. It’s a great field to work in...a lot of fun projects, but also money you can make compared to some other people that graduate in four years is very good. We already spoke about that. It’s just so fun working here that I forget about that! I encourage you to take a look and see where it goes for you.

Monica: Ladies?

Young woman: How fast does the air move through those tunnels?
Engineer: It’s ah… depends on how big the tube is, but there at the beginning of it will be about 50 feet per second. It’s fast. I think they’re 300 hp motors on the… there’s a turban on there that creates that vacuum and they’re 300 hp and there are three of those. Three different systems, so… Pay attention to those when you are driving out of here.

I remember when the facility started, I was here, one of those big pipes, like this, I don’t think they had enough place for the air to come in there and it collapsed. Smashed it because there is so much vacuum pressure in there.

Monica: Alright, well, thank you very much!

We leave the company.

Monica: So, what did you guys think of that?

Young women: It was cool.

Monica: Could you see yourselves doing what those guys did, or… parts of it… or??

Young woman: Sitting behind a desk, yeah.

Monica: You liked the desk part?

Young woman: I was joking. I could do the receptionist part.
D-2: Transcripts of Discussion with Female Engineer

The following transcripts includes a discussion with a female engineer following a tour of the plant, an hour of job shadowing, and lunch with a group of engineers. The transcripts comprise a conversation between the female engineer who hosted us, the young women, and the lead researcher.

Engineer: Let me tell you about some of my friends. I thought about it this morning that I should have brought some of my pictures. I'd like to show you that we are all normal. We don't all walk around with pocket protectors. We have a lot of fun. Four of those girls and I went to Europe after graduating for five weeks. Actually one of them only went for one week. She had already graduated and was working full time. We have a lot of fun together. In a couple of weeks, I think everyone on that list will be in Iowa City for a weekend and like I said, we worked hard together in SWE, but we also played together. I think once you get to school and see what other engineers are like, yes there are some nerdy ones...they are the good ones to have for study partners. They also were involved in intramurals and extracurricular activities and stuff like that, so you'll see that there are a lot of other engineers just like you.

I'll briefly talk about Amy. Amy was basically my right hand. We'd help each other and did a lot of activities together. She now works for GM. She has been there not quite two years and she's doing rotations. One of her...inaudible...shocks and struts and things like that that keep the car from vibrating every time you hit a rock. She had to do testing on that for like springs and struts. Similar to that, she was doing simulations first.

Trish is in grad school. She has a degree in engineering science degree. Engineering science is kind of a general engineering degree. You have to be careful with it because it is hard to get a job because nobody knows what it is. But if you want to specialize in something, like she wanted to go into biomedical. A lot of women I think are interested in the chemical engineering side more than the health side of the sciences. She wants to end up teaching doctors how to use medical equipment. She'll work for a company that produces medical equipment and she'll know all the technical things about it and teach the doctors how to use it.

Sarah is at Proctor and Gamble in Cincinnati and she is in their marketing and research department. That was the route she wanted to go. She never really liked doing all that calculus and calculations and stuff like that. She wanted to get more into how to______, so she's on like a research and development team at P and G.

Angie is working for General Mills. I'm not sure what she'll be doing but I know she's had a couple of internships there and really enjoyed it so she's going back to General Mills. She's a chemical engineer. About ½ of the chemical engineering classes now are women. I would say civil is probably a close second.

Theresa, my best friend from 4th grade up till now. She works for____, which is like a_____ company and she designs buildings.

Tammy is a civil engineer and she works for a consulting firm and she does like...a variety of things, but she works with water treatment...like if they have to put in a new sewer line or something, she'll determine the elevation or the heights. They have like landscape architects. Water mains are a big project of hers.
Carrie is right now in agricultural engineering. She’s at State U and is the SWE president this year. Her focus is more on environmental. She is working for a Senator out in Washington DC. I don’t remember which one.

Engineer: More questions?

Young woman: At the job fair thing that we went to, there were people who designed streets like in Boone. What type of engineer would that be? Would that be more like environmental?

Engineer: I would say it would probably be civil. Roads, bridges, buildings. Civil has some different to it and environmental is one of those if you want to specialize. You could go chemical or you could go agricultural. All three of those has an environmental focus. I’m sure that designing a road you have to have environmental consideration.

Young woman: Does genetic play a part in any kind of engineering at all? I’m kind of interested in the field of science, but I wasn’t really sure if that was engineering or not?

Engineer: I would think, I mean I’ve heard of genetic engineers. At State U, we don’t have specific genetic engineering degree. If I were to guess I would say that’s more under chemical or more maybe take the engineering science degree and make that whole...Liberal Arts program has a huge genetics...

Engineer: Now think about all the machines and conveyors that we have to take apart or sometimes...

Engineer: Is that all your questions?

Monica: How about some feedback for Kim? Continuous improvement always wants feedback. What has been for you today...a good part of today? Or maybe something that you would change. What has been interesting, useful, insightful, wow...I didn’t know that before, or this kind of matters to me now?

Young woman: inaudible...didn’t realize all the machines, the conveyor belt, all the parts to make a window. I didn’t realize it took that much to make a window, but there is a lot of stuff you have to do.

Engineer: What would you do differently like if another group was to come here, what can I do to make it more fun?

Young woman: It’s not that it wasn’t fun. There’s a lot of stuff that you have to...because a lot of this stuff we don’t understand. I got some of it because of my background, my dad fixes stuff, but there’s just so much information that we try to cram into one hour. There’s nothing that you could do, it’s just the situation and you have to try to understand...inaudible...

Young woman: I kind of wish we could’ve just sit by somebody and just watch them do their job. They probably wouldn’t have liked that either. But there’s so many jobs to pick from...maybe just walk around. We did kind of catch some of that.

Monica: This project isn’t necessarily about you becoming an engineer, but it’s about exploring the field and becoming more familiar with it. Was it a day that has peaked or encouraged you to think about the engineering applications...
Young woman: Coming here, I was still trying to choose careers and I think it was better for me to come in here and see what you do compared to just regular stuff we see in Manning. There’s more out there and bigger things and bigger problems to solve than what we think of mainly.

Young woman: I don’t know… I’m still in high school and I have no idea what I want to go into, but this project has shown me what I can do to decide. I don’t know if I want to be an engineer, I don’t know what I want to do yet, but I know how to decide now. What to look for…

Young woman: I really don’t think I want to work in a window store. Windows just don’t do it for me. I like working with people and I like to kind of sit behind a desk and do things like that too. I don’t like being active all day long.

Young woman: I hear you over and over that if you want to be good at engineering that you have to be good at math and science. Sometimes after I’ve started to study, I’ve looked at school and what I want to take now and what I think I could do good in… like this math and science thing, think I could progress in that and maybe that would lead to something better.

Young woman: I don’t like math and science that well… the only thing I like is biological science.

Engineer: That’s why I say to do things that you enjoy. Don’t go be a mechanical engineer because you are good at math. Do what you like. Or don’t be a biomedical engineer…

Young woman: … I hate math and science with a passion. The only things I like are like history…

Young woman: It’s hard to choose especially at our age… well for me… I tend to like almost every subject I take. I’ve liked school ever since I was really little.

Job Shadow visit ends…
REFERENCES


Thomas, Jim (2001, June). Keynote speaker at The Midwest Qualitative Research conference, Minneapolis, MN.


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