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Leaning into Engineering: Tenured Women Faculty and the Policies and Programs That Support Them

Author
Karpman, Deborah

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Leaning into Engineering:

Tenured Women Faculty and the Policies and Programs That Support Them

A dissertation submitted in partial satisfaction of the

requirements for the degree of Doctor of Education

by

Deborah Karpman

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ABSTRACT OF THE DISSERTATION

Leaning into Engineering:

Tenured Women Faculty and the Policies and Programs That Support Them

by

Deborah Karpman

Doctor of Education

University of California, Los Angeles, 2015

Professor Linda P. Rose, Co-Chair

Professor Linda J. Sax, Co-Chair

While researchers have documented the barriers that women in engineering programs face (i.e. gender bias, work/family conflict, "dual career" issues, limited access to information networks), few studies examine the experiences of successful women faculty and the challenges they overcame in their career. This study filled that gap by utilizing qualitative methods to investigate the life stories of tenured women faculty in engineering, including the challenges they faced and overcame and how they navigated their career. The participants in this study were female tenured associate and full professors at three doctoral research universities (Carnegie Classification: Research University/Very High Research Activity) in the United States. This study sought to understand the challenges that

female engineering faculty faced in their careers, as well as the institutional policies and programs (i.e. family-friendly policies, diversity/equity programs, mentoring initiatives, etc.) that helped them to be successful in obtaining tenure. The stories of the twenty-one tenured female engineering professors in this study depicted the unique experiences that women faculty face as a gender minority in academic engineering programs. By situating this study within the context of three selective doctoral granting institutions, this study was unique in that it uncovered how institutional processes and programs directly influenced the success of women faculty in engineering. Although women at all three universities faced similar challenges including gender bias, work/family conflict, the "two-body problem," among other barriers, interviewees' perceptions of the effectiveness of the policies and programs differed significantly by site. This study provided insights into how women faculty perceive many of these programs as well as the factors that influence the decision to utilize the policies that were implemented to support women faculty in engineering.

The dissertation of Deborah Karpman is approved.

Mark Kevin Eagan

Adrienne Lavine

Linda P. Rose, Committee Co-Chair

Linda J. Sax, Committee Co-Chair

University of California, Los Angeles

2015

DEDICATION

This dissertation is dedicated to my husband, Michael Barragan, who has steadfastly supported me in all that I have embarked on; who has stood by me through all of life's ups and downs, and who continuously makes me laugh. I am blessed to share my life with you, and to have the opportunity to raise our beautiful son together.

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VITA

2005	B.A. Art and Art History Colgate University Hamilton, NY
2009	M.F.A Studio Art University of Massachusetts Amherst, MA
2009-2012	Assistant Professor of Art Director of Foundations Program University of Montevallo Montevallo, AL
2011	Visual Arts Fellowship Alabama State Council on the Arts Montgomery, AL
2012	Faculty Awards University of Southern California Los Angeles, CA

CHAPTER ONE

Statement of the Problem

Compared to their male peers in academic engineering programs, the female faculty is less likely to reach full professorships (Easterly and Ricard, 2011; Touchton, 2008). Rather, women are concentrated at the lower ranks of academia as assistant professors, lecturers and adjunct faculty (Fox, 2010). In 2006, women accounted for 30.5% of non-tenure track instructors, but only 11.9% of associate professors and 3.8% of full professors in engineering (Commission on Professionals in Science & Technology (CPST), 2006). Due to low representation at the senior rungs of the academic hierarchy, women have limited access to senior-level administrative positions (i.e. department chair, vice dean, and dean positions) and have fewer opportunities to guide policy and future planning activities (Brockopp, Isaacs, Bischoff, & Millerd, 2006).

Numerous factors beyond the interests, abilities, and technical skills of women influence the representation and advancement of women in engineering. Researchers have cited many factors that influence the low representation of female faculty in tenure-track and tenured positions in engineering, including unconscious bias and gender discrimination (Easterly & Ricard, 2011), lower faculty pay for female professors (Shen, 2013; Hagedorn, 1996), work/life conflict (Burelli, 2008; Rosser, 2010; Fox, Fonseca, & Bao, 2011), limited opportunities for mentorship (Gorman, Durmowicz, Roskes, & Slattery, 2010; Page, Bailey, & Van Delinder, 2010), exclusion from information networks (McNeely & Vlaicu, 2010), marginalization of research (Gatta and Roos, 2006), managing dual careers families (Rosser, 2004), and dissatisfaction with the tenure process (Hamilton, 2004; Pribbenow et al., 2010). Researchers have also identified department climate (Callister, 2006) and "male hegemony" (Page et al., 2009) within the university as additional factors that contribute to the low representation of female professors in engineering. Researchers have found that women with children are less

likely to pursue careers in science and engineering, and female faculty in science and engineering with children who enter the tenure-track are less likely to achieve tenure (Ceci and Williams, 2010). Throughout academia, women also perform a greater share of "nurturing" tasks such as advising and serving on committees, which are perceived as less valuable than research in the tenure and promotion process (Perna, 2001).

Taken cumulatively, these intersecting factors have created institutional barriers that have affected the retention and promotion of women in academic engineering programs. Researchers cite the "leaky pipeline" or "gender filter" to explain why women have not reached a higher level of gender parity within faculty ranks (Bilimoria, Joy, & Liang, 2008). The leaky pipeline has been described as both persistent (the problem remains despite numerous efforts to improve the representation of women in engineering) and progressive (there are fewer women at every stage in the academic pipeline). These metaphors have been used to describe the steady attrition of women at each stage of the educational pipeline.

While numerous studies identify barriers for female tenure-track and tenured faculty in academic engineering programs, few look at successful women and the barriers they overcame. In this qualitative study, I interviewed female associate and full professors in engineering programs at doctoral granting research universities (Carnegie Classification: Very High Research Activity), including women who have been promoted to department chair and dean positions, to uncover how their experiences in the field of engineering influenced their career track. I examined issues surrounding their decision to stay and gain tenure, the factors that influenced their success, and the challenges they overcame. I sought to understand the role the institution played in their career trajectory, including specific policies or programs, as well as external factors of support.

Background of the Problem

In addition to being underrepresented in academic engineering programs, there are also few women within the broader field of engineering. Women account for only 11.7% of academic, corporate, and governmental positions (National Science Foundation (NSF), 2013). The low representation of women in engineering has increasingly been identified as a public policy issue, due not only to the perpetuation of gender inequity, but also the underutilization of human resources and intellectual capital (Shen, 2013; Sonnert, Fox, & Adkins, 2007). The lack of a diverse engineering workforce has economic consequences as well, with engineering impacting a broad range of areas including healthcare, biotechnology, consumer goods, media, transportation, energy, security, and the environment (Fox, 2001).

To remain competitive in a global economy, the United States will need to find ways to encourage women to pursue and remain in science and engineering fields. According to the Bureau of Labor Statistics, from 2006-2016 employment in science, technology, engineering, and mathematics (STEM) fields will increase five times faster than positions in other fields (Bureau of Labor Statistics, 2008). Due to increased sophistication in technology and specific needs for organizations in networking, information sharing, internet and server security, social media, and electronic commerce, computer and mathematical science positions are expected to account for 75% of the new jobs in the professional occupations category, which also includes fields such as education and healthcare (Nixon, Meikle, & Borman, 2013).

At the same time as the increase in demand for science and engineering training, the demographics of the workforce are changing. In 2011, women accounted for 51% of the workforce in management, professional, and related occupations (U.S. Bureau of Labor Statistics, 2013). However, gains for women in professional fields have not been evenly distributed. For example, while women account for 61% of accountants and auditors and 82% of K-12 teachers

(U.S. Bureau of Labor Statistics, 2013), women hold only 11.8% of tenured and tenure-track faculty positions in engineering (Burelli, NSF Statistics, 2008).

To improve the low representation of women in engineering, approaches often focus on "fixing the women" rather than examining institutional culture (Rosser, 2004). Bensimon and Marshall (2001) state, "from a feminist perspective, policy solutions are sought from a focus on transforming the organizational context, not just remediating the individual case" (p. 2). In higher education, organizational policy assumes that academic norms, values, structures, and practices are gender-blind. However, Bensimon and Marshall state that any change in program or policy that does not address the effect of gender, both as a conceptual category and analytical lens, will be limited in its effect. Thus, to improve the representation of women faculty in engineering programs, researchers propose that institutions implement policies that strengthen institutional culture.

To this end, Bilimoria et al. (2008) analyzed the effects of the National Science Foundation's ADVANCE Institutional Transformation Program on nineteen participating universities. ADVANCE is funding initiative that seeks "to develop systemic approaches to increase the representation and advancement of women in academic STEM careers, thereby contributing to the development of a more diverse science and engineering workforce" (NSF ADVANCE, 2014). In addition to implementing a variety of different program and policies, ADVANCE institutions have systematically documented their outcomes on topics including recruitment, retention, promotion, and leadership development programs for women. By analyzing annual reports, websites, as well as conducting interviews with ADVANCE project leaders and senior faculty, Bilimoria et al. found that these programs led to improved outcomes on several key indicators prescribed by NSF, including the composition of faculty by rank and gender as well as tenure, promotion, and attrition rates.

Many higher education institutions have implemented mentoring and advocacy programs, as well as "family-friendly" policies, to improve the recruitment and retention of women in engineering. "Supply-side initiatives," which look at improving the pipeline of women entering the academic profession have included the development of affirmative action and antidiscrimination policies. Many of ADVANCE institutions also established mentoring programs and special job assignments to facilitate career advancement (Bilimoria et al., 2008; Chesler & Chesler, 2002; Gorman, Durmowicz, Roskes, & Slattery, 2010). "Demand-side initiatives," designed to increase the retention of faculty, include flex-time, childcare support, family-friendly policies (i.e. parental leave, paid family leave, domestic partner benefits) and tenure clock extension policies (Pribbenow et al., 2010). Universities have also implemented leadership development programs and best practices guides to improve the institutional culture within engineering programs.

Although increasing the representation of women faculty in engineering remains a key initiative at many universities and is frequently cited as an institutional priority for many campuses, the percentage of women in tenure-track faculty positions has remained low, rising only slightly from 6.9% in 2001 to 10.8% in 2006 (Burelli, NSF, 2008). While researchers describe the success of institutional transformation programs at the nineteen universities receiving ADVANCE funding, they explain that many other universities rely on programs that are "simplistic or piecemeal" and unable to counter the effects of "systematic, historical, and widespread gender inequities" (Bilimoria et al., 2008, p. 424). Thus, although many higher education institutions have the stated goal of improving the recruitment, retention, and promotion of women faculty in engineering, the percentage of tenured faculty has remained persistently low despite these various efforts.

The Problem Statement and Research Questions

Despite numerous barriers, some women have been successful in academic engineering programs, gaining tenure, and often progressing to leadership positions such as department chair, vice dean and dean positions. How did these women navigate their career amid numerous challenges, ranging from gender bias to work/family balance issues and limited opportunities for mentoring? In their own words, what helped at key junctures of their career to enable their success? Did they benefit from any programs or policies designed to improve retention and promotion? What were their greatest challenges, and how did they overcome them? What lessons can be learned from their stories, and can they provide insight and strategies for junior faculty, currently navigating similar environments? This study identified factors that led to the success of these women in engineering programs, and provided insight into what policies and programs can be implemented to improve retention and promotion rates for current faculty.

These issues were studied through two research questions:

RQ1: What do female associate and full professors in engineering say were key factors of support within the institutions they have worked that contributed to their achieving tenure?

1a. Mentoring

1b. Institutional policies/processes (i.e. family-friendly policies, tenure policies, hiring policies, teaching and service policies)

1c. Other factors of support

RQ2: For female associate and full professors in engineering, what were key challenges within the institutions they have worked that they had to overcome to achieve tenure?

2a. Gender bias

2b. Balancing demands of work with family

2c. Institutional policies/processes

2d. “Dual career” problems

2e. Departmental climate

2f. Proportion of female faculty to male faculty

2g. Other challenges

Research Design

The participants in this study were female tenured associate and full professors at three doctoral research universities (Carnegie Classification: Research University/Very High Research Activity) in the United States. I conducted semi-structured interviews with fifty percent or more tenured female engineering faculty at each of the research sites, for a total of 21 women (7 at Research University I, 9 at Research University II, and 5 at Research University III). Some of these women may have achieved tenure at other universities. These three research sites were selected for several reasons. First, the low representation of women in academic engineering programs is most pronounced at highly-ranked doctoral granting research institutions, compared to liberal arts colleges, two-year universities, and less selective universities (Rosser, 2004). Moreover, these universities graduate doctoral and post-doctoral students, thus shaping the future of the overall engineering profession. Finally, all three universities have had major ongoing funding initiatives intended to improve the recruitment and retention of women faculty.

Since these experiences are based on nuanced processes and reflections, qualitative interviews were the most appropriate research method. Qualitative research focuses on the perceptions and perspectives of participants. According to Merriam (2009), qualitative research explores “how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences” (p. 23). Qualitative research enabled me to examine numerous facets of a career in engineering that are not easily quantifiable: how women

experience the early stages of their career, how they experience the tenure process, how they balance work and family responsibilities, and the barriers and challenges they overcame to be successful in their career. Through qualitative interviews, I was able to probe the factors of support that led to tenure. For these women faculty, what were the key junctures in their career, and how did they navigate various career decisions? How did policies and programs affect the tenure and promotion process?

Significance of the Research and Opportunities for Public Engagement

The results of this study will be relevant for numerous stakeholders, including the National Science Foundation (NSF), the National Academy of Engineering (NAE), university engineering programs, deans, and female faculty in engineering, as well as non-profit organizations that advocate for female engineers and engineering students, such as the Society of Women Engineers. I will present my findings to university engineering programs, as well as the Women in Engineering ProActive Network Conference (WEPAN).

At all three research sites, the retention and promotion of women faculty are consistently articulated as an institutional priority, through mission statements and university communications. Thus, the results from this study will have the potential to influence future programmatic efforts at the individual research sites. While the barriers for women in engineering programs have been well documented, there is little research that describes how successful women have navigated their career. Moreover, most of the current body of literature is quantitative, which has identified many of the barriers that women face, but often does not provide the nuanced perceptions associated with faculty experience in academic engineering programs. This study filled that gap, presenting findings that highlight the strategies that women have used to be successful. Also, since the majority of the existing body of literature focuses on

women in STEM (which includes fields such as biology and psychology which have a greater representation of women), this study disaggregated the experiences of women in engineering.

CHAPTER TWO: Literature Review

Introduction

The absence of women in engineering is most pronounced at senior levels of the academic hierarchy. Women account for only 5% of full engineering professors (Burelli, NSF, 2008), limiting access to senior level administrative positions. Since women are generally absent from leadership positions (i.e. department chair, vice dean, dean), they are less likely to guide policy and strategic planning activities. Rather, women are concentrated at the lowest rungs of the academic ladder, as part-time/adjunct instructors and lecturers (Fox, 2010). In 2006, women accounted for 30.5% of non-tenure track instructors, 16% of assistant professors, 11.9% of associate professors, and 3.8% of full professors in engineering (Commission on Professionals in Science & Technology (CPST), 2006). Fox (2010) also reports that female faculty members positively influence the retention and success of female undergraduates. They are more likely to have female graduate students included in their research teams and are more likely to provide advising support. Thus, the presence of women faculty has been shown to have a positive effect on the outcomes of female students in engineering programs.

Numerous studies focus on the barriers that women faculty encounter in academic engineering programs, such as unconscious bias and gender discrimination (Easterly & Ricard, 2011), lower faculty pay for female professors (Shen, 2013; Hagedorn, 1996), work/life balance issues (Burelli, NSF, 2008; Fox et al., 2011; Rosser, 2010), limited access to mentorship (Gorman et al., 2010; Page et al., 2009), limited access to information networks (McNeely & Vlaicu, 2010), marginalization of research (Gatta and Roos, 2006), balancing dual career families (Rosser, 2004), and dissatisfaction with the tenure process (Pribbenow et al., 2010; Hamilton, 2004; Fox et al., 2011). However, there are few studies that examine women who were promoted to associate and full professor. How did these women navigate these complex,

male-dominated organizational environments, and persist through all stages of the academic pipeline? What strategies did they utilize to be successful in their career?

To provide the context for this investigation, I will outline what we know about the attrition of women in engineering. Researchers have used the concept of the "leaky pipeline" or "gender filter" to document the attrition of women at every stage of the academic pipeline in engineering including at the undergraduate, graduate, doctoral, post-doctoral, and faculty levels. This literature review will discuss the impediments to retention and promotion at the tenure track faculty level, specifically work/family conflict, dual career problems, the constraining effects of the tenure process, gender bias, and limited access to resources such as mentoring, funding, space, and information networks. Finally, I will examine strategies that have been found to increase the retention and promotion of women, including policies and programs that foster organizational change.

Navigating the Early Stages of the Engineering Pipeline

Many researchers cite the "leaky pipeline" in engineering fields as a major factor in hindering the progression of women into academic careers (Espinosa, 2009; Greni, 2006; Etzowitz et al., 1994). Researchers describe the leaky pipeline as both persistent (attrition has not gone away despite many different attempts to solve the problem) and progressive (farther along the pipeline, the fewer the women) (Cronin and Roger, 1999). Researchers have also examined the differences in socialization between men and women. Girls are encouraged to be "given a task, complete it well, and then receive a reward from an authority figure" (Etzkowitz et al., 1994, p. 3). However, in undergraduate, graduate and doctoral programs, the academic values shift, promoting work that is independent and often void of interpersonal support.

Many women report that they entered these programs with low self-confidence, which was then exacerbated in graduate school (Etzkowitz et al., 1994). Hannah Valantine, Dean of

Leadership and Diversity at the Stanford School of Medicine, remarked that female students "conclude consciously and unconsciously that these careers are not for them because they don't see people like them…That effect is very, very powerful — this sense of not belonging" (Shen, 2013). In a focus group of 17 female master's and doctoral students in chemical engineering, only three women intended to use their degree in their chosen field. One woman stated:

> Given the investment, I feel huge pressure to use my Ph.D. I mean, I've put five years of sheer hard slog into getting this degree. But when I look ahead I'm really turned off. What I see down the pike is hellish work hours in the seven-year lead-up to tenure, and then you're out on your ear. In this field no female has a chance of getting promoted. You just don't see it happening—there are no senior women out there. The top jobs are tied up by an in-group of men who look out for each other. (Hewlett et al., 2008, p. 62)

In the private sector, female engineers are also more likely to report high levels of dissatisfaction with their careers than men. In a large study (n=2,493) conducted by the Center for Work Family Policy, researchers used surveys, focus groups, and interviews to uncover women's attitudes and experiences in their science and engineering careers in the private sector. Researchers examined work climate, finding that 69% of female engineers experienced sexual harassment. Of the women surveyed, 51% said they lacked mentors, and 79% said they lacked sponsors (individuals who help advance one's career). Forty-one percent of respondents said they felt "stalled" or "stuck" in their career, indicating that women may not know how to navigate their careers effectively. However, women in these careers report being highly committed to their fields, with 75% of female engineers reporting they "love their work," and 77% reporting they "find the work intellectually challenging and stimulating" (Hewlett, et al., 2008).

Undergraduate Women in Engineering

Examining undergraduate education is crucial to understanding the low representation of women in engineering, as this educational stage is considered the "latest point" for entry into engineering disciplines. Researchers have found that women are less likely to be retained in

undergraduate engineering programs, shaping the gender imbalance in the science and engineering pipeline. Contrasted with many other fields that can be accessed from a wider range of educational backgrounds and in later stages of life, the undergraduate years are considered the last access point for a career in engineering. In engineering, women earned 20% of the bachelor's degrees, compared to other fields such as mathematics, biological, agricultural, and earth sciences, where women earned degrees at comparable levels of their male peers (NSF, 2008). Of the women who attained bachelor's degrees, only 61% of women were still employed in engineering after three years (Society of Women Engineers, 2008).

Female undergraduate students leave engineering for several key reasons, including negative instructional experiences, a lack of "belonging" or "fit," and a lack of peer support. Researchers found that an overall lack of student engagement in various areas of STEM programs, including a lack of informal interaction with peers and less participation in class discussions may contribute to the departure of women from degree programs (Zhao, Carini, and Kuh, 2006). Women's Experiences in College Engineering (WECE) (2002) reported that negative instructional experiences are particularly influential on students' decision not to remain in STEM programs, more so than the effects of gender-based programming or perceptions of support in the collegiate environment. Another challenge for the retention of women is the "weed-out" practice at large universities, in which students encounter a competitive educational model that is designed to "eliminate an unwanted excess of prospective students" (Bystydzienski and Bird, 2006, p. 7). Defined by a rapid curricular pace and rigid evaluation system, this pedagogical model is more likely to negatively affect women than men. Bystydzienski and Bird state:

> The science education system, of which weeding out is a central component, tests for characteristics traditionally associated with masculinity in Western societies and is based on notions such as "the challenge," understood by young men who have encountered various rites of passage into manhood (e.g. sports, fraternities,

> military)…Nurturing is deliberately denied because it assumed that it will make men weak and vulnerable (7).

To counter this traditionally masculine environment, female students expressed the importance of having female role models, either on the faculty or brought as guest speakers. According to female students, the visibility of female role models lessened the isolation in a male dominated field and communicated the possibility of balancing work demands with family responsibilities. In a mixed methods study, Amelink and Creamer (2010) found that positive interpersonal relationships formed with other students were more positively correlated with satisfaction in engineering programs for women than men. Female students generally viewed female faculty as more supportive than male faculty, with one student remarking that, "If you want to go talk to them, I feel like the female faculty would ask you a question, what do you think about this, what's going on with you. I think it would be a more personal conversation. I can't imagine a male professor asking me what's going on with me" (Amelink and Creamer, 2010, p.8). Students also cited peer support as a key factor in retention, and that students who had difficulty "fitting in" with social/cultural norms in engineering may leave due to feelings of social isolation and an inability to handle the workload on their own. One student stated, "I feel like that is one reason people drop out of engineering, they don't feel like they have a group of people that can help them. The work here is not to be done on your own" (p. 8). To combat these issues of social and academic isolation, Amelink and Creamer recommend that educators address the dynamics of peer interaction, proactively engaging gender dynamics in both formal and informal academic environments, role-modeling respect for students, and establishing formal mentoring programs that pair female students with female engineers.

Women in Engineering Masters and Doctoral programs

Women continue to earn more degrees than men at every level of education, from associate to doctoral. As of 2009-2010, women earned 52% of all doctoral degrees (National

Center for Education Statistics, 2012). However, while women are attaining doctorates in unprecedented numbers, they are concentrated in specific fields. In 2004, women received 44% of the doctorates in 'science and engineering.' However, the number of degrees earned in a fields like psychology (67.3%) and biology (46.3%), where women have reached or even exceeded parity with men, skew the aggregated numbers for STEM, giving the false impression that women have nearly achieved gender parity overall. In engineering, the percentage of women obtaining doctorates has increased slowly from 15.5% in 2000 to 23.2% in 2010. In some fields, such as computer science, the percentage of doctorates has plateaued over the last ten years, averaging 21.2% (NSF, 2013). However, of those obtaining advanced degrees in engineering, many women report that they do not plan to seek a career in their field.

For doctoral students, women are more likely to drop out due to factors such as marriage and plans to have children. However, researchers have found that being surrounded by a "critical mass" of other women significantly improves retention. In a quantitative study of 3,614 doctoral students in STEM, Lott, Gardner and Powers (2009) found that women are nearly twice as likely to drop out of a doctoral program than men after the seventh year in the program, possibly due to the interplay of factors such as marriage and the decision to have children. Studying programs with ratios varying from 7.5% women (engineering) to 61.3% female (veterinary medicine), the researchers also found that in programs with 33% or more females, students were 39% *less* likely to drop out than in programs with a higher concentration of males. When surrounded by a "critical mass" of other students from similar demographics, women are retained at higher rates and more successful than when they are isolated within a predominately white male environment (Lott, Gardner, & Powers, 2009). Turner (2002) found a similar phenomenon in relation to faculty hiring and retention, which demonstrated that underrepresented faculty is more likely to be retained when there is a "critical mass" of women.

Female Tenure-Track and Tenured Faculty in Engineering Programs

At each stage of the academic pipeline, the representation of women declines, translating into a small percentage of women in tenure-track and tenured positions. As of 2008, women accounted for only 11.8% of tenure-track and tenured positions in engineering (Burelli, NSF, 2008). Only 5% of full professors are engineering are women. Since women are concentrated in the lowest rungs of the academic hierarchy (as adjunct professors, instructors, and assistant professors), they are less likely to guide departmental and school policy, and they are less likely to be eligible for senior leadership positions such as department chair, vice dean, and dean positions. Researchers have cited numerous barriers for female tenure-track and tenured faculty in engineering programs, including work/family conflict, stereotype threat, unconscious and conscious gender bias, and discrepancies in resource allocation, among many others. In a survey of 105 women scientists and engineers, 71.4% reported that the most significant challenge was balancing work and family responsibilities (Rosser, 2003). Respondents also cited low numbers of women (resulting in isolation/lack of mentoring), gaining respect from peers/establishing credibility, and "dual-career problems" (balancing one's career with spouse or partner) as significant challenges.

Dual Career Challenges ("The Two Body" Problem)

Many working couples face the challenge of finding employment in the same geographical location that allows both individuals to advance in their careers. However, this dual-career challenge is often more pronounced for couples in which both individuals are pursuing academic employment (both during postdoctoral training and in seeking tenure-track positions), since academics often work in highly specialized fields (Woolstenhulme, Cowan, McCluskey, & Byington, 2012). Moreover, universities are often found in relatively isolated

geographic locations, which often have limited employment options. In "college towns," a single university may be the only employment option for both individuals.

Since women are more likely to have spouses who have their own careers, the "two body problem" often adversely impacts whether a woman will seek a tenure-track position (Rosser, 2004; Wolf-Wendel, Twombly, and Rice, 2000). Eighty-nine percent of female faculty has spouses who are employed full-time, compared to 56% of male faculty (Jacobs, 2004). Managing a dual-career family is a particular concern for women in engineering. As one female engineering professor explained, "Ph.D. women are often married to Ph.D. men. Most Ph.D. men are not married to Ph.D. women" (Rosser, 2004, p.9). Eighteen percent of women academics are married to male academics, compared to 13% of male academics that are married to female academics (Jacobs, 2004). Thus, women are more likely than men to report being constrained by the need to manage a dual career family.

To address the "two-body problem," many universities have adopted joint hiring accommodation policies. However, since the university is typically finding a position for the partner of the desired candidate, a common concern is that the spousal hire is stigmatized because he or she was not recruited through the traditional process (Scheibinger et al., 2008). However, researchers have found that accommodation policies can improve the recruitment and retention of top academic candidates (Woolstenhulme et al., 2011).

Researchers found that the presence of accommodation policies often differs by institution type, and that doctoral-granting universities are the least likely to have these employment policies. Wolf-Wendel et al. (2004) examined spousal accommodation policies, defined as "written or unwritten, customary, systematic approaches to a given employment situation" (p.4). Through a survey of chief academic administrators at institutions in American Association of Colleges and Universities (n=360), they found that the presence of an

accommodation policy often differed depending on the type of institution. Forty-five percent of research universities had a spousal employment policy, but only 15% of doctoral granting universities had a policy. Only 15% of schools reporting they would do "nothing" for a faculty member who requested assistance for his or her partner. They found that although most universities will do "something" to assist faculty members' spouse or partner, these institutional efforts are typically on an ad-hoc basis.

Although many schools do not have formal policies, most administrators recognized that these employment challenges for dual-career couples are becoming more widespread, and that employment decisions are often made in consideration of a partner's career aspirations (Wolf-Wendel et al., 2004). However, the most salient rationale for adopting accommodation policies was "to be competitive," which was considered significantly more important than the goal of increasing women faculty and increasing faculty of color.

Work/Family Conflict

Citing contemporary social theory, the researchers explain that work and family obligations do not merely interact and coexist, they often are in conflict with each other. To explore the ways that work and family interact and often conflict, Coser (1974) described the concept of the "greedy institution" as those that seek "exclusive and undivided loyalty" (p. 6). As women work outside the home at higher rates, social patterns have diverged from the "separate spheres" model that governed the 19th and 20th centuries in the United States, in which women were primarily responsible for the family and housework, and men typically worked outside of the home (Moen and Roehling, 2005). Over the last decade, the number of women in the workforce with young children has steadily increased. In 1998, only 34% of women with children under six worked outside the home (Department of Labor, 2000). By 2012, this number increased to 64.8% (Department of Labor, 2013). Yet, even when women have demanding, high-

level professional careers, they still continue to perform the majority of childcare and family-related responsibilities (Boulis and Jacobs, 2008). Therefore, women are more likely to report a conflict between work and family responsibilities (Fox, Fonseca, & Bao, 2011).

In engineering fields, the conflict between work and family is particularly acute. Women with young children are both less likely to obtain a tenure-track position, and less likely to gain tenure (Mason and Goulden, 2004; Ceci and Williams, 2010). While single women without children are nearly as successful as married men with children at securing a tenure-track position, Goulden et al. (2009) found that women in the sciences who are married with children are 35% less likely to obtain a tenure-track position compared to married men with children. For married women with children who do enter the tenure-track, they are 27% less likely than their male peers to achieve tenure (Goulden et al., 2009). However, researchers have found that women who seek a faculty position are actually more likely to gain employment than men (Faculty Committee on Women in Science, Engineering, and Medicine, 2010). Yet, it seems that many women do not seek employment in academic careers for a variety of reasons, including not fitting into the norm of an "ideal scientist," and viewing academic careers as incompatible with the desire to have a family.

Researchers have described the normative model of an "ideal scientist" as an individual who prioritizes work over other activities and obligations, has few other interests, and engages in research single-mindedly (Bailyn, 2003). Further, the evaluation structure in academic science demands long hours and sustained achievement, particularly in elite research institutions. In addition to the expectations of a demanding work schedule, women faculty who have children experience the psychological and physical demands of pregnancy and childbirth and tend to describe the care of children as "personal problems" or as one interviewee stated, "my conflict" rather than one based on the broader structure of society (Gatta and Roos, 2004, p. 130).

Prior to entering the tenure-track, women perceive the conflict between work and family (Goulden et al., 2009). Researchers found that women who had children during their postdoctoral training were twice as likely to change their career goal as men, and also twice as likely as women who did not have children and who did not have plans to have children in the future to change their career goal (Goulden et al., 2009). For both male and female doctoral and postdoctoral scholars, research-intensive universities were rated the least family-friendly amid a range of various career options including teaching-intensive institutions, non tenure-track faculty positions, and policy/managerial/research careers outside of academia. For female doctoral students, this view was the most pronounced, with only 28% rating tenure-track careers at research-intensive institutions as family-friendly (compared to 44% men). Female postdoctoral students were also less likely than their male peers to view academic research careers as family-friendly. In this case, 36% of the women and 52% of the men (Goulden, et al., 2009).

For many women who want to have children, the work/family conflict is compounded by the rigidity of the tenure and promotion process, which often coincides with childbearing years. According to one female professor:

> At the risk of stereotyping, I think that women generally struggle more with the daily pull of raising a family or caring for elderly parents, and this obviously puts additional demands on their time. This is true for younger women, who may struggle over the timing of having and raising children, particularly in light of a ticking tenure clock, but also for more senior women, who may be called upon to help aging parents (Rosser, 2004, p.57).

Researchers report that the tenure system discourages women from having children, and more women in the academy are childless than men (Mason and Goulden, 2004). For women who have children, they are twice as likely than men to state that they had fewer children than desired (Ceci and Williams, 2011). Women are also less likely than men to apply for tenure-track positions, and more likely to leave due to family reasons. Thus, women's representation is

highest in the least secure positions (e.g., adjunct and instructors), and less prestigious institutions such as community colleges. Whereas men who leave academic positions are most likely to cite salary as a key reason, women who leave academia are more likely to identify interpersonal and family reasons. Based on these findings, it seems that women are more likely to experience or anticipate conflicts between work and family.

The desire to balance work and family may be why women are more likely to seek out part-time positions. In math-intensive fields, although 77% of women and 81% of men rated working full-time as important, 31% of women versus 9% of men said that working part-time for a period of time is "important" or "extremely important" (Government Accountability Office (GAO), 2004). Women are more likely to fill teaching-intensive and part-time positions, and, correspondingly, to have lower salaries than men (Ceci & Williams, 2011). The GAO report suggests implementing tenure clock extension policies and creating part-time tenure-track positions that segue into full-time posts (2004). Gender equity committees have recommended numerous additional strategies to improve the retention of women in math-intensive and engineering fields, including grant extensions, reduction of teaching duties for parents with newborns, lactation stations, spousal hiring, improved childcare, and supplemental funding to hire post-doctoral students during family leave (Rosser, 2010; Ceci & Williams, 2011). Goulden et al. (2009) recommend coordinating grant extensions between federal agencies and universities, as well as creating pathways to reenter academic research after major life events such as a birth of a child or caring for children.

While women (particularly junior faculty) consistently rate balancing work and family as the most significant challenge they face, some women scientists have argued that this problem is overstated. According to AWIS Fellow Nicole Shepherd:

> I believe the whole child-care issue and balancing career and family is a red herring and dangerous issue that will get women scientists nowhere. More than half of women

> scientists either don't have children or aren't married; young male faculty also wish to spend time with their families…I see child care as only one facet of a bigger problem. Today academia is more and more regulated because of administrative bloat; this is killing scientists and making science very unattractive as a career for younger people. (Rosser, 2012, p. 103).

Rosser also notes that the issues for women faculty change over time, with work/family conflict being more of a challenge for junior women than senior women (based on survey data from 1997-2012). Thus, it is important to frame work/family conflict as one facet of many organizational challenges that women faculty members in engineering face throughout their careers.

Women and the Tenure Process

In the current academic system, tenure is considered among the most visible and valued signs of success for faculty (Perna, 2001). However, researchers have found that women are less likely than men to achieve tenure (Perna, 2001; Goulden, et al. 2004). Women engage in heavier teaching and service loads than men, which often constrain their ability to publish (Aguirre, 2000; Rosser, 2004). Perna (2001) found an inverse relationship between research and teaching in the granting of tenure: an increase of publications led to an increased chance of receiving tenure, whereas an increased percentage of time spent teaching led to a decreased chance of obtaining tenure. Women are also expected to perform roles that further the institutional goals of gender diversity (i.e. disproportionally serving on committees and participating in advising responsibilities), but these roles are largely dismissed in the reward system of tenure.

While it is often unclear if women engage in heavier teaching and service burdens by choice, or if they are guided into these roles, researchers have found that performing more service and teaching decreases one's chance of receiving tenure. One participant explained, "I still find the strong perception that women should be doing more teaching and service because of the expectation that women are more nurturing. Although research as a priority for women is

given a lot of lip service, I have not seen a lot of support for it" (Rosser, 2004, p. 28).

Researchers have found that women are less satisfied with the tenure process than men, both in terms of the clarity of expectations, their understanding of the process, and their perception of fairness (Pribbenow et al., 2010; Trower and Bleak, 2004). In a university-wide study, Trower and Bleak surveyed tenure-track junior faculty at six research institutions. They used 28 measures to rate workplace satisfaction, including faculty perception of the tenure process. They found that men were significantly more likely to view their prospects for tenure clearly. They were also significantly more likely to believe that tenure decisions are based on academic performance as opposed to politics, relationships, or demographic characteristics. Women were also significantly more likely to report having received mixed messages about the requirements for tenure from senior colleagues. Women were also significantly less likely than men to rate their department as fair in its treatment of junior faculty.

To lessen the "lock-step" nature of the tenure process, universities have implemented tenure clock extension policies, which accommodate special circumstances such as family responsibilities or health issues. Although these policies are intended to improve the tenure process and increase retention, they often have the opposite effect (Pribbenow et al., 2010). In a university-wide study conducted at University of Wisconsin-Madison among tenure-track and tenured faculty (n=1,338), researchers found that despite these family-friendly policies, women were significantly less likely to be satisfied with the tenure process than men. Women reported that they were also less likely to feel supported in the tenure process, understand the tenure criteria, and receive useful mentoring from their committee (Pribbenow et al., 2010).

Despite efforts to provide more flexibility in the tenure process, researchers found that women were less likely to utilize the tenure clock extension policy, due to concerns of being viewed negatively by their department. Nineteen percent of female faculty at the University of

Wisconsin-Madison surveyed said they wanted to take advantage of the tenure clock extension policy but did not due to various reasons. In addition, both male and female faculty who used the tenure clock extension reported being less satisfied with the tenure process, felt less supported, and felt like they received an inadequate amount of feedback about their progress towards tenure. Researchers (Pribbenow et al., 2010) found that these policies do not necessarily solve some problems associated with the tenure process.

While institutions have created tenure-clock extension policies to improve faculty satisfaction with the tenure process, researchers have found these policies are often ineffective. These policies can result in "flexibility stigma," which Cech and Blair-Roy (2014) describe as the "devaluation of workers who seek or are presumed to need flexible work arrangements, fosters a mismatch between workplace demands and the needs of professionals" (p. 1). Since using these accommodation policies can be viewed as countering norms of the "ideal worker," individuals can face negative consequences such as (perceived) career setbacks, and can be seen as less committed, and thus, less professional (Cech and Blair-Roy, 2014; Ridgeway and Correll, 2004). In particular, women—and mothers in particular—risk being viewed as "double deviants" due to long standing gender stereotypes that suggest that women are less committed to their roles as professionals (Epstein, 1999).

Job Satisfaction

Researchers have found that women are less likely to be satisfied with their academic careers in engineering, and more likely to characterize their departments in negative terms. To understand tenure-track faculty job satisfaction in STEM, Trower (2008) surveyed 587 women and 1,222 men at 56 universities. Since nature of the work and departmental climate are the most salient predictors of job satisfaction, Trower asked respondents to rate "climate dimensions," including fairness of evaluation, fairness of treatment of junior faculty, opportunities for

collaboration with junior and senior colleagues, personal/professional interactions with colleagues, interest senior faculty take in your professional development, and how well you 'fit' (sense of belonging). Women were less satisfied on every indicator, and significantly less satisfied with sense of fit, opportunities to collaborate with senior colleagues, and the perception of fair treatment of junior faculty in one's department (Trower, 2008).

Researchers also have found significant differences in how male and female faculty experience organizational culture. In a quantitative study of 1,215 male and female science and engineering faculty, Fox (2010) examined four social-organizational features of work, including work/family conflict, departmental climate, ratings of department and position, and the frequency of discussing research with colleague. She focused on these attributes because scientific work is fundamentally social and organizational. Research is often conducted with support from others, including colleagues and students. It requires a large allocation of resources in the form of costly labs and equipment, and is performed "on-site." For frequency of discussing research with colleagues, women were less likely than men to speak about their research daily. Women also reported lower levels of inclusion, access to resources, and recognition.

To understand if there is a difference in how women and men experience department climate, Fox studied eight variables including inclusive/non-inclusive, non-competitive/competitive, formal/informal, boring/exciting, helpful/unhelpful, creative/uncreative, fair/unfair, and unstressful/stressful. Women were significantly more likely than men to describe their departments as stressful, formal, boring, unhelpful, uncreative, and non-inclusive. Women and men gave the level of competitiveness and fairness similar ratings. Thus, female faculty members were more likely to characterize their departments with negative attributes (i.e., stressful), and less likely to use positive attributes such as creative or helpful to describe their

departments. For work/family conflict, women were also more likely to report both interference of work with family as well as interference of family with work (Fox, 2010).

Gender Bias in Academic Engineering Programs

In addition to studying the low number of female engineering faculty by examining the conflict between work and family, researchers have also situated this problem in the framework of feminist theory and gender equity. According to feminist theory, scientific practice is situated within male-dominated structures, and patterns of discrimination towards women have limited the success of women in engineering. Bensimon and Marshall (2001) describes gender bias as "not a concrete thing or act but rather the cumulative effect of inequities which by themselves may appear insignificant but in combination can make women academics feel alien, exhausted, defeated" (p. 2). Researchers critique the claim that scientific study is purely rational and value-free (Bystydzienski and Bird, 2006). Established by and for men, elite institutions of higher education and academic science are gendered institutions. The practices and norms of academic science, defined by competition, challenge, hierarchy, and independence, correspond to constructions and attributes of masculinity.

Researchers cite numerous examples of gender bias, both subtle and overt. While policies and bills such as the Civil Rights Act of 1964 and Title IX were passed to eliminate discrimination, more understated forms of bias still exist in higher education (Rosser, 2012). In its report on the status of women at MIT, researchers explained that "the campus was slow to recognize other, more subtle forms of discrimination; it did not look like what we thought discrimination looked like" (MIT, 1999). Using a randomized double-blind study, Moss-Racusin et al. (2012) found that when evaluating candidates for a laboratory manager position, faculty participants—both male and female—rated the male candidate as more competent and employable than the female candidate. Despite having identical resumes, the male candidate was

also offered a higher salary and more career mentoring opportunities (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). In the hiring process, the male candidate was offered a mean starting salary of $30,238, whereas the female candidate was offered a mean starting salary of $26,507. Babcock and Laschever found that women are also more likely to accept lower salary offers, suggesting that women may undervalue their work (2007).

Researchers have found that women experience gender bias in numerous subtle ways, described by Rosser (2012) as "micro-inequities." Rowe defines these micro-inequities as "apparently small events which are often ephemeral and hard to prove, events which are covert, often unintentional, frequently unrecognized by the perpetrator, which occur wherever people are perceived to be "different" (Rowe, 1974, p.3). According to Rosser, these micro-inequities manifest in numerous ways, including women being guided into "less challenging" research areas, not being listed as a co-author on a paper despite one's contributions, to more concrete inequities such as the gender gap in commercialization and patents or not having access to information networks.

Gender bias does not only affect outcomes in science and engineering. Economists Goldin and Rouse examined the hiring processes in top orchestras in the United States and found that using a gender-blind evaluation process, in which reviewers could hear but not see the applicant, increased the rate of acceptance for women by 30 percent (Goldin & Rouse, 1997). Similarly, researchers report that unconscious bias can be detected by reviewing letters of recommendation (Trix and Psenka, 2003). Trix and Psenka found that letters written for women medical faculty candidates, which are essential for promotion and tenure, award processes, and employment applications, were two and a half times more likely to contain "doubt-raisers," including faint praise, irrelevant details, and more references to personal life. Researchers have

also found that publications, which are central to the tenure and promotion process, are rated lower by both men and women when the author is identified as female (Easterly & Ricard, 2011).

Researchers have also examined the underlying, invisible norms and practices that guide the dominant culture of academia. Page, Bailey, and Van Delinder (2009) explore the notion of "male hegemony" in science and engineering fields. The culture of science, which values objectivity, rationality, hierarchy, and individualism, is associated with masculine traits. Although perceived as gender-neutral, daily organizational practices have significant gendered consequences, ranging from access to networking and mentoring opportunities, evaluation bias, to informal rituals such as golfing, fishing, and drinking after work that often exclude women (Page et al., 2009). Despite the fact that women are academically qualified for participation in STEM fields, they often face systemic barriers and obstacles within an academic setting that rewards masculine attributes.

Fixing the Leaky Pipeline: Promoting Organizational Change

Recognizing the numerous barriers and challenges that disproportionately affect women is only the first step towards improving the retention and promotion of women in engineering. Institutions can provide support to women through various initiatives such as implementing and fully supporting dual career hiring programs, tenure clock extension policies, and access to childcare facilities. In addition, institutions can provide funding for continued research during major life events such as the birth of a child or the illness of a parent (Chesler & Chesler, 2002). Responding to the issue of the low representation of women in science and engineering, University of California implemented the Family Edge Program. Open to both male and female faculty, they have instituted the following policies: a flexible part-time option for tenure-track faculty with child-care responsibilities, university sponsored childcare, emergency childcare, family-friendly calendars and scheduling, adoption benefits, and hiring relocation counselors for

newly recruited faculty (UC Family Edge, 2013). They also instruct hiring committees to ignore family related gaps in CV's and offer postdoctoral fellowships to encourage parents to return to the academy after leaving (UC Family Edge, 2013). While more research is needed to determine the effectiveness of these programs, these coordinated attempts are a crucial step in improving the retention and promotion of women in higher education.

Researchers have also documented the importance of mentoring in addressing the low representation of women faculty in engineering (Chesler and Chesler, 2002); (Gorman, et al, 2010); (Rosser, 2012). In a survey of Association for Women in Science (AWIS) Fellows (n=85), which includes senior, distinguished scientists and engineers from both academia and industry, respondents were most likely to indicate that "Mentoring Junior Faculty" (41.3%) as the most useful change in institutional policy for facilitating the careers of women faculty in science and engineering. According to Kram (1985), mentoring can take on both career and psychosocial functions. Career functions include sponsorship, coaching, protection, challenge, exposure, and visibility, whereas the psychosocial dimensions of mentoring involve role modeling, counseling, and friendship. Contemporary definitions describe mentoring as a reciprocal learning relationship between the mentor and protégé, characterized by trust and commitment. In studying faculty in academia, Carr et al. (2003) found that "faculty with mentors feel more confident than their peers, are more likely to have a productive research career, feel greater support for their research, and report higher career satisfaction" (p. 34).

However, researchers have cited inequity across both corporate and academic fields in how mentoring relationships are distributed. Kanter (1977) states that power within organizations is derived from access to information networks, and that mentoring provides an entry point to these informal networks. Researchers have found that women faculty members do not have the same access to these informal networks (Zellers, Howard & Barbic, 2008). Known as the "theory

of homogeneity," mentors are more likely to seek out others who they identify with, and since there is an absence of women in senior level positions, women are less likely to benefit from these informal mentoring relationships (Johnson-Bailey and Cervero, 2004; Gorman, Durmowicz, Roskes, & Slattery, 2010; Page, Bailey, & Van Delinder, 2010; McNeely & Vlaicu, 2010). To overcome the inequitable distribution of informal networking relationships, many universities have implemented formalized mentoring programs to address the needs of women faculty.

In addition to mentoring programs, modifications in university policy can also be useful strategies to support the success of women faculty in engineering. AWIS Fellows frequently indicated family-friendly policies, access to daycare, tenure-clock extensions policies, career partner positions, faculty diversity training, and monitoring infrastructure issues (i.e. startup packages, salary, space allocation) is important to facilitating the success of junior faculty (Rosser, 2012). Rosser also indicates that the challenges for women evolve over the course of their career, with 75.5% of Clare Booth Luce Professors (comprised of junior female faculty) reporting that balancing work and family as the most significant challenge they face, compared to AWIS Senior Fellows, who report "Gaining credibility/respect from peers and administration," "Affirmative action backlash/discrimination," and the "Executive Glass Ceiling for Women" as the most significant challenges they face (Rosser, 2012).

Summary

The effort to increase the number of women at all stages of the academic pipeline remains a key initiative of many higher education institutions, based on university websites and publications, popular media articles, and scholarly research. In spite of numerous efforts to recruit and retain women in academic engineering positions, there continues to be absence of women in engineering, particularly in senior-level faculty positions at research-intensive doctoral granting universities. Over the last decade, the percentage of female full professor faculty in

engineering has remained nearly flat at 5% (NSF, 2013). To date, studies have documented the numerous barriers that women face, including work/family conflict, gender bias, and challenges with the tenure process. However, there is limited research that specifically addresses the barriers that tenured women in engineering overcame to be successful. Whereas most existing studies use a quantitative approach, the use of qualitative methods will address the decision making processes by which women stay and gain tenure, the barriers they overcame, and the key factors of support they utilized to be successful.

CHAPTER THREE: Research Design

Introduction

While researchers have documented the barriers that women in engineering programs face, few studies examine the experiences of successful women faculty and the challenges they overcame in their career. This study filled that gap by utilizing qualitative methods to investigate the life stories of these women, including the challenges they faced and overcame and how they navigated their career. For this study, qualitative research was appropriate because it focuses on the perceptions and perspectives of participants. As Merriam (2009) notes, "qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world" (p. 13).

This form of research was most applicable to my study, which focused on the experiences of female tenured associate and full professors in engineering at doctoral granting research universities (Carnegie Classification: Very High Research Activity). Qualitative research elicited descriptions of many facets of a career in engineering that are not easily quantifiable: how women experience the early stages of their career, how they experience the tenure process, how they balance work and family responsibilities, and the barriers and challenges they overcame to be successful in their career. For these women faculty, what were the key junctures in their career, and how did they navigate various career decisions? How did policies and programs, if any, affect the tenure and promotion process? Since these experiences are based on nuance, process, and reflection, qualitative interviews will be most appropriate.

The research questions that guided the study were:

RQ1: What do female associate and full professors in engineering say were key factors of support within the institutions they have worked that contributed to their achieving tenure?

1a. Mentoring

1b. Institutional policies/processes (i.e. family-friendly policies, tenure policies, hiring policies, teaching and service policies)

1c. Other factors of support

RQ2: For female associate and full professors in engineering, what were key challenges within the institutions they have worked that they had to overcome to achieve tenure?

2a. Gender bias

2b. Balancing demands of work with family

2c. Institutional policies/processes

2d. "Dual career" problems

2e. Departmental climate

2f. Proportion of female faculty to male faculty

2g. Other challenges

In both research questions, tenure is defined as a proxy for success as a faculty member in engineering. Promotion and tenure are considered the cornerstone of the academic reward system. However, despite much attention to differences in employment status based on gender, women are still significantly less likely than men to gain tenure (Perna, 2001; Goulden, et al. 2004). Researchers have demonstrated that women faculty are concentrated in the lower ranks of the academic hierarchy, even after taking into account differences in variables such as educational attainment, institutional qualities, and academic disciplines (Perna, 2001). While the criteria varies depending on the type of institution, tenure is based on a variety of factors including presenting a strong record of published research and other scholarly accomplishments, as well as effectiveness in teaching and administrative service. In engineering programs at doctoral granting research universities, emphasis is placed on research productivity, as measured

by peer-reviewed/refereed publications, conferences/symposia, patents, academic visibility/research impact (i.e. article citations), awards, sponsored research, and grant funding (Kasten, 1984; Perna, 2001). As Perna (2001) notes, tenure is the most valued, visible sign of success in an academic career. With tenure, faculty members are granted seniority (and accordingly, prestige and status within the organization), which increases both job security as well as access to leadership positions within the organization. Thus, the participants in this study have gained the emblem of success that is most valued and respected in the academic reward system. Amid the numerous barriers, these women faculty members were successful at every stage of their academic careers, from undergraduate through post-doctoral studies, and throughout the tenure-track academic pipeline.

In addition to considering tenure as a pivotal point in an academic career, this study explored the roles that various support factors play both within and external to the university. To this end, I incorporated some of the major themes that are well documented in the literature (i.e. work/family conflict, gender bias, challenges with the tenure process, challenges for dual career couples, and overall job satisfaction) into my interview protocol to understand the participants' experiences with these various challenges. By discussing issues that women face in their career, I was able to understand the effects of these barriers, and how each woman overcame them. While the success of these individuals was likely due to factors that are not easily quantifiable (i.e. the support of certain individuals, personal attributes, career strategies, etc.), the purpose of the study was to elicit these factors of support through in-depth interviews.

Site Selection

In this study, I interviewed women at three research sites, herein referred to as Research University I, Research University II, and Research University III. All three schools are doctoral granting universities with Very High Research Activity, based on the Carnegie Classification

(Carnegie Foundation for the Advancement of Teaching, 2014). These campuses are also rated in the top 40 Engineering Graduate Programs based on the 2015 US News and World Report ranking. These campuses were selected for several other reasons as well. First, the low representation of women is most pronounced at highly-ranked doctoral granting research institutions, compared to liberal arts colleges, two-year universities, and less selective universities (Rosser, 2004). Second, these universities focus on both doctoral and post-doctoral students, thus influencing the future of the profession. In particular, educational experiences in graduate school have been shown to influence students' plans to pursue academic research careers (Goulden, et al., 2009). For example, in a large study at UCLA, postdoctoral and doctoral students rated an academic research career at Research I Universities as the least family-friendly career path amid a range of options including teaching-intensive institutions, non-tenure track faculty positions, and careers outside of academia (i.e. policy, management, and research careers). Third, these campuses have all had major funding initiatives to improve the recruitment and retention of women, either specifically directed at women in STEM fields or for faculty diversity within the entire campus. Finally, these campuses represent a broad cross-section of highly ranked public and private universities in the United States.

By focusing on these three sites, the study examined how much progress each site has made in the retention and promotion of women, and what each institution has implemented to support the success of women. Since I was looking at how institutional processes (i.e. recruitment and retention, tenure, advocacy/outreach programs, etc.) have impacted the success of these women, it was important to have distinct research sites so that I could examine the effects of various policies and procedures on the careers of the research participants within the context of each institution's programs and policies. In some cases, faculty interviewees achieved tenure at previous universities where they were employed, or entered academia from industry

with tenure. In that case, when possible, I looked at documents related to faculty, tenure, and gender or diversity related support at those institutions.

In addition, to include a sufficient pool of participants, three research sites were needed because there was a small number of women at each research site who met the criteria of being associate or full professors in engineering.

Population and Sample

I interviewed women faculty who have their primary appointment in the engineering school each campus (since some faculty have dual appointments). These women faculty may have achieved tenure at their previous institution. The objective for each site was to interview at least fifty percent of the faculty so that my sample would reflect the varied experience of tenured women faculty at each site. Table 3-1 describes the population and sample at each research site.

Table 3-1

Description of Population and Sample

			Female			Male/Female	% Female Among	
Name	Type		Associate	Full	Total	Total	All Tenured	Full Professor
R1	Private	Population	5	8	13	176	7.3%	6.6%
		Sample	2	5	7	--		
		Percentage Interviewed	40%	62.5%	53.8%	--		
R2	Public	Population	7	9	16	194	8.2%	6.7%
		Sample	6	3	9	--		
		Percentage Interviewed	86%	33%	56.3%	--		
R3	Public	Population	4	5	9	92	9.8%	5.4%
		Sample	3	2	5	--		
		Percentage Interviewed	75%	40%	55.6%	--		

R1, R2, and R3 Refers to Research University I, Research University II, and Research University III

Efforts to Recruit and Retain Women in Engineering at the Three Sites

Since my research questions examined the key structures of support within the organization, it was important for my research design to explore each of the three institution's current recruitment and retention efforts for women faculty. How have these strategies changed over time? Do they have specific organizations in place that advocate for women and the issues they often encounter as faculty members? How are these organizations structured, and how do they respond to the needs of female faculty members? For each institution, the efforts to recruit and retain women in engineering are outlined below (program names have been changed to ensure the confidentiality of the sites and study participants). This information was used to provide background information about the initiatives that have been implemented at each research site.

Table 3-2

Gender-Related Recruitment and Retention Efforts at Research University I (Private University)

Program	Goals	General Information	People	Key Initiatives	Changes after Implementation
Women in STEM Initiative	To increase the representation and success of women in engineering through policy and creating a supportive environment, and to increase the number of women in tenure-track and tenured positions in STEM	For all women in STEM	Undergraduate, graduate, doctoral, postdoctoral, faculty (research, teaching, and tenure-track/tenured)	Funding, Providing Mentoring Resources, Lecture Series, Luncheons, Young Researcher Program, Networking opportunities, Work/Family balance resources	The number of tenure-track and tenured women faculty in engineering increased from three to twenty-three (out of 174 total engineering faculty in 2014).

Table 3-3

Gender-Related Recruitment and Retention Efforts at Research University II (Public University)

Program	Goals	General Information	People	Key Initiatives	Changes after Implementation
Faculty Equity Diversity Program	To provide academic leadership for achieving and sustaining faculty diversity	To provide an inclusive campus climate, and to build partnerships with offices on campus	Ladder-rank faculty (not limited to engineering)	Funding/grants, postdoctoral fellowship program/hiring incentive program, work/life balance initiatives, affirmative action/equal employment opportunity policies, provides information for search committees	Increased women engineering faculty (tenure-rank/tenured) from 10% (2007-2008) to 13% in (2011-2012)

Table 3-4

Gender-Related Recruitment and Retention Efforts at Research University III (Public University)

Program	Goals	General Information	People	Key Initiatives	Changes after Implementation
Equity and Diversity Program	Promote an inclusive culture for faculty and graduate student excellence, by promoting recruitment, retention, and leadership opportunities.	Uses distributed leadership to carry out mission at each school within the university. Central office oversees the various initiatives.	Tenure-track and tenured faculty (not limited to engineering)	Uses advisor model (stipend, term position), mentoring, funding, provide information on policies, research and analysis (i.e. surveys, provide startup packages for STEM faculty), workshops.	Increased % female faculty from 24.6% (2001-2002) to 31.8% (2010-2011). Associate professor level increased from 34.6% in 2001-2002 to 38.7% in 2010-2011, and for full professor, from 18.4% to 23.6% in the same period.

To understand how women have succeeded in engineering, it was important to examine each program by looking at external publications such as websites and brochures. By using both interviews and document analysis, I was able to see if current efforts are meeting the needs of faculty. Have there been significant changes since these programs took effect? Do these tenured women participate in these initiatives, and if so, do they find them valuable?

Data Collection Strategies

Documents

In the first step of data collection, I examined documents for each sites including websites, outreach material, tenure/promotion guidelines, and faculty diversity information. This

process allowed me to examine current and past retention efforts at each campus, and to understand if these programs are directed specifically at engineering faculty, or at faculty members within the entire campus. If interviewees achieved tenure at institutions other than the three described in the study, I examined documents at the interviewee's previous institution.

Background Questionnaire

Prior to its administration, I piloted the background questionnaire with one female tenured engineer. I gave the questionnaire in person, prior to the in-person interview. The purpose of this questionnaire was to collect demographic and employment data. Since I was interested in the effects of factors of support in achieving tenure, it was important to collect background information such as the faculty's academic department, the length of time at the institution, how long they have had tenure at that institution, as well as whether they received tenure at another school and were hired at the current institution with tenure. The questionnaire is in Appendix A.

Interviews

I identified faculty who met the criteria of the study by accessing faculty profiles for each institution which are available online. Prior to conducting the interviews, I administered a pilot of the interview protocol with a tenured female engineer who met the criteria of the study. By including this in my process, I ensured that all the questions are easy to understand, and I was able to get feedback from the participant on the interview questions. Once I had piloted and revised my interview questions and received IRB approval at each site, I emailed faculty at each site to set up meetings for the interviews. In each email, I described the purpose of the study and the implications of the research. Since I have faculty contacts at all three research sites, I explained that I am working with specific faculty members in engineering who have provided support for the study. Rather than offering monetary incentives to faculty, the goal of my email

outreach was to encourage a desire to influence the success of future female engineering faculty by participating in the study. At each meeting, I first administered the background questionnaire. Next, I conducted a semi-structured interview (See Appendix B) with each participant. Semi-structured interviews were appropriate because participants were asked to recall past events that are not observable. It was important to let the participants define the barriers and factors of support, and to be able to elaborate on their individual experiences in engineering programs.

Interviews began in fall 2014 and continued until through March 2015. The duration of each interview was approximately one hour and took place in the faculty member's office or another site designated by the interviewee. This choice in location ensured the maximum level of comfort, privacy, and convenience for the research participants. At each site, the interview protocol differed slightly so that I could explore the effectiveness of specific policies and programs on each campus. The oral interviews were recorded with two digital recorders. After each interview, I took field notes to record observations made during the interview.

Data Analysis Methods

Documents

By analyzing existing documents (i.e. websites, tenure guidelines, and faculty diversity information), I was able to identify the programs and policies that have been implemented at each research site. I was also able to uncover if there is alignment between the goals of these various programs and the actual lived experience of tenured female faculty members in engineering. I sought to understand if these programs and policies are meeting the needs of women faculty at each campus. I analyzed these documents in several ways. First, I compared the schools to each other in terms of the programs and policies to see how they are similar and different. Second, I analyze the programs to see if they are designed to respond to the various

challenges that are outlined in the existing body of literature (i.e. dual career issues, work/family conflict, access to information networks). Based on websites and other documents, does each school provide support to address these challenges? Is support for faculty available at the department or school level, or are initiatives organized to meet the needs of the entire campus?

Background Questionnaire

The data from the pre-interview questionnaire was used to add to the data collected from the interview. This information was helpful in developing a fuller picture of each woman's experience getting tenure and both the challenges and supports that were involved.

Interviews

After transcribing the interviews, I used a coding technique to look for common themes that emerged. Using coding, I was able to analyze any commonalities in the experience of tenured associate and full female engineering professors. I used the inductive approach, which as Merriam (2009) explains, is designed to "build concepts, hypothesis, or theories" by analyzing "themes, categories, typologies, tentative hypotheses, and even theory about a particular aspect of practice" (p.16). I sought to understand how women faculty in engineering overcame challenges in their career. I also sought to understand if there are overlapping characteristics (i.e. adaptability, resilience, seeking mentorship, etc.) of these "persistent" women. While there are many documented barriers (gender bias, work/family conflict, the two body problem, etc.), there remains a gap in the literature as to how successful women in engineering overcame these challenges.

Ethical Issues

The most important ethical consideration for this study was ensuring confidentiality and anonymity at each research site, both for the institutional identity as well as for each individual participant in the study. This was especially important because the number of tenured women

faculty in engineering is low at each campus. Similarly, if I provided too much descriptive information for the background of each site, it would not be difficult to figure out the institutional identity (there are only so many highly-ranked doctoral granting institutions with Very High Research Activity). To address this, I disguised the identity of each site (i.e. Research University I, II, and III in the United States) so that the exact geographical location of each site remains unknown. I also omitted the names of participants, and I made sure that each finding does not contain identifiable information for individual participants. In addition, when including background employment and demographic data about the participants, in some cases it was necessary to aggregate the information rather than describing the information for each individual site. I also omitted information such as department name in order to protect the identity of the participants. Finally, when discussing background initiatives/programs at each site, I provided limited information so that the specific site is not identifiable.

Validity and Reliability

Bias

My own biases in doing research were monitored due to my background as a research administrator in an engineering school, and as a former female faculty member in higher education. My assumptions are that there are structural impediments (i.e. rigid processes such as tenure, access to information networks, and conflicts between work and family) that exist in organizations that often affect female faculty more than male faculty. However, since this study is grounded in data from an existing body of literature, its goal was to uncover nuanced perceptions and decision-making processes in the lives of tenured women faculty in engineering. In addition, the research study was framed in such a way to examine how women overcame these challenges, which have already been well documented in the existing body of literature. I also

utilized member checks, in which I had two colleagues review the data to ensure that the coding analysis accurately reflects the data.

Triangulation of data sources

Data triangulation involves utilizing multiple sources of evidence in order to increase the validity of the findings. Through the analysis of multiple sources of evidence, including interviews as well as document analysis, I was able to provide a more comprehensive understanding of each case, as well as the particular experiences of each participant.

Generalizability

One of the potential limitations of this study is its generalizability. Since I worked with three sites in the United States that are all doctoral granting institutions (Carnegie Classification: Very High Research Activity), they will have some commonalities (selectivity, expectations for faculty productivity, etc.) to other research universities. However, each campus has its own distinct institutional culture. Each institution differs in how they have responded to the issue of the low representation of women in engineering: some schools having created many formalized programs that specifically support women in STEM, whereas other schools have implemented programs to improve faculty diversity for the entire campus. Others have implemented "family-friendly" policies but do not have specific programs designed to improve the recruitment and retention of women faculty in engineering. In addition, it is difficult to generalize the findings to all doctoral granting institutions in the United States. Also, some of the faculty members were hired as associate or full professors from other institutions or from industry, so they spent a portion of their careers elsewhere. To respond to this issue, I have designed the interview protocol so that it accurately reflects the participants' varying career histories.

Summary

Upon the completion of data collection and analysis, I had findings that displayed the key factors of support that helped women achieve tenure, as well as the barriers that women overcame to be successful in engineering, both within and external to the institution. While a large body of research has documented the varied barriers that women have encountered in academic engineering programs, there are few studies that examine the perspectives of female tenured faculty who have been successful at achieving tenure, and in many cases, women who were promoted to senior positions such as department chair, vice dean, and dean positions. Adding to the existing body of mostly quantitative studies that outline the barriers that women in engineering face, these findings will provide a comprehensive understanding of the unique, nuanced experiences of tenured women faculty in engineering. Moreover, since the recruitment and retention of women faculty are consistently articulated as an institutional priority through university communications and mission statements at all three institutions, this study will have the potential to influence future programmatic efforts at each research site.

CHAPTER FOUR: Findings

Introduction

This chapter discusses the ways in which lives of tenured female faculty in engineering are influenced both negatively and positively by the policies and programs various universities have implemented to retain and promote women. In particular, I found that while all three institutions offer "family-friendly" policies, women described important differences in how policies are communicated and interpreted, thus impacting whether female faculty decided to use these policies or participate in programs. While many women faculty encountered various challenges in their careers (i.e. work/family conflict, gender bias), this chapter will describe the policies, programs, and career strategies that positively impacted the careers of women faculty, including informal and formal mentoring, leadership opportunities, and the importance of recruiting not only a "critical mass" of women, but also establishing a mechanism to bring women together within the engineering schools.

The purpose of this study was to uncover how tenured (associate and full professors) women faculty in academic engineering programs overcame various challenges to be successful in their career track. The study also examined the factors of support within the institution, with an emphasis on understanding the effectiveness of various programs and policies (i.e. family-friendly policies, mentoring programs, faculty diversity initiatives) designed to support women faculty in engineering. Using qualitative methods, I interviewed 50% or more of the female engineering faculty at each of the three research sites, for a total of twenty-one faculty members. The findings addressed the following research questions:

> RQ1: What do female associate and full professors in engineering say were key factors of support within the institutions they have worked that contributed to their achieving tenure?

1a. Mentoring

1b. Institutional policies/processes (i.e. family-friendly policies, tenure policies, hiring policies, teaching and service policies)

1c. Other factors of support

RQ2: For female associate and full professors in engineering, what were key challenges within the institutions they have worked that they had to overcome to achieve tenure?

2a. Gender bias

2b. Balancing demands of work with family

2c. Institutional policies/processes

2d. "Dual career" problems

2e. Departmental climate

2f. Proportion of female faculty to male faculty

2g. Other challenges

This chapter begins with a description of the programs and policies at each research site designed to support women faculty in engineering. As discussed earlier, I have disguised the names and other identifiers of the programs in order to protect both the identity of the institutions as well as the individual participants. Next, I provide a summary of the demographic and employment information for the participants. To protect the identity of the participants, I have aggregated the data in some categories, rather than providing information for each research site. The paragraphs that follow discuss the experiences of women engineering faculty participants—both the challenges that they overcame to be successful in their career, as well as the factors of support that were helpful in gaining tenure.

Programs and Policies to Improve the Recruitment and Retention of Women Faculty at the Three Research Sites

Research University I

To improve the recruitment and retention of women faculty in engineering, Research University I implemented various programs and policies to support women in science and engineering at all levels within the institution including undergraduate students, doctoral and post-doctoral students, and faculty. The goal of the Women in STEM Initiative is to increase the representation of women in science and engineering at this university. From 2000 to 2014, the number of tenure-track and tenured women faculty in engineering increased from three to twenty-three (out of 174 total engineering faculty in 2014). People involved in this initiative work with Department Chairs and Search Committees to provide strategies for broadening the scope of faculty searches and to ensure that outstanding candidates are considered. Initiative leadership also meets with female faculty candidates during campus visits and provides start-up research lab funding to new female faculty hires. In addition to these recruitment efforts, this program works to support women on campus in ways that include programmatic efforts focusing on topics such as work/family balance and networking. They also host events for Ph.D. students and networking luncheons for faculty, which are aimed at creating an atmosphere of support and collegiality.

Faculty members who participate in this program also serve as mentors for undergraduate students, graduate students including Ph.D. students, postdoctoral scholars, and junior faculty. The Women in STEM Initiative also provides grants to Ph.D. students, postdoctoral scholars, and faculty who have primary caregiving responsibilities for infants and small children. According to the program's website, these efforts "aim to minimize disruptions to research productivity at sensitive times in a young scholars' career while also providing needed encouragement to help achieve work-family balance within the academy." This program is

specifically designed for women at all career levels in STEM and is an ongoing funding initiative for the university. All female faculty members at Research University I also have access to family-friendly policies such as paid family leave, tenure clock extension, accommodations for nursing mothers (guaranteed by state law), as well as a human resources employee who is designated to assist faculty and staff with questions about pregnancy disability leave and paid family leave.

Research University II

Research University II does not have any programs that are designed specifically for women in engineering or STEM. Rather, Research University II provides information online about various family-friendly policies, with the stated goal of improving work/life balance. The university states that it seeks to provide resources and strategies to use to manage faculty's time, balance responsibilities, and maintain health. This website summarizes family accommodation policies such as childbearing leave, parental leave without pay, and active-service modified duties, and provides links to complete policy information. For all types of leave, the policy states that the faculty member should not be disadvantaged in his/her promotion, advancement or compensation due to taking leave or stopping the clock. On the faculty diversity page, there is a link for Women in Engineering, which contains information on a past conference to discuss the retention and advancement of women in engineering. This conference examined the current status of women faculty in science and engineering at Research University II. The goals were to increase the university's ability to hire top women faculty, to improve the institutional climate for women faculty, and to ensure the retention of women faculty, especially in science and engineering. The webpage provides a link that includes a summary of issues and recommendations, which included themes such as access to childcare, dual career recruitment, retention, family-friendly policies, and marketing the surrounding area to prospective faculty.

This site also provides links for various publications that discuss the low percentages of women in engineering. Finally, this page contains two links for the Women in Science and Engineering Networking Group, but one contains a broken link and the other email address is for someone who is no longer at Research University II.

Research University II also has a university-wide formal mentoring program for junior faculty (not limited to engineering or STEM). This mentoring program matches junior faculty with senior faculty members within the institution (always outside of the junior faculty member's department). Providing an opportunity to gain insight and advice beyond one's department, the mentoring program also enables a broader view of the campus. According to the mentoring program's publication, advisees stated the most frequent topics discussed included promotion and tenure, publications, research, grants, and work/life balance.

Research University III

Research University III has an Equity and Diversity Program that seeks to provide an inclusive culture for faculty and graduate students, by promoting recruitment, retention, and leadership opportunities. Using peer-to-peer collaboration, Research University III appoints advisors at each individual school to carry out the mission of improving the recruitment and retention of diverse faculty, including both women and underrepresented minorities. Initiatives include fundraising, strategic planning, as well as research and analysis (i.e. surveys of faculty and chairs, annual reporting, and providing start-up packages in selected STEM fields). The Equity and Diversity Program also states that it provides search committee workshops, lectures, and information on best practices. Research University III does not offer any programs that are specifically designated to promote the recruitment and retention of women in STEM. Rather, all diversity and equity programs are implemented university-wide.

Demographics of the Sample

Twenty-one tenured female faculty members across three research universities participated in this study. This included 11 associate professors and 10 full professors. Across the three sites, nine out of twenty-one of these professors had served or were currently serving in administrative/leadership positions such as Department Chair, Center Director, or Vice Dean (5/7 at Research University I, 2/9 at Research University II, and 2/5 at Research University III). Study participants were from different departments within engineering representing aerospace engineering, biomedical engineering, chemical engineering, materials science, industrial and systems engineering, electrical engineering, computer science, and civil and environmental engineering. Faculty members are not identified by academic department due to the small sample size of tenured women engineering faculty at these three institutions. Table 4-1 describes the demographic data of the faculty participants. In some categories, data was aggregated to protect the identity of the participants.

Table 4-1

Demographic and Employment Data

Ethnicity	Number of Respondents	Percentage
Hispanic/Latino	2	10%
American Indian or Alaska Native	0	0%
Asian	7	33%
Black or African American	0	0%
Native Hawaiian/Pacific Islander	0	0%
White	12	57%
Other	0	0%
No Response	0	0%
Total	21	100%
Age*	Number of Respondents	Percentage
25-34 years old	0	0%
35-44 years old	12	57%
45-54 years old	4	19%
55-64 years old	4	19%
65-74 years old	1	5%
75 years old or older	0	0%
Total	21	100%
Years at Current Institution*	Number of Respondents	Percentage
0-7 years	5	24%
8-15 years	12	57%
16-22 years	1	4.75%
23-30 years	1	4.75%
31 years or more	2	9.5%
Total	21	100%
Served in a Leadership Role	Number of Respondents	Percentage
Research University I	5/7	71%
Research University II	2/9	22%
Research University III	2/5	40%
Received Tenure at Another Institution Prior to Joining Current Institution	Number of Respondents	Percentage
Research University I	3/7	43%
Research University II	2/9	22%
Research University III	1/5	20%

*Aggregated Among the Three Sites to Protect Participant Identity

Summary of the Findings

Throughout their career, many tenured women faculty in engineering—though not all—encountered gender bias and faced challenges associated with balancing work and family at the three universities. However, tenured female engineers found strategies to navigate the complex environment of a male-dominated profession. In the words of one faculty member, her experience was one of "coping" rather than "overcoming." Women faculty sought out what they needed to be successful – whether that was getting more involved in external organizations (e.g., technical societies, conferences), seeking out both informal and formal mentors both within and external to their academic department, as well as outside their university, utilizing family-friendly policies, or seeking leadership positions within their department or university. Others became more confident as their academic record began to "speak for itself" and learned how to promote themselves as their career progressed. While each participant had a unique experience in their career in engineering, several challenges consistently emerged across the interviews, including dealing with gender bias, facing work/family conflict, facing the effects of the "two-body problem," and being assigned disproportionate service assignments but fewer leadership opportunities. For interviewees, the most important factor of support was informal mentoring and, for women at one of the research sites, being part of a supportive academic community of women in science and engineering. Several faculty members also shared that formal mentoring programs (in particular, the program at Research University II where faculty were matched with senior faculty outside of their department, and often outside of engineering) had been instrumental to their success. Interviewees had both male and female mentors, but more frequently described receiving practical advice from male mentors, whereas female mentors provided both practical advice as well as psychosocial support, serving as role models to younger faculty. Women faculty had mixed perceptions of "family-friendly" policies, with some faculty

describing them as very important to their success, whereas other faculty described a stigma associated with taking time off. Women faculty frequently recalled how they had to become more comfortable with being "aggressive" as their career progressed, and frequently stated that this trait is necessary for a successful career in engineering, but is not always an attribute that women display. The sections that follow outline the findings of the study, including both the key factors of support that helped women to be successful in academic engineering programs (Research Question 1) and the challenges that women frequently faced and overcame in their career (Research Question 2).

The Challenge of Balancing Work and Family Demands: Making Tradeoffs

Women at all three campuses described balancing work and family as one of the most challenging aspects of their careers in engineering. Female faculty members explained that they had to make significant tradeoffs to have children, either limiting the time they could spend with their family and/or adversely affecting their career progress. Work/family conflict was a major challenge at all three sites and did not differ among interviewees by site. Eighteen out of twenty-one described balancing work and family as one of the most challenging aspects of their career in engineering. All three faculty members who stated that work/family conflict was not a major issue did not have children.

Several professors stated there was no balance, since work dominated all of their time. An associate professor encapsulated this challenge, explaining, "Sometimes you're not even aware what it means to balance. You think you're balancing, but then you realize that this is not really a balance because it's not sustainable." Faculty members struggled with this decision to work such long hours. In the words of one faculty member:

> When I was moving here, I went to my daughter's pediatrician's office to pick up files, because I had to transfer [the] medical records. That was the first time I actually knew that the pediatrician kept track of who took [my child] to the office. Shamefully, 90% of the time, it was Dad. My husband took her to the pediatrician. I probably only went a

> couple of times, when she was born. I don't have enough time. I wish I could spend more time."

Another professor echoed this sentiment, stating she was more of a primary home organizer than a primary caregiver. Finally, an associate professor explained that it was more about coping with the challenge than overcoming it, stating, "balance is always this elusive thing. I'm beginning to think there may not be such a thing as balance anymore. You just have to survive."

Other faculty members explained that they realized they had to make tradeoffs to be an engineering professor—either putting family before career, or vice versa. One professor stated, "You just have to balance. There's no choice. Like I said, I do actually spend time with family with the kids, not as much as I should have, but that's the tradeoff you have to make." Another faculty member explained that she has to sacrifice both her career and how much time she can spend with her family. She stated, "Every time they ask, 'How do you do it?' They sometimes call me superwoman but I said, 'No, I'm not. The truth is I have to sacrifice at both ends.'" Other professors stated that they were willing to sacrifice aspects of their career for their children. As one professor stated, "I think women have to choose. I was very stubborn saying that if you're going to have a child, you're going to do whatever it takes to have a healthy child. That's the priority, and that's the way I look at it, but I have to choose…It's a big thing…It's not, who does dishes at night? It's what do you do when there is a crisis?" Many women faculty described situations in which they had to make sacrifices or choices that their male colleagues did not have to make.

Female faculty members described the logistical challenges they encountered trying to balance the demands of work and family. One professor explained that she spent a lot of her "creative energy" figuring out how to juggle all of her responsibilities, whereas another professor described how there was no room for error in her schedule:

> If I make one mistake on my calendar, it could be critical. It can be critical to a child crying and making me feel like the worst mommy in the world. It could be critical to me feeling like my reputation just got dinged pretty good because I missed something or came late. Or, the heart pounding, "I didn't catch this overlap, how can I figure this out." I have learned that if there is one thing I cannot make a mistake on, it's the calendar.

Other faculty members described situations where they had a sick child and had to miss class or meetings. Many of the female faculty described their male colleagues having wives who "picked up the slack," and so their careers often continued uninterrupted when they had children. In particular, women faculty described the challenge of being unable to travel to conferences since they had childcare responsibilities, which are important for furthering one's career in engineering. Faculty also explained that departmental events are often in the evening or late afternoon, so they cannot easily attend. However, one faculty member stated that it was helpful to have male colleagues who had children, because they often experienced similar demands. One professor described a conversation with a male colleague who said, "Do you believe this, seeing between husband's career, wife's career, and the kids, each family can pick two out of the three." This professor continued on, "As I look back, I kind of feel it had lots of truth because I see lots of examples of that. If both parents are super busy with their career, I think somehow the children's education or training, or development [can be] affected." Many women faculty struggled with their decision to devote so many hours to their engineering career.

Sources of Support: Mixed Perceptions of Family-Friendly Policies

All three sites offer both male and female faculty options to accommodate the birth of a child, including paid family leave, tenure-clock extension, and, upon review, modified teaching responsibilities. However, faculty perceptions of the effectiveness of these policies differed by site, with faculty at Research University I describing these policies as mostly effective, whereas faculty at Research University II frequently perceived a stigma from taking leave. At Research

University III, faculty stated that they believed it was important for the policies to exist, but that the interpretation of the policy was at times uneven or still "evolving."

At Research University I, the three faculty members who took leave at their institution described the process in positive terms, but two out of three believed there could be improvements. One professor explained that for most faculty members, there is still no solution to the "problem of family commitments taking time." She reflected:

> There are times when people just can't devote 80 hours a week to their careers. Solving that somehow would be a really good thing to say, "Look, okay, you're on reduced workload" like I did for three years to let people step back for a while because it is intense. We're competitive. We're all very high achievers so it's intense to keep up that pace and to have little children. That doesn't work. I think it's much better to do something.

Another faculty member at Research University I stated that it would be beneficial if both men and women utilized these various family-friendly policies, because it would remove the stigma for women. Describing the tenure-clock extension policy, this professor stated:

> It would make it more of a norm. People won't say "Oh she got an extra year on the clock." It would be normal to see people have a longer tenure clock if they had a child. The extension I think is taken fairly infrequently. I don't mean just at [Research University I.] I think anywhere that people tend to say well if they had an extra year, there should be an extra year worth of work, which isn't the point of it.

A full professor at Research University I, who was previously employed by another institution, described receiving an extension on her tenure clock before these types of policies formally existed. She recalled a dean who had asked her how the university could attract more women, to which she replied that universities must stop asking women to choose between career and family. Years later, this dean came up with a solution, which this faculty member described in favorable terms, explaining that the dean created an "extension on my tenure clock because I had gone through these pregnancies in an untenured phase. There was no policy. He had taken what I told him to heart and this was what he came up with, as something he could offer to assist

me. It was like, 'Oh, my God. Nobody had ever.'" For this professor, the tenure clock extension policy served an important role in her getting tenure:

> [It] enabled me to get tenure in a manner that it was never going to be looked at as, "Oh, they lowered the bar for her." The bar was the same and nobody ever said anything about the fact that I got the extra year. That was one year for two pregnancies. That was a good deal for them.

At Research University II, "family-friendly policies" were not viewed in as positive terms compared to Research University I. Female faculty members often described a stigma associated with taking time off. Although "family-friendly" policies (i.e. paid leave, modified teaching duties, tenure-clock extension policies) are offered by this campus, they were under-utilized and were not communicated to faculty in a consistent manner. Of the nine interviewees at Research University II, five had children while at the university, and so these policies were applicable to them (of the remaining four, two did not have children and two had children prior to joining Research University II). Of the five faculty members who had the option to utilize various family-friendly policies, four described a stigma attached to actually taking time off. One full professor explained:

> I never really formally used the maternity leave that they had…I wasn't even sure that the dean at the time would be that receptive or psychologically okay with my taking a maternity leave. I'm pretty sure he knew I was pregnant, but I didn't take it. It was almost like I had to show that I was tough [and] I didn't need to take it.

While the full professor's experience is based on an environment that existed decades ago, her sentiments are reiterated by an associate professor who had a baby within the past half-decade. The associate professor expressed concern that "people would be thinking, 'She just started, she's taking all this time off.'" Opting to take off only one quarter when she was entitled to four quarters, she stated that it would have been helpful if she had a mentor who had told her that it was her right to take leave, and that she would not be discriminated against for doing so. She said that in hindsight it was "lesson learned—if you don't ask or if you don't really push for

it, they're not going to give it to you." Another faculty member put it simply, stating that as a new faculty member you "don't want to request too much." Finally, the fourth faculty member explained that the problem was not the policies, but rather the way they are interpreted. She believed that these policies lead to implicit bias, further disadvantaging women. Reflecting on her experience, she stated:

> When women have a baby…senior professors who are male, who had a wife at home, say "You just had a baby. Why do you need [a] promotion so quickly? You just take time. Take time." It's very…again, implicit. He never says, "You shouldn't be promoted." It's more of like, "Why accelerate a promotion and drive yourself crazy when you could use your time?" Again, that's very discriminatory, because it's actually, in some sense, to say, 'You can go slower than us.'"

In comparison, one associate professor did not perceive a stigma for taking leave, and recalled that her department chair was proactive in explaining all of the resources available and providing relevant information. She explained that "the department has been very supportive in terms of making sure that I know all the different opportunities there are for stopping the clock or doing whatever needs to be done in terms of having a time needed to have a small child at home." While she opted not to use the tenure-clock extension policy because she said she was making good progress, she had a favorable view of the family-friendly policies at Research University II.

At Research University III, faculty generally described leave policies in positive terms, but stated that many of the policies are still evolving in the way they are interpreted by colleagues and can in some cases disadvantage women. Faculty had mixed perceptions regarding tenure-clock extension policies because colleagues often do not know how to interpret gaps in research productivity. A full professor explained:

> I think the issues are they are still having a hard time looking at some of the policies and how that translates into tenure decisions and other things. For example, if you take longer because you took a leave of absence when you had a child, then how do you measure that person's productivity versus someone who, in 5 years, did it…I think there's still a little bit of grappling with that because those policies are fairly new.

A full professor in another department in the School of Engineering stated that she was glad that these policies existed, but that they can in some ways disadvantage women in the way they are interpreted. In particular, she perceived that *not* stopping the clock after the birth of a child may be viewed as if the faculty member asked for an acceleration. This faculty member explained why she did not decide to utilize the "stop the clock" option:

I feel like it [tenure clock extension] will just push me back, and then the [male faculty] advance; the other people advanced a lot faster if I automatically get the clock pushback. If I started at the same time as a male colleague [but] I'm being pushed back automatically, I'll be forever behind him. I don't like that.

Of course, if I need it, I think there should be the flexibility for me to apply for it. A lot of times, I feel like, why are females being slowed down? Because they said, "Oh, you can do this later, you can do that later," or they automatically push you back. Then just because you had a child and then they feel like you're not good enough, even if you said, "I don't want that. I want to go forward."

If you're too aggressive, they look at your case more seriously. The acceleration is viewed with a different lens than the normal merit. If you do a normal merit and I only have, say, two to three papers in the three-year period, no big deal, but if you do acceleration, they all said, "Do you have 35 papers?" I was like, "What?!" That's why if you're automatically being pushed back and then you said, "No, I don't want the pushback," they'll look at you, they said, "Hey, you must be doing really well." Let's look at her case seriously, because she is looking for acceleration or a break off that clock, and then they will examine you a little bit different.

Interviewer: So you're saying that if you decline it [the tenure clock extension], it's almost being considered as an acceleration even though it's not an acceleration?

Interviewee: Exactly.

For this faculty member, she perceived that opting out of the tenure-clock extension policy was viewed as a form of an acceleration (i.e. going up for a promotion sooner than the usual time-frame), and that it can inadvertently disadvantage women because the tenure case is scrutinized more heavily. This perception of the tenure clock extension policy echoes another faculty member at Research University II who stated that the policy is similar to saying *"you can go slower than us* [male peers]." According to this associate professor at Research University II, the interpretation of the policy was a form of implicit bias.

Gender Bias Within the Institution

Women frequently experienced gender bias but their experiences differed by site. Female faculty not only encountered overt and implicit bias from colleagues, but also internalized gender bias, often questioning if they belonged in the field. Referring to "impostor syndrome," this sentiment was encapsulated by the an associate professor at Research University I who reflected, "I would guess that anyone who does something with the majority of their time, as their occupation, surrounded by people who are in some notable way, identity-wise, different, you're going to kind of wonder whether you should be there." Several interviewees described creating obstacles for themselves that did not need to be there because of persistent self-doubt. However, this feeling lessened as their career progressed and they had accumulated more publications and research experience.

Women faculty also described challenges in gaining credibility from their male peers. At Research University I, four out of seven women faculty said that they had experienced gender bias at their institution. In comparison, three women faculty members did not describe any instances of gender bias at their current institution (of those faculty, one had experienced bias during her doctoral career at another university). Women faculty at Research University II were more likely to have encountered overt or implicit gender bias, with seven out of nine women faculty describing this challenge than women at the other two universities. For example, a full professor described the interactions with male colleagues in her department, which only had two women faculty members:

> When you have so few, it's as if we're looked at as "the women." There are also significant, I would say cultural differences in the sense that when people are born overseas, they come from a culture that's different from the typical American culture. Women are treated differently in that culture, so…they were raised to see women differently. That kind of naturally spills into the relationships, the connections, the discussions that they would have with women faculty as opposed to male faculty…I think it's not exclusive to men from overseas. Some are completely fine with women who are

> professionals. I often wonder, especially when I hear men talk about certain things or discuss certain things and I am thinking to myself, "This doesn't make much sense."

At Research University III, all five women faculty had experienced gender bias either within the engineering school or the broader engineering field. At this university, several women stated that their department climate was friendly to women, but they still described gender bias in various situations including hiring and promotion, and in interactions with male students. At all three sites, gender bias manifested in several ways, but the most common themes described were 1.) gender bias in hiring and promotion 2.) navigating a male-dominated profession (i.e. "boy's club"/lack of access to information networks), and 3.) challenges with students based on gender.

Gender Bias in Hiring and Promotion

Women faculty frequently said they encountered or observed gender bias in hiring and promotion (i.e. in search committees and the tenure and promotion process), but the prevalence of this issue differed by site (2/7 at Research University I, 4/9 at Research University II, and 3/5 at Research University III). Both associate and full professors reported observing or experiencing gender bias in hiring and promotion. Moreover, although hiring, promotion, and other evaluative decisions are made through a peer review process in the academic system, faculty often stated that a single outspoken male colleague had the potential to sway the process in a manner that disadvantaged women. According to one faculty member at Research University I, "I think when it comes time for a promotion, it could be tougher for women. That people are willing to complain about things I think they wouldn't complain about for a male colleague." Similarly, this faculty member reflected on hiring female candidates:

> You always bump into people who want to interview women just to satisfy a requirement and they have no intention of hiring them. Then if they bring in the weaker ones then it reflects poorly because other people say, "Well there aren't any strong ones out there" which is not true. Of course there are. Or again people start putting out barriers to hiring that they wouldn't put up for male colleagues. They will start talking about their family and I've heard people complain that colleagues would start talking about family

> obligations of the people being interviewed. Whereas the male counterparts that are being interviewed who also have family obligations…that is not being discussed.

Some faculty described experiences that were more overt and direct, compared to more subtle forms of gender bias. One full professor at Research University I recalled, "I didn't think about being a woman in especially male discipline. When I became a professor it became obvious almost immediately, because there were male professors who just said 'The only reason you're here is because you're a woman and affirmative action.'" However, this professor stated that the situation had improved for women faculty over time at that site, and that senior leadership had been instrumental in these changes.

Women faculty at Research University II were more likely to have encountered gender bias in hiring and promotion than faculty at Research University I, with 4 out of 9 faculty reporting gender bias in hiring and promotion. One full professor explained that her department hired almost forty white or Asian men over the course of thirty years, without hiring any women faculty. She reflected:

> The chances of that happening randomly given the relatively low availability…is something like 6% or 7%. There are many men in this department that I think are very supportive of hiring women, well-qualified women and we had brought forward, many were very well-qualified women. Some faculty have told me, "Gee, she was much better than the guy we eventually hired."

Yet, for this faculty member, she believed that even despite the small pool of female applicants, the probability of hiring no women faculty in thirty years suggested that there was gender bias within the hiring process. Two other faculty members from different departments at Research University II said they had observed their male colleagues evaluate women's dossiers with a more "critical eye" compared to male faculty's tenure cases. For example, one of the faculty members who had served in tenure committee meetings for other faculty explained:

> It's like if you have the same number of the publications and if you are a male faculty, they would say, 'Oh yeah. You've done a really great job.' The choices of the words in

> their review is different and if you are a female, you've done exactly the same or even better and they will just say, 'Oh yeah. This is just satisfactory."

The other faculty member echoed these concerns, stating that there were consistently more questions about female promotions that had the same research and teaching record as a male peer. In these instances, the bias was more implicit and had the potential to alter the outcome of hiring decisions and tenure cases. This faculty member explained that tenure cases and hiring are based on interpretation. She continued, "You cannot ever really accuse people that that's a sexism or even that it's a bias toward these women, because it will always appear in the form of a merit." One faculty member at Research University II had a different perspective, stating that her department tried very hard to recruit women faculty. She explained, "We have made progress, we got a new one last year. Therefore, as far as diversity's concerned, of course, our department still has low percentage of female faculty members, but I don't think it's the fault of lack of trying. We do try hard." At Research University II, faculty members were more likely to report gender bias at their institution but perceptions and experiences varied among interviewees.

At Research University III, faculty explained that the prevalence of bias differed among the individual engineering departments. According to an associate professor, in her department there was "positive bias" meaning that academically qualified female applicants had a greater probability of being offered a position than their male peers. Faculty also frequently stated the senior administration had articulated diversity recruitment as an institutional priority, and so awareness of this issue had increased among faculty. One full professor who coordinates diversity recruitment stated, "I'm in charge of diversity recruitment. I actually want to recruit female engineers, minorities, and actually I seek them out."

However, a colleague in a different department which had a higher representation of women faculty explained that there was not bias in her department, but that she had observed

gender bias in other departments: “Oh, there's definitely bias. It's, again, not from my department…Because I'm a woman in engineering, there's so few of us; I've had to sit, as the token female, on other departments' search committees. There's definitely bias.” However, several interviewees stated that search committees were encouraged to consider women and underrepresented minorities to make sure that these candidates “that might be passed up get a second look.” Faculty explained that members of the diversity initiative (external to the engineering school) would review the applicant pool to make sure that the academic departments were interviewing a diverse pool of candidates. An associate professor stated that university’s diversity policies were helpful within her department to ensure that they were considering women. She recalled, “our diversity advisor, she will look at our list and say, ‘why do you have no women here when you have 10% in your candidate pool? Why do you have zero on your short list?’ That was helpful actually. It started creating this culture that we need to have women in the short list.”

A senior colleague in the same department explained that there was not necessarily outright bias, but that women “don’t ask for things,” and when they do ask, they are not perceived as well as when men ask for the same things. She reflected:

> I think when they do [ask], when they get very pushy, then they have bad labels put on them. I would say that's when I've seen it be different. That when a guy goes up and says to the dean, "I need this or I'm leaving." Then it's like, "Okay." A woman goes up and says, "I need this." Then, she's whiny or she's demanding.

Women engineering faculty frequently described having to balance between being seen as “pushy” or “aggressive” versus being invisible and not asking for what they need. An associate professor at Research University III stated, “I think it’s good to be aggressive. If women are aggressive, they do well so that’s good.” However, she stated that women (herself included)

were less likely to promote their achievements and ask for the resources they need to be successful. When asked how being "aggressive" translates into actual action, she explained:

> If you're in [a] meeting, you will get up and be loud and talk and insist. You will not sit in the back and just vote quietly. [If] there's a meeting about resources, you will get up and say I want that much pay, that much money and blah, blah, blah. You will…self promote…All of us in this job have successes but some are more aggressive in publicizing them. I will get an award, I will not say anything. I will put it in my website. Other people, they get the same award and they will send email to everyone and then they will make the most out of it, which is good.

This faculty member believed that women are not brought up to promote their achievements in the same way as their male peers. A full professor at the same institution agreed, stating that "there are gender differences in people's worldview and how should we behave. I don't know, is that because society? That's a deeper question I cannot answer." However, many female faculty members recognized that they needed to be aggressive to be successful in engineering. They had to change their mindset and expectations, realizing the importance of self-promotion. This full professor reflected:

> I feel [that] my personality a little bit more subdued. I want other people to nominate me for [an] acceleration rather than request [an] acceleration. I thought about that and I always feel like maybe I'm not excellent enough to apply for [an] acceleration, but I see some male colleagues starting about the same time as me [who had fewer] scholarly publications or impact factor in that sense in the scholarly work and then [they] received [an] acceleration because they asked for [it].

Many women faculty members said that their ability to be "aggressive" in highlighting their accomplishments evolved over time as they learned that their research accomplishments would not "speak for themselves" but rather that they would have to promote their achievements.

Navigating a Male-Dominated Profession

Women faculty frequently encountered challenges that stemmed from working in a male-dominated academic environment (4/7 at Research University I, 6/9 at Research University II, and 4/5 at Research University III). At all three sites, women faculty often described having to

work harder than their male peers to gain credibility with colleagues both within and external to their institution. In addition, women faculty described having limited access to information networks. However, faculty frequently described male colleagues and mentors who were very supportive of their success. At Research University II, an associate professor explained that it is more difficult to gain credibility, but also believed it may be due to her age: "I think that it's not an immediate respect but if someone comes in that is a male that is older, I think that they get immediate more respect, but maybe that's just also cultural, older people getting more." However, another women faculty at Research University II had not felt disadvantaged as a woman in engineering, stating that she pushed through: "Get in my way, you like it or not, I get it. I think in that sense I didn't feel I had been treated unfairly because I was a woman." Yet, colleagues at the same university (and even the same department) described subtle challenges to not being "one of the boys." These challenges ranged from small "slips" like being told to "come for dinner and bring your wives" to larger issues such as being denied access to information networks. In the words of an associate professor at Research University II:

> On a daily basis, I think women in this field face isolation. Isolation is something that you could feel is emotional, but it does affect your career too, in some sense. You don't have a really natural way of getting together that easily [with male colleagues], which then it leads to implicitly not knowing about grant opportunities or collaborations with teams that people are forming, and in these days, it's very hard to write a grant by yourself.

She continued to explain that the lack of access to informal networks has the potential to negatively impact productivity or efficiency. An associate professor in a different department at Research University II, wondered, "maybe men just feel more comfortable working with men." Another faculty member explained that although the university had hired more women, there is no mechanism to bring women faculty together. She stated"

> People would say, "Oh, yeah. We have like 15% of woman faculty which is higher than the national average." That doesn't mean anything. I think maybe during the recruiting

> process, they purposely try to recruit woman faculty so that number can improve but once you come, I don't see much of support at all out of the school level.

Finally, a senior colleague explained how she had been mistaken for her female colleague a few times each year for decades stating, "it's inadvertent, but it's strange. We've always found it strange, because we don't look alike and we're not in the same field." She continued to describe how she perceived her contributions less valued within her department as compared to the broader engineering field. She explained that because of this lack of recognition, she had become more active in the broader engineering community where she felt she had been more recognized for her contributions.

At Research University I, four faculty members out of seven also reported experiencing gender bias in their departments. One full professor explained that when she started, her male colleagues simply did not believe that women should be in the workforce. She said that there had been improvement in that area over time, but that she still believed that women in engineering face a "double-bind:" "If you are powerful and assertive, that's off-putting. On the other hand, if you're not powerful and assertive, you get ignored." A full professor in a different department explained that she would only address gender issues with her colleagues if there was an issue that was "egregious." She stated, "I don't typically give it any credence or acknowledge it. We're here to do a job." However, she stated that at times she felt like she was "back in the 1980's." However, another faculty member said that she had not felt either advantaged or disadvantaged for being a woman in engineering. Finally, an associate professor in a different department also reported a strong amount of support from both male and female colleagues at Research University I. Yet, she described a "systemic bias" during her graduate and postdoctoral career that caused some of her female peers to decide not to seek a faculty position. She recalled, "I had

a lot of friends who wanted to be faculty and they just got tired. They got tired of constantly fighting."

At Research University III, women faculty reported that colleagues in their departments were supportive and friendly. However, they had experienced gender bias within the larger engineering field. In addition, women faculty at this site stated that women were less likely to ask for what they need to be successful or to promote their accomplishments to colleagues. According to one full professor, "I see the differences whether people ask or not. They're treated the same once they ask." However, she admitted that women are more likely to be seen as "pushy" or "demanding" when they ask for acceleration for a promotion, or for more resources.

Gender Bias: Teaching Engineering Students in A Male Dominated Field

Across the three sites, seven faculty members (2/7 at Research University I, 3/9 at Research University II, and 3/5) at Research University III) had experienced challenges with students that they ascribed to gender bias. A full professor at Research University I summarized this problem:

> I think they don't always view me in the same way as students view male colleagues. I think they write things in the evaluations that they probably wouldn't write for the male colleagues. I have students for example comment on my shoes. I don't think they would do that for a male colleague. I think if I'm tough then it's taken in a different light than it would for a male colleague. I think they try to get away with … See if they can get away with more than they would with a male.

At Research University II, an associate professor reflected on a similar problem, explaining that students would comment in teaching evaluations on personal qualities such as if she is "nice." She stated, "For men, they would never write, "He's nice," you know? "He's a good Professor, he's enthusiastic, he explains things well, he's very knowledgeable." No one says, "He's nice." For women it's like, "I didn't like her, she's nice," all these feminine things really come up, which is strange." At Research University III, a full professor explained that this difference stems from

the expectation that as a female faculty member, she should be “nurturing” and “sweet” like their mother:

> You also get the feedback you're not like their mother. You're not motherly. I'm not motherly at all. I'm an engineer...“Here's the syllabus, do it, you'll get good grades. No, you didn't do it? Guess what, you failed. No, I don't have any pity for you. Get out of my office.” I'm not like their mother. I'm not nice and soft and supportive and sweet. I think that's a dual edge. They come in and they see a woman. They haven't seen a lot of women and the one woman there is, their mother, and I'm not like their mother…I feel it's actually the students I see most of this commentary with in terms of the challenges and the differences.

This faculty member explained that these attitudes are partly “because we have a large number of international students who come from traditional cultures where they're not used to seeing women in positions of authority.” She recalled that she had seen teaching evaluations for female colleagues that were negative and had focused on attributes such as “ has a high pitched voice" or "kind of trails off.” Citing national studies that reveal that women are evaluated in more negative terms than men, this faculty member was frustrated that the department and university had no way of taking into account this form of bias in tenure and promotion cases. Instead, they “take teaching evaluation numbers and they go, ‘Here's a number. This tells you what you are.’”

Self-Advocacy in a Male-Dominated Field

In the interviews, women faculty often described that, despite facing many challenges, they did not experience their career in a passive manner; rather, they viewed themselves as having the ability to seek out what they needed to be successful and to speak up when necessary to advocate for themselves. For an associate professor at Research University III, this meant addressing situations in which male colleagues were dismissive of her work or her opinions. She believed that this behavior was unconscious, reflecting, “It's really difficult because then I just had to learn that, okay, people, if they're behaving this way, they probably have no clue that they're behaving this way so I need to alert them in a polite way and I think that's the difficult thing is that because you really can't let people get away with it.” Her strategy was to rely on the

facts and not be emotional when responding to these situations. Not "letting it go" was important because as she explained, "there is so much peer review in the academic system, and that's why you can't let these things go, right?...You're being reviewed by everybody around you constantly so if somebody said something negative about your work…you have to say your piece."

Women faculty faced the problem of having to "prove themselves over and over" because of the "implicit assumption that they're not going to be as successful or capable." A full professor at Research University I acknowledged that women "tend to overwork and overcompensate as a result" constantly trying to demonstrate that they belong. This professor remembered how she decided to make a conscious decision not to fall into this cycle of having to "prove it again." She reflected:

> There was a point where I just had to change myself to be who I really was. When I said, "Wait, I'm not comfortable. I'm really tired playing this kind of game of being like one of the guys." I just got tired of doing that. When I pulled back from that, some of the feedback was negative but it's who I am. I'm more social, I'm more involved with the students in terms of their progression to their degrees and more caregiving. There are things that are different that I do, and that's because of who I am. I just said, "Maybe it's time to do that" regardless of the feedback or the reactions of men.

Other faculty members explained that because they had a thicker skin, many of these issues were not of a concern. An associate professor at Research University II reflected, "I just don't know if things really bother me. I think that some are too sensitive. I definitely am not that person." A colleague at the same institution said that she realized that there was some implicit bias, but that she did not pay it much attention. She stated, "Life has been too busy. There are always just too many things to do and you never have enough time…I just ignored those things. I don't really care a lot about how other people treat me. I need to get what I need to get done. I'm just not sensitive enough for those issues."

Dual Career Couple Hiring Policies Are Still Evolving

Fifteen out of twenty-one women faculty stated that dual career couple hiring and the "two-body problem" continues to be a major barrier to recruiting and retaining women faculty in engineering. According to faculty at both Research University I and II, dual couple hiring is on a case by case basis, and there is no formal university policy to address the issue of when a couple is looking for job opportunities in the same geographical area. On Research University II's website, they state that human resources will provide services to spouses of job candidates, and also lists opportunities in higher education on a link on their website. Research University III has a formal policy on partner hiring that faculty interviewees described as successful for recruiting women faculty.

Faculty described the two-body problem as one of the most common reasons that women do not accept (or in some cases, seek) job offers. One full professor at Research University I remarked:

> It comes up actually often for women, so over the years I think if I had asked department chairs what is the most common reason for losing women, losing—meaning you make an offer and they don't take it, I think the most common reason is the dual career issue…I was interviewing one woman and she said that her advisor told her to hide the husband—to do everything she can to make sure that nobody finds out that she has a husband who needs a tenure type position because she was worried that either she won't get the interview or if she gets the interview, people will not want to make her an offer…I think sadly women are right to be concerned because I think it does happen. I think people will shy away from giving a woman an offer because of family considerations.

Another full professor at the same university explained that, "There's no written policies that I know about. In fact that's been one of the problems that we've had because other universities have been much more proactive…We see a lot of dual career couples in engineering. That's really the norm now. The fact that we don't have anything specific, it could be a problem." A department chair at Research University I noted that they are currently offering headhunter services to the spouse of the job candidate, and another colleague in a different department

explained that they should be able to utilize the university's strong networking opportunities to address the dual career couple issue. However, faculty described these services being offered on a case-by-case basis rather than as a formal policy.

Six out of seven faculty at Research University I explained the logistical challenge of solving the two-body problem. The department who is hiring the new faculty member is unable to ask if the potential hire has a dual-career situation (due to employment laws and discrimination), and job candidates are hesitant to bring it up for fear of reducing their chance of receiving an offer. According to one full professor:

> The timing is also very difficult because something at a junior level like an assistant professor level once an offer is made people get two to three weeks to respond. If you find out the person was a dual career issue at the time that you make an offer, to have three weeks to find a faculty job for someone is nearly impossible. To be perfectly honest, my experience over the last few years has been that most women are terrified to bring it up during the process because they worry that they are not going to get the offer if people know that they have a dual career situation.

A senior colleague in another department had similar perceptions, remarking that "I do feel like the 'don't ask don't tell' policy is not beneficial."

A full professor at Research University I stated that she also tries to address this issue but in a different way, explaining that "You can open the door so that if they want to walk through it and bring it up, you sort of signal that this is a good time if you want to do this. I usually will do that and if they walk through or not, that's their choice." She was part of a dual career couple situation herself, and so the "two-body problem" had affected her career as well. Similarly, one associate professor described how at another school where she interviewed, the dean went over all the different policies, stating:

> 'We have practice that whenever candidates come, we let them know about the same set of things which may or may not apply to you, but we let everyone know.' Then he outlined all the policies. That means that then the candidate is not in a position of wondering whether asking about something will disadvantage them, whether asking about family leave or whatever else was included in that interview, maybe dual career stuff. The candidate is not left wondering whether they should bring it up or not.

Another associate professor at Research University I was also personally impacted by the two-body problem, since her husband also is an engineer. She explained that the number of female engineers who are married to other scientists and engineers is significantly higher than the number of male engineers who are married to female engineers simply because there aren't as many female engineers. She continued, “Therefore, when men are applying to jobs, simply the number of jobs that they can apply to is larger. I think [Ivy League University] is a fabulous institution. I got a job offer from [Ivy League University]. There's no way I could take it. My husband would have been miserable. It wasn't possible. Then you basically reduce the number of possibilities.” However, faculty members at Research University I believed that solving this issue could benefit both female applicants as well as the university. A full professor proposed a solution, stating that there should be “extra dollars, extra slots that can be awarded to schools that play nice and accommodate.” She continued that, “universities haven’t caught onto the fact that if you can resolve a dual career situation, the two faculty you bring in will never leave because no one else will solve their problem…and they will work so hard for the university. I think it’s a win-win situation.” However, she and many of her colleagues believed that the solution would require more formalized policy from the provost or a similar higher-level administrator that would incentivize individual departments and schools to cooperate.

At Research University II, five out of nine faculty described the two-body problem as a major issue that women faculty encounter in securing a tenure-track position. Similar to Research University I, faculty stated that there are only “informal measures” to address this issue, Spousal hiring occurs on a case-by-case basis, and faculty perceptions differed in terms of whether the school or department tries to find a spousal position. According to one associate professor:

> There was one candidate in particular that we wanted to hire and her husband would have needed a position in electrical engineering and they had an open position and they hadn’t

> filled it and it wasn't even considered. So there is no real consideration as far as I can see. The department has tried to help out in specific cases but there is only so much they can do.

A full professor in a different department stated that she believed that in their recruiting efforts they did attempt to solve the "two-body problem" but that it can be difficult to help with this issue.

Among the three sites, Research University III was the only institution that had established a formal policy to address the "two-body problem" in which the universities provides a financial incentive to the individual departments to collaborate in spousal hiring. Yet, three out of four faculty described the "two-body problem" as a significant challenge to recruiting and retaining women faculty in engineering. According to a full professor explained she was "more willing to make career compromises" for her partner and family. She continued:

> It's not just having children, it's having a spouse. Let's particularly say a husband…is a big challenge. I left [another state], which is a fantastic place, and I came out here… I'm willing to make that compromise to come here so this family unit could be together. I'm not leaving for the same reasons.

A colleague in the same department had taken positions in industry while her husband completed his Ph.D. and postdoctoral fellowship. Thus, her career did not follow a linear trajectory whereas her husband's career did. She explained, "following his career path and then every time I started at a new company, I would be the one starting over and starting, in some ways, the career over because you would be put into a new project. You have new people to impress…while he was always able to build up." She had taken the position at Research University III as a "spousal hire." She believed that dual career couple hiring was helpful in that without it, she would not be at the school. However, she stated that it took getting tenure to fully prove her place in the department.

At Research University III, women faculty were pleased that the university had adopted the policy to accommodate dual career couples. In particular, a senior faculty member stated that

it was useful because the department could hire faculty without having to contribute the funds for an entire tenure line. Yet, three out of five faculty explained that the "trailing spouse" is often stigmatized because they are not hired through traditional processes. In the words of one full professor:

> If you're being hired as a spouse and then you're the wife and they are like, 'Gosh, you'll never get this job if not for her husband.' That's such an insult that is carried with you forever in your job here. I support it again. Again I'm telling you, from someone who has been in this world for very long time, it's good to have the job, but it's not good to carry the view throughout your life.

An associate professor that joined the university as a "spousal hire" reflected that although she believes the policy is useful, when she was hired when it had recently been established and so she was often treated as a "second-class citizen." She recalled:

> I actually had a fairly negative initial situation because of that…before tenure, there were people that thought that I wasn't as good as other people because I didn't come in through the traditional way…Including the department chair at the time, which made it really difficult…I think after getting tenure and seeing the research record, in the end, no one has any doubt now, but it took that long to get to that point where you didn't feel like you were slightly...There were certain people in the department and even in the school that looked at you differently.

Yet, this professor explained that most colleagues did not have an issue with her being hired, but a few vocal colleagues who had a lot of influence made the beginning of her career at the university difficult. An associate professor in a different department said she had been "pleasantly surprised" with how the dual career hiring policy had been implemented. She explained that in her department, they had hired the women first, and so the men were "spousal hired." In her own case, her husband was offered a position after her, but he decided to work at another institution. She said, "It's nice we had the option. For some people that don't have other options in the area, so that's a big deal. Dual academic career positions are not easy to find."

Many More Service Tasks but Fewer Leadership Opportunities

Women faculty at the three sites frequently explained that although they are assigned disproportionate service tasks (i.e., committee work, planning events, advising students) compared to their male colleagues, they have fewer opportunities for leadership. Five out of seven at Research University I, six out of eight at Research University II, and two out of five at Research University III stated that they were asked to do more service assignments, which they knew "don't count" towards getting tenure. A full professor at Research University I summarized the issue that women faculty encounter:

> Everyone wants to make sure that women are involved so you get asked a lot more. Part of it is that women aren't just good at saying no I think. Then the other thing is that I think what happens frequently is women get asked to be, let's say if it is committee type work, women get asked to be on the committee but not the Chair**…**I think they are not as frequently considered for leadership roles.

A senior colleague echoed these perceptions, stating that " Sometimes I'll ask, 'Why did this person get to be asked to be chair and not me because I'm the one who does blah blah blah…The answer will be 'Well, I just never thought about you.' It's that typical 'I don't see you in a leadership role because I don't see you in a leadership role.' That's a gender-based thing, that's typical." Moreover, women faculty described being asked to serve on more education and outreach related committees compared to strategic planning committees that carry more weight and influence within the university. An associate professor at Research University I remarked that for outreach committees and events, administrators consistently ask her and two other female faculty members within the school of engineering. She explained her reaction: "The first thing that goes through my mind is, really? There are 170 other faculty. Why don't you ask one of them?" One of the faculty members who did not perceive service assignments as a major challenge explained that she is strategic about saying "no" but that "flat out telling them no is somewhat of a risk in that they are going to be around for the next thirty years." However, a full

professor in a different department viewed the disproportionate requests as an opportunity, stating:

> I had advantages especially when I was the only woman, any time they felt they needed to be careful about representing different interests, I was the only one who could represent. That was a little bit of a time drain but it also exposed me to a lot of things that I never would have been able to participate in.

An associate professor at Research University II explained that one of the major problems with service activities is that they are "not appreciated that much." She had served on many committees because "everybody wants to have women" for gender diversity. However, she perceived that these activities would not help her in securing tenure and future promotions, and that she was spending too much time on "things that don't count." She continued, "When we count towards promotion, they're going to look at how much research dollars I bring in. They're going to look at my h-index. They're going to look at my publications." According to this faculty member, service activities are time consuming and peripheral in the academic reward system of tenure and promotion. Another associate professor at Research University II explained that she sometimes perceived that she was asked to be on a committee "not because they really want you as a person. It's more like because they want your background and you're a female faculty and you're Hispanic. Perfect, win-win." As her career progressed, she said that she learned to decline assignments that she either does not enjoy or that will not advance her career. Faculty members at Research University II were more likely to report having disproportionate service assignments (75%) versus having opportunities to serve in leadership positions (22%). In comparison, for faculty members at Research University I, 71% said they had disproportionate service assignments, but 71% had also served in a leadership role. These faculty members were more likely to view service as an opportunity to expand their skills as opposed to a burden that is less appreciated and can prevent faculty from being productive in their research.

At Research University III, faculty also explained that service "doesn't count." A full professor recalled that when she first started at the university, a senior colleague advised her to decline participating and organizing "minority events" which will not help a faculty member get tenure. She explained that her colleague said:

> You're just wasting so much time. You better just focus on your work…Otherwise people will recruit you on all the committees because they want to hear your minority opinion, they want to have a good representation on their committee, they to want to feel like they have an equal opportunity given to minorities. You'll end up doing more service than other colleagues.

She still said that she did more service because she was passionate about education, mentoring, and diversity recruitment. A senior colleague in another department recalled that when she told her male colleagues she was being asked to do too much service, they simply asked why she did not decline the request. She said, "It never occurred to me [to say no]. Nowadays I say no. I say, 'I'm not going to teach that…or if I'm doing this kind of service. I don't need to do that.' I think that was a really great insight from their perspective, you're kind of volunteering for all this extra work and we're not going to give you a pass." She also recalled that although she was Chair of the Academic Senate, she was not considered for participation in a leadership seminar or to become a department chair. She believed that in general, women are passed over for leadership positions in engineering, explaining that women get caught in a double bind. If they are too "nice and quiet" they are never noticed, and if they are always challenging the status quo, they do not seem like a "team player." She reflected, "I realize you're fighting so hard and you get harsh trying to get equitable things for yourself and other people. You get frustrated with it. I'm in their face. I'm challenging them. I'm doing things. I think that's true of a lot of my women colleagues." She continued, "I think we need to do a much better job to promote the women and to give them those tools so they'll be on a leadership. Let me take

[on] a leadership position. There hasn't ever been a woman chair of any department in engineering, ever."

Key Factors of Support: Informal Mentoring

"I Created My Own 'Board of Advisors"

All of the interviewees at each research site described informal mentoring, often both within and external to the institution, as a key factor of support. Women faculty recalled strong mentorship often at every stage of the academic pipeline (i.e. undergraduate professors, Ph.D. advisors, colleagues, etc). Within the institution, several faculty members described how they would seek advice from more than one colleague, often with varying years of experience. For example, an associate professor at Research University II stated, "I was looking at him at how he was so successful to learn from him. I would just ask him questions in terms of 'Hey, what do you in this situation, that situation?' He had very practical advice because he had just done it. He was just two years ahead so he knew exactly what I was doing. That was very helpful. The other mentor, he had been a professor for like 14 years already. It was very different because he was more "grand picture" like, "Overall, this is what I would suggest that you do and I wouldn't worry about those things." She explained that had she only had one mentor that would not have been as helpful, so it was the combination of mentors with differing perspectives that was the most beneficial. A senior colleague at the same institution recalled, "They talked to me about what is involved with getting tenure, what I ought to be thinking about. A couple of them offered to read my proposal before I submitted it to NSF, which was really helpful."

At Research University I, the strategy of having several mentors was reiterated women faculty. One full professor explained:

> It's a group of people. I would say that I have taken bits and pieces of advice from many people that I have talked over the years. I think those snippets collectively have, have helped me get through, and help me get to where I am today.

For this faculty member, advice ranged to how to understand the finances of running a lab, how to choose strong students, how to navigate the university, and "what to say yes to, and what to say no to." An associate professor in another department at Research University I echoed these comments. She stated that her primary strategy for being successful in her academic career was to develop a strong support network. She explained:

> I have a really good support network of a lot of other faculty colleagues, both at Research University I and outside of Research University I. That's really helpful. It's almost like I have a board of advisors, so having I think a really good support network has really helped.

She described it as having "targeted mentors" depending on the question or issue. Since she had funding from multiple agencies (i.e. Department of Defense, National Science Foundation), she sought out colleagues who had been successful at acquiring funding from those various agencies. She continued, "Then I have mentors I go to and ask for advice on teaching, different things I'm doing in class. Then I have advisors I go to and I ask for on university issues, like I'm thinking about seeing if I can start a center within the university. How would I go about doing that?" Using this strategy, she not only received targeted information for her specific questions/needs, but also did not rely too much on one person. She reflected, "I basically just have this entire suite of mentors that I ask different questions, so that way I'm not always asking the same mentor all the time. I'm not emailing the same person every single day and then they start ignoring my emails." A senior colleague in another department agreed that this approach was the most useful so that you do not "wear anybody out." She believed it was also important to have mentors both within and external to one's department.

Types of Informal Mentorship: Practical Advice Versus Psychosocial Support

Women faculty described mentors who were both female and male. However, interviewees typically described receiving practical advice from male mentors, such as how to navigate a specific situation, how to structure a tenure dossier, how to manage your research group, or providing introductions to senior researchers, whereas female mentors were often described as providing psychosocial support in addition to other forms of mentorship. For an associate professor at Research University I, having a female mentor made science feel more "normal." She reflected:

> There was something really nice about having a female advisor for a while and actually talking to another woman about science. Again, it was one of those things where it's not like we were talking about anything different than if she had been a male advisor, because we were talking about some extremely technical project about modeling some material. All the conversations were just about that, but I think having her as an advisor made it seem more normal to be doing physics and [it] just felt more normal. It made me feel a little bit more normal to be doing physics as a woman just because she was there, and she was doing physics.

A full professor at Research University III described a female colleague who was a role model for the kind of resilience needed to be successful in a competitive field. She recalled, "She always told me, 'If people tell you 'No' 10 times, you dare to push yourself forward, either for grant proposal applications or any other things you want, and then to apply for the 11th time, you will be successful.' That's her advice. I think that's really helpful. I forever remembered it."

An associate professor at Research University III explained that mentorship often extended beyond career matters, with female mentors helping to provide perspective in balancing work and family. In discussing the challenges she faced and how she overcame them, this faculty member recalled, "It's really not so much about solving the problem, it's being able to just deal with it. That's helped a lot actually, just having someone go, 'You're doing okay. You're fine. This is not unique. Everything is okay. Step back and look at the big picture. Your kids are doing fine.' They're not in five different after-school activities like everyone else is, and that's okay. It's

actually helpful to have people that will remind you of these things." A female colleague at the same university reiterated this theme as she discussed her two female advisors. She reflected:

> I didn't specifically pick them. I picked them, but I don't know why I picked them. They both are excellent advisors…I learned a lot from each of them. Maybe it's accidental, I don't know, but I do feel the impact of empowerment and you can say that, and they both have family and they both manage their life very well. Maybe they make me not fear about staying in the academic world.

For interviewees, having female mentors often enabled them to envision a career in engineering, and also to provide perspective when they faced various challenges.

Mixed Perceptions on Formal Mentorship Programs

Across the three sites, nine out of twenty-one faculty members identified formal mentoring programs as a factor of support that helped them get tenure. The nature of these programs varied by both department and research site. At Research University I, the Women in STEM Initiative had recently implemented a formal mentoring program, and the individual departments provided a mentor to newly hired assistant professors so they had access to a mentor within the department and external to their academic department. Faculty at this site had mixed perceptions on whether these formalized programs are effective, and the usefulness often depended on whether the mentor and mentee "clicked." According to an associate professor, "My opinion about formal mentoring is that if you have to be assigned a formal mentor, you're kind of screwed. It's nice to have someone assigned as your formal mentor, and universities should do it, and that's great. If they're really telling you things that you've never heard before, then where have you been?" However, a senior colleague (who had been a Department Chair and had implemented formal mentoring programs) stated that for faculty who are less proactive in seeking out a mentor, it is helpful to provide that guidance. She reflected:

> I believe the best mentors are the ones that we choose ourselves and we seek out. That's the recommendation I give to people. Don't wait to be assigned a mentor, go seek one out. I do know there are personalities not comfortable with seeking one out, so for Pete's sake, give them one.

At Research University II, several faculty members had participated in a campus-wide mentoring program, in which assistant professors are matched with two senior colleagues outside of their department (and often in different fields). Within Research University II, several faculty also stated that their individual departments had formal mentoring, and that these programs were helpful. At Research University III, formal mentoring varied by academic department. Four out of five interviewees stated that their department did not offer formal mentoring, but they believed it would be helpful, especially for the "quieter ones who aren't as likely to go out and find mentors." The one interviewee who did have access to formal mentoring in her department said that it was not helpful because she did not click with the assigned mentor.

The Presence of a "Critical Mass:" Creating A Mechanism to Bring Women Together

A pronounced difference among the research sites was whether they had a mechanism to bring women engineering faculty from different departments together. At Research University I, where faculty participated in the Women in STEM Initiative, the interviewees were more likely to be satisfied with their career and department/school climate. All of the interviewees described this program is being integral to their success, and stated that it had improved the culture of the school of engineering for women. One senior professor described the program like "tossing a life preserver to somebody who is drowning." A colleague explained that instead of feeling isolated as the only female professor in a department of 18 male colleagues, she felt mentored by the program and her female colleagues in other departments.

The Women in STEM Initiative also provided a significant amount of mentorship. A senior colleague reflected that program provided "a sort of network of more senior women looking out for the junior women, that sort of made the environment, the culture, everything a little bit better." Another professor in a different department described it as "a source of

mentorship from outside of my department; people I can talk to, sort of really without worrying about what's going on or how that's going to affect things in the department."

In comparison, faculty members at Research University II, which did not have this type of program, frequently described themselves as the "only one" in their department, and did not feel like they were part of a critical mass of women. Although the percentage of women faculty in engineering is higher at Research University II compared with Research University I, women faculty members are spread out among more than half-dozen academic departments, and so some of the interviewees were the only female faculty in their department. For example, a faculty member at Research University II explained, "I think people like to talk about numbers [of recruited women faculty in engineering]…I think the number doesn't say much about what has been done in the school. I haven't seen much improvement since I came here." Overall, they described being more isolated and less supported than their colleagues at Research University I. Several faculty recalled attempts to organize the women faculty but none of the efforts had gained traction. Also, according to interviewees, having more women was important not only to improve the experience of each individual woman faculty member, but also to change the culture of the school. An associate professor explained:

> We don't have enough support to change anything. I myself on my own won't be able to change much, right? It's almost like a perception, if you understand what I'm saying. You need a bigger mass so that people change their perception, otherwise I think they are still dealing on a case by case basis.

Some of the faculty at Research University II had sought mentorship outside of the school of engineering, but there were no institutional efforts to bring together women faculty in engineering. Another professor reflected:

> I don't know outside engineering school because we have really limited interaction on the campus level with people outside the school and even inside the school. I don't think that there is mechanism that actually really helps the woman faculty to connect with each other and then provide the support necessary for the woman faculty. But you do hear …

> People would say, “Oh, yeah. We have like 15% of woman faculty which is higher than the national average.”

At Research University III, three out of five faculty members interviewed were from the same academic department, and so they had benefitted from having a critical mass of women within their department. The fourth interviewee also had female colleagues in her department, and stated that her female colleagues were an important source of mentorship. Within the academic departments, having a critical mass of women had positively changed the culture of the individual department. According to a full professor:

> It's great because we're at the critical mass. I think by having 1/3 of the department being women that it's no longer "a woman." It's more like, this is a person. Which, I think is healthy. They're not, "She might have a baby." It's like, "Oh yeah, all the rest of the women had babies. That was fine." There's not this, "They're going to be so different." I think with the faculty in the department and the leadership of the department has always been fairly supportive.

However, women faculty at Research University III said that not all of the departments had many women (one had just hired the first woman faculty member), and that they had observed examples of gender bias serving on search committees for the other departments.

Although the three sites have similar percentages of associate and full professors (Research University I: 7.3%; Research University II: 8.2%; and Research University III: 9.8%), faculty described their experiences differently by site in terms of being supported within their institution, and faculty felt more supported when their was a “critical mass” of women either in their academic department or when there was a mechanism to bring engineering faculty from different departments together.

Conclusion: Learning the “Rules of the Game”

Women faculty face unique challenges as they navigate the male-dominated environment of academic engineering programs. Most, but not all, of the women who participated in this study had experienced gender bias in their department, the school of engineering, or the broader

field of engineering. In addition, for engineering faculty who were mothers (18/21 interviewees in this study), they faced additional struggles trying to balance their career and family obligations. Despite the challenges, participants in this study were successful at gaining tenure, and some were promoted to department chair and other leadership positions. All of study participants described informal mentoring as the most important factor of support that helped them to achieve tenure. Most of the faculty were highly proactive in the manner that they sought out mentoring, and when they were in an unfriendly or unhelpful department, sought out mentorship beyond their department, either within the broader university or from faculty at other institutions. In the words of an associate professor from Research University III, she did not have strong mentorship from her department, but received guidance from two female colleagues who work at different institutions. She remembered how these two women had "went out of their way to get me off the ground." She reflected that within her own department:

> I didn't have a 'mentor-mentor.' It would have saved me a lot of time. I would have done even better if somebody had told me all the tricks a little earlier. For example, there are these early career awards but you're only eligible if you are within three years of tenure track and within eight years from [your] Ph.D. By the time I realized what was going on, it was too late. The other people with better mentoring, they know…For early career [faculty,] if you know the rules of the game, it saves you time.

Other faculty benefitted from participating in a supportive academic community, particularly at Research University I, which offered the Women in STEM Initiative. Women faculty also described several policies and programs as helpful to their success (i.e. tenure clock extension, paid leave, modified teaching duties, dual career couple hiring policies, and formal mentoring programs) but perceptions of the implementation of these policies and programs were often mixed.

CHAPTER 5

Discussion

In 1991, Zuckerman, Cole, and Bruer described the current situation of women in the scientific community and found structural barriers that prevented women from participating in the "inner circle" of science. In a realm that is dominated by men "not only numerically but in the exercise of authority, power, and influence" (Zuckerman, Cole, and Bruer, 1991, p. 13), the researchers found that women were less likely to be "aggressive advocates" of their work and also encountered "discriminatory employment and promotion practices" that constrained their success and recognition (p.17).

This study sought to understand the life stories of tenured women faculty in engineering departments. Over the course of the more than two decades since Zuckerman, Cole, and Bruer (1991) portrayed the distinctive structural obstacles that women in STEM faced, universities have taken many steps to improve the recruitment and retention of women faculty in academia, many of which specifically targeted the low representation of women faculty in science and engineering fields. Although initiatives differed by research site, all three campuses offered "family-friendly policies," such as paid leave after the birth of a child, and the option to stop the tenure clock. In the words of a full professor who started her career in the 1980's, universities have made a significant amount of progress throughout her career. She recalled, "Whatever meeting I was in, it was me and the guys. It didn't matter. There was not a mentality of offering support, right?" She remembered the dean who asked what the university could do to support women faculty, stating, "That's why I credit this one guy for having asked me the question, "What could we do?" Because that opened the door there that it was previously not even a sketch on a piece of paper." To this professor, compared to the environment thirty years ago,

universities have come a long way in developing policies to support women faculty in engineering.

Yet, as female faculty at all three sites described, many barriers for women in engineering remain. This research study sought to understand the challenges that women faculty in engineering encountered in their career, and to uncover the strategies they used to overcome them. Did women faculty participate in programs or utilize policies that are intended to improve retention and promotion of women faculty? If so, what was their perception of these programs and policies? How did they persevere within the complex, male-dominated arena of academic engineering programs, and how can this information benefit women engineering faculty who are currently navigating similar situations, as well as inform the development of programmatic and policy efforts in the future?

Compared to existing literature on women faculty in engineering, this study was unique in that it situated the experiences of tenured female engineering faculty within the programs and policies of their institutions. By interviewing 50% or more women faculty at each site, this study demonstrated how policies are communicated and understood, as well as the complex decision-making processes that goes into the choice of whether to participate in diversity programs, to take time off after having children, or to "stop the clock."

The results of this study provide insight into the strategies that institutions can adopt to better support women engineering faculty. Chapter Four described the salient findings that emerged from the study, including the challenges that women faced as well as the factors of support that helped them be successful in their career. This chapter considers the study's most important findings within the context of the existing body of literature to better understand how tenured women engineering faculty navigated their careers, and provides recommendations of how institutions can better promote the success of women engineering faculty. I will also explore

the impact of policies and programs that were identified as key factors of support, including informal and formal mentoring, as well as programs that advocate and support women faculty. I examine the importance of male faculty who advocate and support women, as well as the potential impact of leadership opportunities for women engineering faculty, and what universities can do to promote leadership among women faculty. After discussing the limitations of the study and the implications for further research, I provide recommendations for practice that universities can draw from to better support women faculty in engineering.

Factors of Support That Contributed to the Success of Women Faculty

Informal Mentoring

Women faculty described many different factors of support that helped them to be successful in their career in engineering. The type of support that was most consistently and enthusiastically articulated was the effect of informal mentors. Described by Kram (1985) as individuals who provide "sponsorship, coaching, protection, challenge, exposure" as well as "role modeling and counseling," informal mentors can take on many different roles for female faculty. In addition, faculty who were most satisfied with their careers and job climate typically identified not just one or two mentors, but rather a "suite of mentors" or in the words of one associate professor, a "board of advisors"—relationships she had cultivated throughout her academic career. Interviewees were highly proactive in seeking out different types of mentors, whether it be someone who could consult on how to get research funding, how to navigate the process of obtaining additional resources with senior administration (i.e. lab space), or how to deal with challenging students. Mentors typically went beyond simply giving practical advice—they were individuals who served as role models to female faculty, introduced them to other senior researchers, and provided advice at critical junctures in their career. For example, an associate professor at Research University III recalled a post-doc advisor who she identified with

because “he grew up really poor and so I think he saw that I came from the low-income family in [Large City], so he saw lots of similarities and understood how it was difficult to get to where you are and do so well with these hurdles.” A full professor at Research University I remembered a “supervisor who supported me and encouraged me to have that other side—family. That was critical. I can't imagine people who are in a different culture and have to fight that. I never did.”

The experience of these tenured women faculty counters the notion that women are less likely to benefit from informal mentoring (Johnson-Bailey and Cervero, 2004; Gorman, Durmowicz, Roskes, & Slattery, 2010; Page, Bailey, & Van Delinder, 2010; McNeely & Vlaicu, 2010). For this group of women, their personal attributes (i.e. being proactive and assertive) and approach to seeking out informal mentorship contributed to their success. Interviewees recognized that formal mentoring programs were of particular importance for “quieter” faculty who may be less comfortable seeking out mentorship the same way as the interviewees in this study.

Family-Friendly Policies

Across the three sites, perceptions of family-friendly policies (i.e. tenure clock extension, paid leave, and reduced teaching policies) were mixed among study participants. Out of the twenty-one interviewees, some faculty members stated that these policies were very helpful for getting tenure, while others cited concerns regarding how policies are not always adequately communicated and interpreted by faculty and administrators. When asked about tenure-clock extension policies, female faculty explained that the policies were established with positive intentions, but several interviewees did not want to be “slowed down” in relation to their male peers. Using accommodation policies can contradict “ideal worker norms” making faculty who take time off be perceived as less committed and successful (Cech and Blair-Roy, 2014). Since

women—especially mothers—are already perceived as less committed to their profession than men (Epstein, 1999), deciding to take time off can exacerbate this perception, leading to what researchers have described as "flexibility stigma" (Cech and Blair-Roy, 2014). Many of the interviewees recalled concerns that they would be viewed negatively for asking for too much time off. Yet, several of the women faculty who decided to stop the clock described the policy is positive terms, explaining that with the extra year on the clock they knew they had a very strong case for tenure.

Dual Career Couple Hiring Policies

Among the three campuses, Research University III was the only site that had a formal policy to address the "two-body problem." In comparison, the "two-body problem" was most often cited as a major obstacle in hiring qualified women faculty at Research University I, since female academics are more likely to be married to academic men and are more likely to make career compromises (Jacobs, 2004). According to a survey of chief administrative officers associated with the American Association of Colleges and Universities, only 15% of doctoral granting institutions offer a formalized employment policy for partners and spouses (Wolf-Wendel, Twombly, & Rice, 2000); thus, Research University III is unique among doctoral-granting institutions that offer an employment policy for faculty couples. At Research University III, female faculty described this policy as generally effective, although they said that they sometimes perceived a stigma associated with being the "trailing spouse," a concern addressed in the literature on the "two-body problem." (Scheibinger et al., 2008). However, interviewees also stated that it was advantageous for the individual department, because they could acquire another faculty position without having the provide all of the funding (since the upper administration (i.e., provost level) provides a portion of the funding).

While Research University III provides a model for addressing the "two-body problem," faculty members at the two other sites discussed prospective partnership initiatives with other local universities to broaden employment options for faculty couples. Most female faculty agreed that these initiatives must come from the provost level, and that hiring partners on a "case-by-case basis" has been a less effective strategy because job candidates are reluctant to bring the issue up during an interview. An associate professor at Research University I explained that dual career hiring was still a "disaster" because:

> The person who's interviewing doesn't want it to be held against them while they're in the initial phase of interviewing, that their significant other is interviewing. Then by the time that the person fesses up to us that their significant other is interviewing, it's typically after all the other departments have already completed their interviews. Then it's too late…It's kind of this lack of trust going both ways. As the interviewers, technically it's illegal for us to ask. Then our hands are tied unless someone offers up the information.

Since dual career hiring is currently addressed on an ad hoc basis, and interviewees are reluctant to state that their spouse is also interviewing, Research University I was still losing qualified female candidates to other universities that offer a more formalized hiring policy.

Attributes of a Supportive Academic Community for Women

Although women at each site reported many of the same challenges including gender bias, work/family conflict, excessive service loads, and the "two-body problem," interviewees at the different research sites described significant differences regarding department climate. The faculty members who were most satisfied with their department and school environment described benefitting from a network of supports which included mentoring, family-friendly policies, networking opportunities for women faculty, funding/grants (for childcare, travel with children, etc.), events, and leadership opportunities. Most frequently discussed was whether there was a critical mass of women in engineering, and if there was a mechanism to bring faculty together in a meaningful way. Faculty also described the importance of male colleagues who advocate for the success of women faculty (particularly male colleagues in leadership positions).

Finally, the level of support offered within the department and school of engineering influenced the rate at which women faculty sought out and were chosen for leadership positions within the school and the broader university.

Bringing Together a Critical Mass of Women

While many institutions have focused on recruiting women faculty and implementing family-friendly policies, women faculty still leave academia at greater rates than their male peers and are less likely to get tenure (Bilimoria, Joy, & Liang, 2008). This study demonstrated that simply recruiting more women is not enough since women are often isolated as the only female faculty member within their academic department. Since engineering programs often have six or more departments, institutions must provide ways to bring women faculty together in meaningful ways. Rosser (2004) explains that organizations that have been successful at recruiting and retaining women in STEM focus on examining and improving institutional culture. These efforts to create a supportive academic community for women differed greatly among the three sites, with Research University I providing a program that was highly effective according to interviewees at creating a welcoming and inclusive academic environment, offering mentoring opportunities for senior and junior women, helping women faculty navigate institutional processes for acquiring resources, providing funding for traveling to conferences with young children, and supporting female undergraduate, graduate, and post-doctoral students. A full professor at Research University I stated that the Women in STEM Initiative plays a role as a "facilitator" rather than only advocating for women. She explained the difference between advocacy and facilitation:

> Actually, their philosophy on how you support women is so in tune with mine. I've been to places where the counterpart group was more advocacy. They were out there trying to advocate, "why don't we have more women tenure, why don't we have this, why don't we have this." Women in STEM isn't like that. Women in STEM has resources and they set up these programs that either they know from personal experience or because somebody has told them, "These are things that we should look at doing." They set them out there

> and they're available to support the women who are working their way through. They don't play an advocacy role, they facilitate. To me, that's the most valuable thing.

This finding regarding the importance of a critical mass of women is consistent with previous studies that demonstrate that women are more successful when they are not isolated in male-dominated environments (Lott, Gardner, & Powers, 2009).

In comparison, Research University II did not make these kinds of sustained efforts. Although their website describes a faculty diversity program at the university level, interviewees were not aware of any program that is designed to support women faculty in engineering on their campus. At Research University II, female faculty typically viewed themselves as the "only one" in their department, a feeling that is encapsulated by the comment of one professor who reflected, "It's lonely because I'm the only one that's full time here…I would like to have another woman faculty at the same department so at least I can talk to." In discussing efforts to bring women together, a colleague at Research University II remarked, "I do not think the administration is interested in doing that." For faculty at Research University II, they were more likely to describe an unfriendly work environment, and perceived themselves as isolated within their academic departments.

At Research University III, the Equity and Diversity Program advocated for the recruitment of diverse candidates (i.e. reviewing applicant pools to ensure they were considering women and underrepresented minorities in faculty searches), but did not play a significant role in the daily lives of women faculty in engineering. At Research University III, women faculty members recalled attending annual lunches for women but said they were sporadic and did not have clear objectives. In the words of an associate professor at Research University III:

> It's not a bad idea. You need to do networking events to bring people to get to know each other and then you hope something takes off. For me, maybe it helped in terms of knowing 'who is who.' I knew who these women were and when I saw them around, I actually did follow up with two of them on things that made sense. For example, one of them had started a company and when I started my company, I knew I could talk to her.

> The lunch itself was just a social like let's get to know each other. There's nothing actionable out of the lunch.

Research University III had made some attempts to bring women together, but they were not as comprehensive as the programs for women faculty at Research University I.

Male Advocates

Bensimon and Marshall (2001) contend that in order to transform institutional norms, values, and structures, universities must address the effects of gender in academic settings. This study found that male faculty and male administrators play an important role in advocating for the success of women, whether in the form of mentorship or as leaders who advocate for the success of women. At Research University I, when asked what the Women in STEM Initiative could do to further support women faculty, interviewees frequently stated that they were doing enough, but that male faculty also need to step up to address to create a more equitable, supportive work environment for women. In the words of a full professor, "What would help change the environment is actually to have more male advocates speak up, and perhaps, correct the impressions of colleagues who aren't as supportive and are destructive in some ways." She continued by explaining that it would have to be senior male colleagues who are highly respected for their research since their words would "carry weight." A full professor in a different department at Research University I reiterated the importance of men taking an active role to confront bias toward women:

> Just like with Twitter when things erupted with the women who were being harassed, the women in electronic gaming. It finally boiled down to the males starting to take control and saying "Okay, stop harassing these women." The reasonable academic males stepped in and kind of blew the whistle and said, "No, you can't do this." I think it's going to take males saying, "We want something different." Because if the four women in the department say "We want something different" they're four out of 40, the world won't change.

In addition to having the support of individual male faculty, universities must also invest in comprehensive programs that will help improve the situation for women in engineering

through organizational change (Bilimoria, Joy, & Liang, 2008). According to an associate professor, her university has been more successful at supporting women faculty because the problem is communicated openly and transparently, and that the university has taken steps to find solutions and had "put their money where their mouth is." She explained:

> It's communicated openly, so when [the Dean] talks to the incoming freshman parents…[he says] that the entering freshman class this year is 38% female and I think the national average is something like 19%. He even says, even though we're doing really well, we're almost twice the national average, it's still bad. He openly admits it, right? So it's communicated right out there. Then the university also invests in the problem... There's actual financial resources. Kind of like the old saying like, put your money where your mouth is. They actually do that. They don't just say, "Oh yeah, there's this horrible problem and we're going to work on doing targeted recruitment because it sounds really good for an NSF grant." They actually do targeted recruitment and they actually do invest in it.

At the other two sites, interviewees frequently recalled individuals who had contributed to their success through informal mentorship, but did not describe examples of male faculty or administrators in leadership positions who addressed the low representation of women in engineering.

Opportunities for Leadership for Female Faculty in Engineering

Women faculty in engineering frequently stated that they were interested in serving in leadership positions, but were often not considered for these roles. Bilimoria, Joy, and Liang (2008) reported that women faculty in science and engineering are less likely than their male counterparts to occupy leadership positions such as named/endowed chairs, department chairs, and deans. Similarly, researchers have found that women frequently describe themselves as less influential in the decision-making processes within their departments (Fox and Colatrella, 2006). This study demonstrated that the percentage of women who served in leadership roles differed significantly by site, with the largest percentage at Research University I (71%), compared to 22% at Research University II and 40% at Research University III. Several of the interviewees stated that there had never had been a female chair in their department's history. Study findings

suggest that institutions can take steps to foster leadership opportunities for female faculty members in engineering and may offer possible explanations for the high variance of women in leadership positions at the three sites.

Interviewees at Research University I described the effects of a supportive academic community, with an administration that was committed to improving the recruitment, retention, and promotion of women faculty in science and engineering on an institutional level. However, women faculty still had to navigate the complex dynamics of serving in a leadership position in a male dominated environment. Describing her department, a faculty member explained:

> I'm the only female and I'm the department chair. You have these multiple layers of potential sources of tension. With most of the guys, there's no issue. We've all been through this for so many years by now that it's not a big deal. Some of them, I think there's still a little bit of a deal that goes on. I'm a colleague but I have to make decisions that affect people as well.

She said that her challenge was that she never knows if someone is reacting to her in a certain way due to her "minority status" or "what factors are influencing what." As department chair, she stated that the "politics are escalated" so she needs to continually navigate her role as a female leader in an all-male department.

Niemeier and Gonzalez (2004) identify department chairs as "guild-masters identified by their peers, most of whom are men." Department chairs make decisions about teaching assignments and space allocation, determine the makeup of hiring committees, and influence salary decisions. They often set the entire culture for an academic department, and can impact how well policies and procedures are communicated to faculty. According to Niemeier and Gonzalez (2004), department chairs also acquire administrative experience that enables faculty to compete for senior leadership positions within the university (i.e. dean, provost, president positions). However, although researchers have reported that women faculty are less likely to be represented in academic leadership positions (Niemeier and Gonzalez, 2004), there are few

studies that examine the factors that influence whether women pursue or are chosen for academic leadership roles, particularly in engineering.

During this research study, several interviewees discussed being interested in leadership development, but felt that they were overlooked because they constantly had to "fight really hard" throughout their careers. A senior faculty member at Research University III reflected, "I realize you're fighting so hard and you get harsh on trying to get equitable things for yourself and other people." She stated that she knew she had "offended people" and so she was less likely to be seen as a "team player." Several women faculty also described that they were concerned that serving in a leadership position would be an added challenge to balancing work/family demands.

In comparison, Research University I, which offered the Women in STEM Initiative to support female faculty members, women were much more likely to have served in a leadership role. Although female faculty at Research University I had encountered many of the same challenges that women faced at the other two campuses, they were more likely to describe the administration as being committed to supporting women faculty in engineering. In the words of an associate professor, her university had invested financial resources to improve the experience of women in engineering. She explained, "There are scholarships dedicated to trying to improve the issue. There's funding not just for undergraduates, but also for grad students and post-docs and faculty." At this site, the majority of faculty research participants had served in a leadership role, either within the school of engineering or within the broader university.

By contrast, women faculty at Research University II felt that they were frequently "bypassed" for leadership positions. An associate professor described a situation in which a senior female colleague was passed over for a vice chair position. Instead of being appointed vice chair, she was asked to chair the accreditation committee which is not only "tons of work and service to the department" and had also been the responsibility of the vice chair in the past.

She said it was like being told, “You do the work but that [other] person gets the title.” A full professor in another department in engineering who had served in many leadership roles outside of her institution said that it was frustrating to be overlooked in her department:

> I've been vice chair of the [High-Level] Scientific Advisory Board, and what I say they pay attention to. I've chaired a number of studies for the air force. I've given briefings to [high-level governmental officials], stuff like that. People pay attention to what I say and what I think on the outside. Then I go to a department meeting and it's very often what I say is ignored or I think I don't have the respect in my department that I do from the outside. I would say that to me is a challenge. I'm not the person that would toot my own horn or brag about myself, but it is frustrating, because I know that I have a lot of capabilities that could be used by the school, that are not. I think there is recognition of what I've accomplished in some circles in the university, but not entirely in the department.

Unlike at Research University I, faculty at Research University II often described that they were overlooked for leadership positions within their department and the school of engineering. For some engineering faculty, they had sought leadership positions beyond the institution where they found their contributions to be more valued.

Study Limitations

The purpose of this study was to examine the life stories of tenured faculty women with the goal of understanding the barriers they overcame in their career, as well as the factors of support within the institution that contributed to their success. In particular, I focused on how the policies and programs at each research site impacted the faculty careers. In order to have a sufficient pool of participants, three sites were needed since there is small number of women at each research site who were associate or full professors in engineering. Given the specific purpose of this study and the low numbers of tenured women faculty in engineering at each site, there are limitations of generalizability due to low sample size. The study’s findings are limited to the perceptions, experiences, and stories of the twenty-one female faculty members at three doctoral granting research universities, and do not necessarily reflect the experiences of female

engineering faculty nationwide. The experiences for women faculty in engineering may be different at doctoral granting universities compared to other types of institutions such as liberal arts colleges and less selective four-year colleges and universities.

Moreover, the faculty who volunteered to participate in the study includes approximately 50% of eligible faculty (associate and full female professors in engineering) at each research site. Thus, the perceptions and comments described by study participants do not necessarily capture all of the perspectives of the tenured female faculty in engineering at each site. In addition, interviewees were asked to recall events and experiences that often occurred many years ago (in some cases, more than 30 years ago), so it is possible that their recollections may have been affected by recall bias. Another potential limitation in this study is that some faculty participants (6 out of 21 across the three sites) received tenure at a prior institution, so their experiences may have been shaped by the job climate or their experience in the tenure process at their previous university.

Implications for Future Research

There are several implications for further study based on these research findings. The scope of this qualitative study involved twenty-one tenured female faculty members across three research sites to understand the challenges that female engineering faculty overcame, as well as the factors of support that helped them achieve tenure. To expand on the findings presented in this study, future research could also include the male faculty to understand their perceptions regarding the job climate in engineering. As a full professor at Research University I reflected, "A piece of the problem is women but the other piece is men. They have to do something. I think that's where the biggest impact will be is when the male faculty are all on board." Examining the perceptions of male faculty—particularly colleagues who are in leadership positions or "male advocates" that study participants described could shed further light on this issue, especially

since female engineering students are likely to have male faculty, advisors, and mentors throughout their academic career.

Future research could also investigate how work/family challenges impact male faculty in engineering programs. Recent research findings have shown that male faculty members in biology and physics who have children also face the challenge of balancing work and family (Damaske et al., 2014). With norms of fatherhood evolving, male faculty continue to face "ideal worker" norms in academic science that encourages exclusive devotion to work, yet have to also negotiate the expectations of fatherhood with the demands of their careers. Researchers have also found that male faculty in academic science also often delay having children (Drago et al., 2006), and have fewer children than other professionals (Wolfinger, Goulden, & Mason, 2010). However, more research is needed to examine how work/family conflict impacts male engineering faculty, and if these changing norms for fatherhood are impacting work climates in engineering programs.

Another important theme that emerged in the interviews was the need for greater leadership development for women faculty in engineering. Although women are frequently asked to perform a disproportionate amount of service to their departments (i.e. committee work, planning events, advising students), they are less likely to serve in leadership roles in their departments (Niemeier and Gonzalez, 2004). Two future directions for research would use qualitative methods to examine the pathways to leadership for female department chairs, vice deans, and deans in engineering and to examine current programs that work to develop a pipeline of females to leadership positions in academic science and engineering programs. Since there are relatively few women in these positions, an approach to identifying potential study participants would have to be found.

Finally, this study focused on the factors of support that helped female faculty members in engineering achieve tenure, as well as the challenges they overcame. In the academic reward system, tenure is considered one of the most visible signs of success for engineering faculty. However, this study did not specifically focus on the transition from associate to full professor, which was identified by several interviewees as a critical transition to leadership. According to a full professor at Research University III, she got "stuck" as an associate professor beyond the "normative time" and said that she would have benefited from mentorship to understand what was required to advance to full professor. Future research could focus on examining the pathway from associate to full professors, and how well female faculty in engineering understand the expectations for promotion to full professor.

Recommendations for Practice

Based on the research findings, the following recommendations emerged from the interviews with women engineering faculty.

Develop "Best Practices" for Communicating Family-Friendly Policies

Create "best practices" for how to ensure that family-friendly accommodation policies are communicated to faculty, and that faculty members understand that these policies are available to them and will not hinder their chances of obtaining tenure. These best practices should be communicated to department chairs, deans, faculty, administrators, and other personnel. Based on the findings in this study, the degree to which policies are communicated frequently depends on how proactive the department chair is, and in many cases, universities are depending on one individual to communicate policies to faculty. Thus, the extent to which policies are communicated and interpreted varies substantially by academic department. Instead, family-friendly policies should be communicated at every stage of the employment/hiring process (i.e. as a job candidate, during the on-boarding process, and as an employee) to ensure that new and

current faculty members are aware that the university offers these policies, and that utilizing them will not jeopardize their chances at obtaining tenure. Universities could also provide marketing materials (i.e. brochures) that list available policies and could provide an HR liaison to serve as a resource regarding questions about family-friendly policies. Institutions also should ensure that individual faculty understand the purpose of these policies, and should provide instructions for

Expand Family-Friendly Policies to Meet the Needs of More Female and Male Faculty Members. Currently, most family-friendly policies only address the needs of faculty with very young children (i.e. under age 1). However, as many faculty members explained, the challenge of balancing work and family continues after children turn one. Often, women are still nursing, and it is still difficult to travel to conferences. Female faculty frequently described the challenge of being unable make travel arrangements that accommodated their child-care needs. To address this issue, several universities offered travel stipends but the process for applying was arduous and only covered childcare if the faculty traveled with the baby (rather than if they needed expanded childcare while they were away). In addition, faculty stated that for many of these policies, only pre-tenure faculty members are eligible, which leaves faculty who waited until after tenure to have children disadvantaged, since they also face challenges of balancing work and family. Also, according to interviewees, of the three research sites, only Research University III had adequate childcare facilities. While universities have made significant efforts to implement family-friendly policies, interviewees in this study identified a number of ways these policies could be improved, including expanding child-care options so that women faculty can attend conferences, and extending family-friendly policies to women who already have tenure.

Formalize Dual Career Couple Hiring Policies. Interviewees suggested that dual career couple hiring policies should not only be formalized, they should be communicated to all job candidates along with other family-friendly policies, so that they know this is available and they do not have to be concerned about bringing up a "spousal situation" in the interview. Research University III provided an effective model, in which the funding comes from the Provost level and is also shared between the two academic departments (an academic department obtains a new faculty position for 1/3 the cost).

Develop Strategies and Resources to Connect Women Faculty in Engineering. These efforts must be sustained and have a clear mission and purpose. Hosting sporadic lunches is not an effective strategy for developing a supportive academic community. Research University I provided a strong model for what this could look like, with a targeted approach to many of the issues cited in the literature (i.e. providing travel grants, hosting networking events, bringing speakers who discuss STEM related issues, providing mentorship opportunities between senior and junior faculty, serving as a liaison with senior administration). Research University I devoted significant resources to this program, with a Program Director, Program Manager, and Advisory Board as well as a significant amount of funding.

Provide Leadership Development Opportunities And Coaching for Female Faculty in Engineering. In this study, women frequently explained that they were asked to participate in a disproportionate amount of service tasks (i.e., committee work) compared to their male peers. This finding complements existing research that states that women are more likely to perform the "office housework," (Aguirre, 2000; Rosser, 2004) which competes for their time, even though faculty in doctoral granting research universities are evaluated primarily on research productivity (Perna, 2001.) Although women faculty in this study were frequently asked to engage in heavier service loads than their male peers, several interviewees recalled being bypassed for leadership

positions. However, at Research University I, which had the highest percentage of women faculty who had served in a leadership role (71% versus 21% at Research University II and 40% at Research University III), women also described their school as more inclusive and supportive than the female faculty at the other two research sites. Universities could consider taking more concrete steps to developing a leadership pipeline of women faculty, particularly in engineering. This could be achieved through workshops and seminars, as well as by giving more leadership positions to women (e.g., in a committee assignment, asking the female faculty to serve as the chair rather than a member).

Build Awareness among Male Faculty of Gender Bias and the Distinct Challenges that Women in Engineering Face. Women faculty often stated that it was critical to have male faculty who not only understand the barriers that women faculty in engineering encounter, but who also advocate for their success. In the words of a full professor from Research University I:

> One of the things, I think, will help Women in STEM Initiative achieve its goals and help change the environment is actually to have more male advocates speak up, and perhaps, correct the impressions of colleagues who aren't as supportive and are destructive in some ways, to the efforts that we're trying to put forth, but to have more male advocates speak up with Women in STEM would actually be more helpful than having Women in STEM try to do more.

This awareness or "understanding" is of particular importance since male faculty and male administrators are frequently in the position to interpret the policies that have been established to improve the representation of women engineering faculty on campuses. They are also more likely to serve in decision-making roles (Fox and Colatrella, 2006), such as chairing recruitment committees.

Conclusion

This study sought to understand the challenges that female engineering faculty faced in their careers, as well as the institutional policies and programs (i.e. family-friendly policies, diversity/equity programs, mentoring initiatives, etc.) that helped them to be successful in

obtaining tenure. The stories of the twenty-one tenured female engineering professors in this study depicted the unique experiences that women faculty face as a gender minority in academic engineering programs. By situating this study within the context of three selective doctoral granting institutions, this study was unique in that it uncovered how institutional processes and programs directly influenced the success of women faculty in engineering. Although women at all three universities faced similar challenges including gender bias, work/family conflict, the "two-body problem," among other barriers, interviewees' perceptions of the effectiveness of the policies and programs differed significantly by site. This study provided insights into how women faculty perceive many of these programs as well as the factors that influence the decision to utilize the policies that were implemented to support women faculty in engineering. For example, interviewees' reflected on the substantial differences as to how policies were communicated and interpreted (often differing significantly by academic department), with some faculty reporting a stigma associated with taking parental leave or stopping the clock. However, other faculty described these policies in positive terms, viewing them as major steps forward for supporting women faculty.

Although women faculty faced numerous challenges in their career in engineering, they sought out what they needed to be successful. In many cases, women who were in an unfriendly or unhelpful department decided to seek support either outside of the school of engineering (in the broader university structure) or in arenas outside the university, such as technical societies and other external organizations, and often advanced to leadership positions in these organizations. In addition, this study uncovered that although women faculty members are often assigned a disproportionate amount of service tasks, they are less likely to be considered for leadership positions. However, at Research University I, 71% of interviewees had served in leadership positions, such as department chair and center director roles. Women faculty members

at Research University I were also more likely to describe their academic community as supportive, and were more likely to utilize family-friendly policies.

While all women faculty described informal mentoring as critical to their success, another significant difference among the three sites was whether the universities provided a mechanism to bring women engineering faculty together. Since engineering programs are comprised of six or more individual academic departments, within institutions that did not provide a venue for bringing women engineering faculty together, female faculty were more likely to describe feeling isolated and the "only one" in their department. Based on the interviews, the most effective strategies for supporting women faculty in engineering involved the development and implementation of integrated, complementary programs and policies that had clear missions, were well communicated to the university community, that impacted both institutional policy (i.e. recruitment and retention policies) as well as the daily lives of women faculty through mentoring and outreach initiatives, and that sought to reshape institutional culture to more effectively retain and promote women faculty in engineering.

Appendix A

Biographical Questionnaire

1. **Please specify your ethnicity:**

☐ Hispanic/Latino
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or Other Pacific Islander
☐ Caucasian
☐ Other_____
☐ No Response

2. Please specify your age:

☐ 25-34 years old
☐ 35-44 years old
☐ 45-54 years old
☐ 55-64 years old
☐ 65-74 years old
☐ 75 years or older

3. How many years have you worked at this institution_____

4. What is your primary role at the school of engineering?

_____

5. Were you employed as a tenure-track or tenured faculty at another institution?

☐ Yes
If yes, please indicate what school(s) and length of employment:_____

If yes, did you achieve tenure at this institution?
_____

☐ No

If no, where did you achieve tenure?_____

6. **Approximately how long did it take to gain tenure**?_____

7. Have you held administrative positions in addition to faculty positions (i.e. Department Chair, Vice Dean, Dean, etc.)?

☐ Yes

If yes, please indicate the position(s) and approximate dates:

_____

☐ No

8. Please select your department or primary appointment:

☐ Biomedical Engineering
☐ Aerospace and Mechanical Engineering
☐ Industrial and Systems Engineering
☐ Computer Science
☐ Electrical Engineering
☐ Civil/Environmental Engineering
☐ Chemical Engineering/Materials Science
☐ Other _____

9. Where did you receive your doctorate?

_____

Appendix B

Interview Protocol

The goal of this interview protocol was to gather data on the perceptions and beliefs of female engineering faculty in regards to the factors of support within and external to the organization that helped them to be successful, as well as barriers they have to overcome to be successful in their career in academic engineering

1. **Introductory Questions**
    a. How would you describe your primary role at the school of engineering?
    b. How long have you worked as a faculty member at the school of engineering?
    c. Have you worked as a faculty member at other universities? If yes, why did you leave?

2. **Tell me about a mentor you had early in your faculty career?**
    a. In what ways did the mentor assist you?

3. **In your current department, what kind of formal mentoring exists for faculty?**
    a. Have you participated? Why or why not?

4. **What kind of informal mentoring takes place?**
    a. How have you participated? Why or why not?
    b. What did you learn from your mentor?
    c. In what ways was advice helpful or not helpful?

5. **Tell me about any junior faculty or students that you've had the opportunity to mentor.**
    a. What is their gender?
    b. How did you select them?
    c. How have you mentored them?

6. **What are the biggest challenges that you've faced in your career as a woman in engineering?**
    a. In your department?
    b. In your university?
    c. In your field?
    d. How have these challenges changed over time?

7. **What kinds of strategies did you use to overcome these challenges?**

8. **What people or entities inside of your university helped you to overcome these challenges?**

9. **How would you describe research collaborations with colleagues?**
    a. External to the university?
    b. Internal to the university?

10. What kinds of service have you done for your department? For the university?
   a. Why have you selected these?
   b. Do your choices (or assignments) differ in any ways from your male colleagues

11. Have you participated in professional organizations? What have those experiences been like?

12. How would you describe the tenure process in your department?
   a. What was it like working with your tenure committee?
   b. Did you consider using "tenure clock extension" policy?
   c. What do you believe helped you to get tenure?
   d. What were the challenges to securing tenure at your university?

13. If you were to describe the tenure process for women, how would you describe it?
   a. Does this differ in any way from the process for men?

14. How do you think faculty success is measured by the university?
   a. How is faculty success measured within your department?
   b. How are faculty success measured by your colleagues?

15. How do you measure your own success?
   a. Do you measure success for yourself the same way the university measures success?

16. How do you explain your career longevity?

17. Does your department have any policies that apply to women and/or dual career couples in engineering? If yes, what are they? How are they used?

18. As a woman, do you think that there are department or campus resources that are not available to you?

19. Are there department or campus resources that would be helpful to you but which you do not pursue? If yes, why?

20. What helps you to balance work/family demands?

21. How would you describe the role of WiSE?
   a. When you think of WiSE, what comes to mind?
   b. Are there specific programs or policies that WiSE advocates or offers that have been helpful to your success?
   c. How were they helpful?
   d. What can WiSE do to further support women faculty?

Appendix C

Consent to Participate in Research

Qualitative research study on the experience of women tenured faculty in engineering

Deborah Karpman, MFA, under the faculty sponsorship of Dr. Linda Sax from the Graduate School of Education and Information Studies at the University of California, Los Angeles (UCLA) is conducting a research study.

You were selected as a possible participant in this study because you are tenured female engineering professor. Your participation in this research study is voluntary.

Why is this study being done?

The purpose of this study is to understand the experiences and perceptions of tenured (associate and full) women faculty in engineering at research institutions. Study participants will include tenured female faculty at three research institutions in the Western United States. This study is designed to learn more about the factors of support that influences the success of women faculty in engineering, as well as the challenges that women faculty overcame to be successful in their career.

What will happen if I take part in this research study?

If you volunteer to participate in this study, the researcher will ask you to do the following:

- Participate in a 1-hour interview at a location of your choosing
- Complete a background questionnaire at a location of your choosing
- Answer interview questions regarding your career experiences as a faculty member in engineering program at a research institution.
- You will be asked for permission to have the interview audio recorded

How long will I be in the research study?

Participation will take a total of about 1 hour.

Are there any potential risks or discomforts that I can expect from this study?

There are no anticipated risks or discomforts.

Are there any potential benefits if I participate?

You will not directly benefit from your participation in the research. The results of the research may positively impact academic environments to better support women faculty in engineering.

Will information about me and my participation be kept confidential?

Any information that is obtained in connection with this study and that can identify you will remain confidential. It will be disclosed only with your permission or as required by law. Confidentiality will be maintained by coding the data so that your identity is unidentifiable. Additionally, all data will be stored in a password-protected device and/or a password-protected cloud storage system.

What are my rights if I take part in this study?

- You can choose whether or not you want to be in this study, and you may withdraw your consent and discontinue participation at any time.
- Whatever decision you make, there will be no penalty to you, and no loss of benefits to which you were otherwise entitled.
- You may refuse to answer any questions that you do not want to answer and still remain in the study.

Who can I contact if I have questions about this study?

- **The research team:**
  If you have any questions, comments or concerns about the research, you can talk to one of the researchers. Please contact:

  Deborah Karpman, Graduate Student
  UCLA Department of Education and Information Studies
  413-896-2898
  deb.karpman@gmail.com

  Dr. Linda Sax, Professor of Education
  UCLA, Department of Education and Information Studies
  (310) 206-5875
  lsax@ucla.edu

- **UCLA Office of the Human Research Protection Program (OHRPP):**
  If you have questions about your rights while taking part in this study, or you have concerns or suggestions and you want to talk to someone other than the researchers about the study, please call the OHRPP at (310) 825-7122 or write to:

  UCLA Office of the Human Research Protection Program
  11000 Kinross Avenue, Suite 211, Box 951694
  Los Angeles, CA 90095-1694

You will be given a copy of this information to keep for your records.

SIGNATURE OF STUDY PARTICIPANT

Name of Participant

Signature of Participant | Date

☐ I give permission to the researcher to audio record the interview. I understand that the recording and any transcription of the interview will be kept confidential and stored in a locked safe. ____
Initial

SIGNATURE OF PERSON OBTAINING CONSENT

Name of Person Obtaining Consent | Contact Number

Signature of Person Obtaining Consent | Date

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