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

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Abstract

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. The participants in this study were female tenured associate and full professors at three doctoral research universities 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 depict 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, and the "two-body problem," 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. In addition, this study provided recommendations based on the research findings that address best practices related to family-friendly policies, combating "flexibility stigma," leadership development, and novel strategies related improving the effectiveness of informal and formal mentoring.

Introduction

This paper 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. While all three institutions in this study offer "family-friendly" policies, interviewees 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 paper 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.

Background on 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).

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

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). While the criteria vary 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). 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.

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). 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. 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.

Population and Sample

I interviewed women faculty who have their primary appointment in the engineering

school each campus (since some faculty have dual appointments). 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 1-1 describes the population and sample

at each research site and Table 1-2 provides employment and demographic data.

Table 1-1

Description of Population and Sample at Each Site

Name	Type		Female Associate	Female Full	Female Total	Male/Female Total	% Female Among All Tenured	% Female Among 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

Table 1-2

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 assertive 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 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.

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 [a lot] of truth because I see [a lot] 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.

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 are offered by this campus, interviewees described them as under-utilized and 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 qualified for taking up to four quarters of leave, 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 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 experience as a faculty member.

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 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."

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."

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, [and] 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 [respect]."

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 [students] don't always view me in the same way as [they] view male colleagues. I think they write things in the evaluations that they probably wouldn't write for the male colleagues. I have students who, 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 subconscious, 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 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 dual career hiring 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.

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 members at Research University I explained the logistical challenge of solving dual career hiring issues. 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 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." 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.

Among the three sites, Research University III was the only institution that had established a formal policy to address dual career hiring. Yet, three out of four faculty described the dual career issue 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.

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 [members]. 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."

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. 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 that 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.

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. Overall, they described being more isolated and less supported than their colleagues at Research University I. Several faculty members 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 department had just hired the first woman faculty member in its history), 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 there 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.

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.

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 discussing a "spousal situation" in the interview. Research University III

provided an effective model, in which the funding comes from the Provost/Vice Chancellor 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 endowed 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, vice dean, or 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.

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