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Women Electrical Engineering Faculty: How do they Experience EE Department Climate and Promotion and Tenure?

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Abstract

Women Electrical Engineering (EE) faculty are without question an elite group of highly educated professionals. Nonetheless, only 14.2% of women EE faculty are tenured/tenure-track [47]. Attracting, retaining, and promoting women faculty members are essential to the engineering professoriate and deserve further exploration. This paper highlights recent research on women EE faculty members at four-year research institutions for those who have an interest in studying women faculty in academic settings. This qualitative study found that women EE faculty members face an alienating, isolated and sometimes hostile work environments. These findings were evident in work processes such as collaboration, networking and mentoring which women EE faculty members faced explicit and implicit bias. Nearly all women EE faculty members experienced emotional harassment while a third experienced physical or sexual harassment in the department or with the promotion and tenure process. Although work-life balance and support from other women could be a positive aspect, sometimes these experiences paralleled the negative department environment. Such work environments can have lasting repercussions for women personally and professionally and negatively impact their experiences with the promotion and tenure process. Recommendations for institutions, EE departments, department chairs, faculty members and future research are offered to help promote a supportive culture for women EE faculty members applicable to other STEM environments.

Introduction

Women faculty members have an important place in universities in the United States as an elite group of highly educated professionals. However, women faculty members are underrepresented in all professorial ranks of the Science, Technology, Engineering, and Mathematics (STEM) fields despite an increase in the number of women in graduate and professional schools and the undergraduate women population exceeding 50% [15, 47]. For electrical engineering (EE) degree attainment, the numbers are more dismal. In 2017-2018, 14.2% of all bachelor's degrees; 23.5% of master's degrees; and 17.3% of doctoral degrees were awarded to women in electrical engineering [36]. Percentages for women faculty members in tenure positions parallel percentages for degree recipients. In a report for the American Society for Engineering Education (ASEE), Yoder (2017) found the mean percentage of women tenured/tenure-track faculty in all engineering disciplines was 16.9%. That same year, only 14.2% of women faculty members in electrical engineering were tenured/tenure-track. The percentage of women faculty members in all engineering disciplines was higher in lower academic ranks (associate professor 19.5% and assistant professor 24.3%, respectively). The trend in these percentages suggest women faculty members are highly concentrated in the lower academic ranks. Consequently, disparities in gender representation across academic ranks in the engineering professoriate deserve further exploration.

History of Women in Science & Engineering

Historically, women faculty have been underrepresented in all educational levels of American higher education and impacted by gender policies, furthering the challenges of women's access to educational opportunities. Opportunities for women in science expanded but gender segregation still existed. In the nineteenth century, women participated in aspects of science but mainly engaged in data-gathering rather than idea-creation [26] and were largely invisible and concentrated in nurturing career tracks [39]. Prior to the 20th century and beyond, women

supported science but not pioneers in the field; reflective of the patriarchal society they lived in. Commonly known as biological determinism, the physical, psychological, and intellectual nature of women prohibited them from producing great science [38]. The Nineteenth and early Twentieth centuries posited if women were incorporated into scientific employment, they were segregated in it with stereotypes of appropriate sex roles [22]. During World War II (1939-45), women engaged in roles that were previously exclusive to males although women did not benefit equally [34]. The 1960's and 1970's led to the creation of law and programs to promote equity and challenge gender-related disparities including the 1964 Civil Rights Act, the Title IX of the Education Amendments Act of 1972, and the Women's Educational Equity Act of 1974 to name a few. Nonetheless, these women scientists continued to bring "modest but essential change to higher education in the years 1972-1985" [35, p. 39].

In the Nineteenth and Twentieth century, women studying or working in engineering were perceived as outcasts. The first women pursuing engineering were labeled as "others"; a small threatening group of outsiders who defied the traditional gender norms and invaded a man's world [9]. In response, many organizations instituted formal barriers to maintain engineering as a male-only domain [9] including the refusal to enroll females in undergraduate engineering programs and have membership in scholastic honor societies. Coupled with unwritten rules, women were discouraged from beginning engineering education and those admitted to engineering programs struggled with a hostile intellectual and social environment and diversity and fairness in the engineering sub-fields.

Women in Engineering Today

The topic of women's unequal progress in science and engineering fields continues to gain the attention of scholars despite new initiatives such as the ADVANCE program (2001).[1] Although the ADVANCE program has contributed to the development of a more diverse science and engineering workforce, much remains to be done. Women face deep-seated challenges from when they enter academia as students and these challenges continue through the faculty ranks [34, 39]. As undergraduate students, women encounter differential treatment within the classroom, contributing to a different and inferior experience than men. Women's contributions to classroom discussions tend to be ignored or trivialized by men [40]. Women cope with this marginalization by creating their own networks of support through close bonds with other women and forming all female clubs [27, 34, 35]. Additionally, the inclination for males to outnumber the females in the professoriate has existed since higher education institutions formed in the early 1800's and still persists today [28].

Retention of the engineering workforce is of national importance for global competitiveness [31, 44]. The retention rates for women in engineering are lower for women than men [10]. For women, exit rates from engineering fields are highest within the first 10 years after graduation [44]. This may be due to the fact the workplace climate has a male-dominated culture, with gendered stereotypes contributing to a chilly climate [10, 48].

Colleges and universities were formed for the purpose of educating men [25, 42]. Thus, these environments are often historically male-dominated, and science and engineering is numerically and culturally male-dominated [25]. Historically, engineering education has a gendered history

[1] Advance program (2001) places emphasis on improving the institutional climate while increasing representation and the advancement of women in academic science and engineering careers.

that until recently prevented women from finding a place in a predominantly male world [9]. Engineering education is a "prescribed set of appropriate, academic courses, and an enculturation into a well-established system of practices, and beliefs" [43, p. 218). This education provides the training for what to expect and how to act in the engineering workplace [43]. Gendered understandings of engineering influence women's participation in the field. Two factors, engineering is male-dominated and gendered as masculine, lead to the exclusion of women [10, 18, 45]. Studies document the ways men have placed themselves in positions of power attributing to women's underrepresentation as students and faculty members in engineering [10]. *First*, engineering education is considered "a test of one's manhood" preserving middle class male privilege and effectively screening out women [10, 18, 45]. Women made modest gains in the profession, but engineering is considered more appropriate for men based on gendered stereotypes. Women who enter this field must continually prove their suitability as engineers [10]. African American women faculty have a higher level of stress because they must convince white men they are good enough to be part of a majority academic community [6].

Second, the field of engineering contains a diverse set of areas and job types where diverse gender disparities are apparent. Faulkner (2009) examined how some engineering tasks are perceived as feminine and placed gendered dualistic styles into six groupings: technical (i.e. engine design), social (i.e. working with people such as clients), hard (i.e. computer programing), soft (i.e. implementing safety procedures in the workplace), abstract (i.e. doing calculations), or applied (i.e. running an experiment). The technical aspect is highly valued, associated with masculinity and more fitting for men whereas the social aspect is less valued, referred to as feminine and more fitting for women [10]. Pawley (2012) explained how engineers in academia use language to construct, reproduce, transform, and resist gendered symbolic and social boundaries of engineering. She identified engineers' assigned status by using gender as a category of analysis based on where certain disciplines are located administratively [10, 29]. Understanding the institutional climate and the experiences of women faculty members in EE departments is a crucial first step.

Institutional and Department Climate

There are two types of climate that exist within higher education institutions: *institutional* climate-factors associated with the larger academic community (employment policies, institutional resources, salary equity, presence of women in leadership roles) and *departmental* climate factors that are department specific (e.g., collegiality, sense of community, networking and mentoring, committee/service obligations, women in senior positions) [17].

Relatively few studies have examined the direct experiences of women faculty members with the department climate. When department climate is explored, the frame of reference is often intermingled with the components of institutional climate (defined by male standards, different experiences for women and men, job satisfaction, work-family conflict). Department climate is defined as "the way members of a department interact with one other" [37] and has three dimensions: *affective*- involvement with people and interpersonal relationships, *instrumental*-involves work processes, structure, and extrinsic rewards, and *cognitive*-involves intrinsic rewards from work [13, 14]. When women encounter a negative departmental climate, they likely experience lower job satisfaction and have a higher intention to leave the institution or academia [13]. Thus, this study focused on the affective and instrumental dimensions of department climate specifically, the collegial environment, relationships, and work processes.

Bilimoria, Joy & Liang (2008) examined faculty members at several ADVANCE institutions and found that women in Science and Engineering perceive the departmental climate at their universities "as more disrespectful, non-collegial, sexist, individualistic, competitive, non-supportive, intolerant of diversity, and non-egalitarian (p. 432)." Their findings suggest the negative departmental climate experienced by women faculty members in STEM is not isolated to one institutional type but consistent across several types of institutions [7]. Yentsch and Sindermann (2013) explained one of the more persistent forms of subtle discrimination by men is the devaluation of women scientists' abilities and accomplishments (p. 220) which can be destructive to the career of a women scientist. If their contributions are deemed insignificant or consistently ignored [46], another layer of stress occurs in a demanding environment.

Women faculty members in STEM encounter *exclusion* from valuable activities contributing to their development as a scholar. A damaging form of exclusion is the lack of participation in research related activities. Not exchanging ideas or collaborating on projects are detrimental to promotion and tenure and affect a faculty members' career [46]. Ultimately, exclusion results in higher attrition rates, isolation, stress, marginalization, underutilization [3], differential treatment, devaluation, and underrepresentation in departments.

Promotion and Tenure

Women are more prominent in certain academic professions (nursing, education, library science) and less evident in the male-dominated fields (business, science, engineering, medicine, and law) [2]. One reason for this may be with the promotion and tenure (P & T) process. According to the 1940 Statement of Principles on Academic Freedom and Tenure, tenure represents a long-term commitment by the university to the individual and safeguards academic freedom for those who conduct research and teach in higher education. Tenure is attained through distinction in teaching, research, and service to the university and the profession and not granted to faculty members having an imbalance in one or more of these areas.

Two factors are prevalent for women faculty members achieving promotion and tenure. *First*, within departments, micro inequities lead to differential treatment, isolation, and less networking opportunities with male colleagues and less support and approval from senior colleagues and chairpersons, including less information about promotion and tenure [1, p.179]. *Second,* women and men described different experiences with promotion and tenure. Women described the promotion and tenure process as a balancing act with work and life, whereas men viewed the process as a game or competition [21]. Men discussed the "rules of the game, the strategies to which they played by, and evoked images of a game or competition to discuss how they responded to the promotion system" [21, p.34]. The competition "involves strength and willpower-characteristics commonly associated with masculinity and the stress, strength, competitive sportsmanship, and endurance are associated with masculinity" [21, p. 35]. Gunter and Stambach (2003) concluded the different ways men and women experience the promotion system can best be understood as an intersection between gender and the institutional structure.

Purpose of Study

To understand the difficulties of women faculty members in EE departments, new initiatives should be informed by current research. Concentrating on the departmental climate offers a deeper perspective about the experiences of women faculty members in a STEM department and contributes to research and literature in the field in three ways. *First*, this study examines how

the experiences with the EE department climate affects the promotion and tenure process and addresses a gap in literature. By focusing on EE departments, a deeper understanding of women faculty members' experiences occurs while making an immediate and vital contribution to scholarly research in the field. *Second*, illuminating the experiences and "voices" of women faculty members in EE departments at different institutions offers perspectives of how department climate may impact the promotion and tenure process. If institutions want to attract, retain, and promote women faculty members in EE departments, it is important to understand their experiences to promote a climate conducive to equalizing the numbers. *Finally*, this study used a qualitative research design to uncover the experiences of women faculty members in EE with departmental climate and the promotion and tenure process. Quantitative research would not be able to achieve the rich detailed responses unique to this type of inquiry and supplement the limited literature on the experiences of women faculty members in EE departments.

Methodology

A qualitative study design with a narrative inquiry methodology was utilized for this study to acquire a deeper understanding of the stories and lived experiences of being a women faculty member in an EE department and going through the promotion and tenure process.

The experiences of women faculty members in EE departments were examined using the following research questions:

1. How do women faculty members in EE departments perceive their department climate?
2. How do women faculty members in EE departments perceive the promotion and tenure process at their institution?
3. How do women faculty members in EE perceive the effect of department climate on the promotion and tenure process?

Sample: In this study, institutions were chosen before the participants were selected. The institutions were selected from the listing of "R1: Doctoral Universities-Highest Research Activity" public institutions on the Carnegie Classification Institutions of Higher Education website and limited to academic institutions in the United States from different geographical areas containing all four STEM departments- Science, Technology, Engineering and Mathematics. For purposes of this study, a science department was classified as "natural sciences" and technology departments included "computer science or engineering technology." The college where the STEM discipline was located was irrelevant to this study but only institutions with EE departments not combined with other disciplines were utilized. A total of 14 institutions served as the sampling frame for this study.

The faculty rosters on the institutions' EE department websites were utilized to examine the number of women faculty members paying close attention to the race/ethnic characteristics and academic rank. The number of eligible institutions with women faculty members with academic ranks of (assistant, associate and professor) was reduced to ten. Two criteria were used to select participants for the study: (1) a faculty member in an EE department and (2) actively employed (including sabbatical, but not retired) at a four-year public research institution. Using a nonrandom, purposeful sampling technique, I selected three women from each EE departmental listing on institutional websites. Seven women faculty members from five institutions in

different stages of their academic careers (See Table 1) were utilized. Five of the participants identified as White/Caucasian and two identified as other ethnicities. This constituted the sample of the women faculty members in the EE departments for this study.

Table 1
Participants

Participant	Name	Geographical area of institution	Academic Rank	Years in academic position
1	Karen	Southwest	Professor	21 years
2	Cathy	Northwest	Professor	22 years
3	Eleanor	Northwest	Professor & Associate Dean	27 ½ years
4	Samantha	South	Endowed Professor	24 years
5	Amanda	Midwest	Assistant Professor	5 years
6	Bridget	Midwest	Professor	28 years
7	Tatiana	Midwest	Assistant Professor	3 ½ years

Women faculty members were underrepresented in their EE departments regardless of the size of the department. Both the number and proportion of women faculty members in the participants' EE departments was low and was approximately 20% of the size of the EE department. Regardless of the actual number depicted by the participants, there were significantly less women faculty members proportionate to the total number of faculty members in their respective EE departments.

Interviews: Interviews were set up via email and lasted between 45 min-1 ½ hours each and conducted over a two-month period. The interview questions allowed the participants to offer a free and open-ended account of their experiences in EE departments while targeted probes were used to gain additional information. At times, I circled back to the central research questions to gain a general sense of the participants' experiences before utilizing the interview questions. At the conclusion of the interviews, the data was sent to a third-party transcription service. The coding process was labeled as participant number and year date (Participant 1, 2018). When the interview files were returned, a multi-layered approach for accuracy and analysis was utilized. The approach included reviewing the transcription files for inconsistencies and inaudible wording, speaker labels, assigning pseudonyms, member-checking interview accounts by participants, thematic grouping, and labeling themes and review of data on different occasions.

Findings

From the interviews, commonalities and differences with department climate and the promotion and tenure process emerged. *Two contextual themes*-career paths to academia and satisfaction in EE departments and/or with faculty work life; *Seven major themes*- collegial and supportive environments, collaboration and networking, mentoring, bias, harassment, the promotion and

tenure process and the equity of the promotion and tenure process; *Two other themes*-work/life balance and support from women emerged from the interviews with women faculty members in EE.

In addition to the demographic information, women faculty members were asked about their career paths to their current academic positions. Many of the participants started at academic institutions though some participants chose to work in the field or industry before beginning their academic careers (See Table 2). For those who worked in industry prior to academia, they were more passionate about their reasons for becoming women faculty members in an EE department including the flexibility of an academic lifestyle, mentoring future generations of students, and teaching. These explanations provided insight of whether the initial intent of the women faculty members was academia. Although satisfaction was not limited to faculty life, perspectives of experiences in industry and/or at other institutions are varied and applicable here. Intellectual freedom, flexibility and work-life balance contributed to positive experiences and a high level of satisfaction. Isolation, lack of collegial and supportive environments contributed to a lower level of satisfaction. Some of these experiences occurred early in their career whereas a few faculty members currently faced negative situations within the department. Their decisions for academia and satisfaction in EE departments and/or with faculty work life supports the recounting of experiences for the seven major themes.

Table 2
Career path before academia

Name	**Same institution**	**Other institutions**	**Industry before academia**
Karen	Yes	No	Yes
Bridget	Yes	No	Yes
Tatiana	Yes	No	Yes
Eleanor	Yes	No	No
Samantha	No	Yes	Yes
Cathy	No	Yes	No
Amanda	No	Yes	No

Five of the seven themes; collegial and supportive environments, collaboration and networking, mentoring, bias, and harassment are associated with department climate and two themes focused on progression and equity in the promotion and tenure process. The themes often overlapped and are summarized here:

Career Path. The women faculty members provided various reasons for entering the academic environment. Over half of the women made the professional move from industry in search of a flexible lifestyle and job security. For others, the pathway into academia was accidental but aligned with their interests of teaching and research. Women faculty members predominantly

cited professional reasons but a few mentioned personal reasons for entering academia. Just under half of women were employed at other institutions before their current institution.

Satisfaction in EE and/or with faculty work life. Satisfaction with the faculty work life ranged from being content with their faculty position to having less than favorable experiences. The women faculty members in EE identified several positive experiences, including intellectual freedom, flexibility, and efficient work-life balance. Less favorable experiences such as isolation, and non-collegial environments were focused on a negative department climate. Some of these experiences occurred early in their career whereas a few faculty members currently face unbearable situations within the EE department.

Collegial and Supportive Environments. The women faculty members noted that the institutional environments at their previous and/or current institutions were collegial at times and isolated and non-supportive at other times. Cathy shared what made her environment isolated, oppressive, and discriminatory:

> There's a few factors that I think makes it toxic - One, my workload is disproportionate to my peers. My teaching load on paper looks the same as other peers - we teach one course a quarter. However, I have more student credit hours, and different metrics in terms of my teaching load and my research.

The women faculty members had positive experiences such as supportive EE department chairs, opportunities to collaborate, and the teaching and mentoring future generations of students. Women faculty members had negative experiences such as imbalance of teaching, research and service obligations, isolation, and overt discrimination and bias, sexism, and harassment by male peers. The role of the department chair was frequently mentioned as an important element in creating a supportive environment.

Collaboration and Networking. Most of the women faculty members had few opportunities to collaborate and network with colleagues at their present and previous institutions. The lack of opportunities for collaboration and networking was attributed to external roles (i.e., marriage and family), being status oriented, and interpersonal conflicts with colleagues.

Mentoring. Findings indicate a good mentor was a key element in the satisfaction of the women in this study. However, finding a mentor was particularly difficult given the low number of women in the departments. Bridget shared her experience of one of only two people in her area:

> When I started…I was all by myself…I felt like I had no support. I had to do everything on my own and didn't know what I was supposed to do or how to do it. When I would ask, I would get comments like, "Well you're not aggressive enough" which wasn't helpful.

Some of the women in this study went outside their departments, and even the university, to find mentors. Female students benefited from having women faculty members as mentors and role models in the EE department. Several women faculty members cited the department chair was an important part in this process.

Bias. Women faculty members mentioned that bias existed and was based on physical characteristics, competence, and gender-role perceptions. Significant bias existed when female candidates were evaluated as part of the hiring process. Karen shared an example:

> What happens is you have a candidate that has a certain CV and then you've got a male candidate with a different CV. Some of the people on the committee will tear apart the female CV and just a lot of times argue hiring decisions in these committees… if there is a consensus or a kind of outcome; with a female you cannot get consensus… you can't get a majority of the committee to agree.

Bias was also present in the roles assigned to women during committee meetings. The imbalance between teaching, research and service duties that negatively impacts one's promotion and tenure were frequently mentioned. Women faculty members had more teaching and service responsibilities whereas their male colleagues had more research opportunities. Once again, the department chair plays an integral part in ensuring bias does not occur in these environments.

Harassment. Women faculty members stated there was more emotional than physical harassment. Almost all the participants experienced emotional harassment while less than half experienced physical and/or sexual harassment. The forms of harassment included personal and professional attacks, inappropriate and suggestive remarks, and in a few instances physical contact which escalated into a formal complaint. Often, a lack of collaboration and support created an opportunity for emotional, verbal, and physical harassment from both colleagues and students. A non-supportive environment created an avenue for emotional and physical harassment to occur.

The Promotion and Tenure Process. Many of the women experienced varied issues during the promotion and tenure process. Some of the women had difficulty in moving from the assistant to associate level, whereas others experienced greater difficulty moving from the associate to full professor level. Cathy shared there were "moving target issues and the department didn't provide consistent feedback from year to year." Reasons mentioned for difficulties with the promotion and tenure process included the requirements and expectations for promotion.

Equity of the Promotion and Tenure Process. Most of the women said the promotion and tenure process was equitable but noted that women were held to a higher standard. Women who did not believe the promotion and tenure process was equitable stated that women were treated differently, the metrics used to evaluate performance were different for women and men, and that there was no accountability in the process.

Work-life Balance. More than half of women faculty members discussed work-life balance in their interviews. The challenge of being a mother and balancing of children and other caretaking duties with work was mentioned the most frequently.

Support from Women. Supportive relationships with other women were important because of the low number of women faculty members in EE departments. Relationships with other women

faculty members were frequently used as a coping strategy. In some instances, however, other women in the department were not supportive.

Discussion

The findings from this study answered the research questions in the following way:
Research Question #1: How do women faculty members in EE departments perceive their department climate?

Faculty members perceive the department climate as isolating and lacking collegiality. For a majority of faculty members, the department climate was collegial at times and isolating and non-supportive at other times. Other faculty members had either positive or negative experiences exclusively. Opportunities for collaboration and networking were minimal for many of the faculty members. The lack of collegiality forced women to seek collaborative and networking relationships outside of the department and university. A majority of the faculty members did not have mentoring relationships with either a male or female colleague. Several participants noted that the department chair was an important element in creating a supportive environment.

Several faculty members encountered explicit and implicit bias in the EE department. Biases based on physical attributes, perceived competence and gender role perceptions were most common. Two faculty members perceived the EE environment to be overtly discriminatory and biased. Bias was most apparent during the evaluation of female candidates for faculty positions and in the roles assigned to women in committee meetings. Most of the participants stated that women were held to a higher standard. Nearly all faculty members' experienced emotional harassment while two faculty members experienced physical and/or sexual harassment. Forms of harassment included personal and professional attacks, inappropriate remarks, and physical contact. A lack of collaboration and support created an opportunity for harassment to occur from both colleagues and students. Once again, several faculty members noted the department chair was an integral part for mitigating bias in the environment.

Research Question #2: How do women faculty members in EE departments perceive the promotion and tenure process at their institution?

Faculty members perceive the promotion and tenure process as fair and equitable on paper, but unfair in practice. Although the promotion and tenure process was equitable, women faculty members were treated differently. Women were held to a higher standard and different metrics were used to evaluate performance. The requirements and expectations for the promotion and tenure process were not well-articulated and frequently changed. In addition, participants stated there was little accountability in the process.

The imbalance between teaching, research, and service duties for many of the women faculty members negatively impacted their promotion and tenure. Specifically, the women had more service and teaching duties and was considered less valuable for promotion and tenure.

Research Question #3: How do women faculty members in EE departments perceive the effect of department climate on the promotion and tenure process?

Faculty members noted three ways department climate can affect the promotion and tenure process. *First*, the lack of collegial environments made the promotion and tenure process more

difficult for women. Diminished opportunities for networking and mentoring isolated women from the valuable information needed for promotion and tenure. Minimal collaboration with colleagues also contributed to lower levels of scholarly productivity. *Second*, bias was evident in the committee process when evaluating women for promotion and tenure. Like hiring evaluations, women faculty members were subjected to greater scrutiny during the committee discussions and evaluations for promotion and tenure. *Finally*, the department chair can have a significant effect on the promotion and tenure process. Department chairs have an important role in setting a collegial climate to help women navigate the promotion and tenure process and ensure bias does not occur in promotion and tenure decisions.

Recommendations

The experiences of women faculty members in EE departments have practical implications for women faculty members in EE and other engineering disciplines. Thus, I provide a few recommendations for institutions, EE departments, department chairs and faculty members and recommendations for future research on women faculty members in EE and other engineering disciplines.

For Institutions: With the small percentage of electrical engineering doctoral degrees awarded to women, a concentrated effort is needed to *increase* the number of women who pursue careers as faculty members and *retain* women in EE positions. Women faculty members in EE cited professional and personal reasons for entering the academic environment. Institutional recommendations include:

- **Evaluate the STEM climate on a department-by-department basis.** Institutions should not evaluate the STEM climate collectively but look at all STEM fields independently. Assessment of structures and processes at the department level (e.g., programs, hiring practices, etc.) can provide a baseline for each STEM department of which to build upon instead of a broad overall picture.
- **Offer lucrative incentives to attract females to underrepresented departments.** Understanding the successes and failures of what has been in place can guide institutions in their efforts to create diverse campus environments. Welcoming, supportive climates that enable women faculty members to succeed and thrive can be a valuable employee satisfaction and retention measure.
- **Utilize initiatives of ADVANCE from the institutional to the departmental level.** This allows institutions to address factors that lead to underrepresentation (lack of support, collegiality, mentoring, bias, harassment, inequities in the promotion and tenure process) and contribute to collegial and supportive environments for women.
- **Presence of senior women in leadership positions.** It's critical for female students to have women faculty members as role models and junior women faculty members to look to these women for guidance.
- **Address harassment and bias in the overall environment.** Re-evaluating how legislation (1964 Civil Rights Act and Title IX of the Education Amendments Act of 1972) addresses current institutional environments [9, 35] and applicability to all women regardless of gender, race, ethnicity, and sexual orientation. With better enforced institutional policies on sexual harassment for all faculty members, we can hold individuals accountable and impose appropriate remedies. A system of better reporting

with an impartial third party may ensure reports of harassment are not deemed as insignificant or unfounded as described by the women faculty members in EE.

- **Reevaluate work-life balance and the tenure clock policies.** Since work-life challenges affect women and men differently, a consideration to extend the tenure clock for faculty members would meet the needs of all faculty members.
- **Reexamine the promotion and tenure process.** Although the process is fair and equitable on paper, interview accounts indicate there were different (more stringent) and sometimes discriminatory standards for women. The imbalance in teaching, research, and service loads greatly disadvantages women in the promotion and tenure process. Providing fewer service burdens in early faculty years can allow more time for women to become established in their careers [8] and ensure an equitable promotion and tenure process for all faculty members.
- **Appointment of department chair w/pertinent skills.** Department chairs have an important role in the EE department climate. Skills such as empathy, cooperation and understanding are a few of the essential skills necessary in the department chair role and institutions should require these skills when promoting individuals to these positions.

For Electrical Engineering Departments: The findings of this study suggest that changes to policies and practices at the department level are needed to attract and retain women faculty members and these departments can create better climates for women faculty members. EE department recommendations include:

- **Stress the benefits of the educational environment**. The women faculty members in this study all noted there were relatively few women in their departments—approximately 20% on average of all faculty members in EE. Stressing the higher education environment provides greater flexibility and offers better work-life balance could assist in attracting and retaining women faculty members.
- **Implement mentoring programs and structure opportunities for networking**. Women faculty members in EE frequently described the department climate as isolating, with few opportunities for networking. Creating structured opportunities for networking and mentoring with other faculty members may help to overcome the sense of isolation and improve the department climate. Mentors can help new women faculty members better understand what it means to be an engineer, how to effectively manage an engineering lab, and how to network at conferences. Having multiple mentors (inside and outside the department) may be beneficial for a junior faculty member.
- **Address issues of bias in hiring committees and analysis of CV's**. Women faculty members mentioned explicit and implicit bias in hiring committees and when analyzing female candidate's CV's. By utilizing the same guidelines, a checklist with detailed metrics, and a uniform review process for evaluating all prospective applicants, committee members would follow the same procedure minimizing bias and making the hiring process more equitable. Instituting a blind review process with the CV could lessen bias when comparing CV's and could decrease the chance for additional biases to develop before the interviews take place.
- **Institute change from within the department**. Engineering departments may find it difficult to institute change from the outside. Faculty members suggested there is resistance to working with people outside of the discipline. Thus, decreasing the

perception of rigidity in the profession and EE department can promote research while welcoming more women faculty members to the EE department.

For Department Chairs: Throughout this study, women faculty members in EE emphasized the importance of the department head or chair. From leading committee meetings to ensuring faculty member success, the relationships department chairs develop with faculty members are extremely important. Bystydzienski, Thomas, Howe and Desai (2017) argued that a department chair should improve faculty satisfaction and the experiences for women in science and engineering.

- **Address bias in the department**. As Eleanor mentioned, the department chair is the most important in addressing biases. Department chairs that tacitly approve bias through inaction help institutionalize those behaviors in a department whereas those who take immediate, forceful steps to address issues of bias help create a positive department climate.
- **Conduct a yearly review of the climate within department**. By instituting an anonymous survey to faculty members using a third-party administrator, departmental initiatives to improve faculty satisfaction could be based on solid data.
- **Work with the ADVANCE program at their institutions.** By learning about the ADVANCE program and implementing the program and policies around inclusivity would ensure women faculty members' needs are being met while encouraging healthy relationships between faculty members.
- **Lead by example and be transparent with departmental policies and procedures.** The department chair would enable all faculty members to succeed by protecting junior faculty members from too many service-related activities and encourage them to achieve awards for teaching and research activities. Equally, chair should mitigate the imbalance with teaching, service, and research activities to ensure equal opportunity and eligibility for promotion and tenure.

For Faculty Members: Collegiality is related to greater higher levels of productivity [11]. Supportive environments and the opportunity to collaborate with colleagues are indicators of collegiality [17]. Throughout the interviews, the most prominent negative experience was a lack of collegiality and the absence of a supportive environment. For minority women, the challenges are exacerbated because they feel they always have to be perfect.

- **Create a collegial environment where faculty members are mutually supportive and committed to the success of all faculty in the department.** Success cannot be seen as a zero or some-game. Changing the perception and attitudes is essential for building a collegial and supportive environment.
- **Collaborate on common research interests**. By exchanging ideas on research and successes with teaching and service opportunities, such collaboration will create collegial relationships women faculty members mention are missing from the EE environment.
- **Consequences for harassment occurring within the EE department**. In a recent study, Lindquist and McKay (2018) found harassment experiences included gender-based harassment (insults and lewd comments), unwanted sexual advances, stalking, and sexual assault. Most of the sexual harassment was gender harassment [32] among reported incidents. Faculty members should be aware of how harassment allegations may impact their career, the reputation of the department, and the university. To mitigate incidences,

faculty members should think before acting or saying something to determine if a reasonable person would be offended and speak up about harassment that occurs.

- **Awareness of the bias occurring in the EE department**. As noted in the interviews, bias occurred during the evaluation of female candidates. A way to mitigate this is during the evaluation process, mention whether all candidates are evaluated on the same criteria including the language in letters of recommendation.

Recommendations for Future Research: Based on my experiences and findings, I offer a few recommendations for similar studies and future research.

- **Utilize a larger sample of women faculty members in EE and from colleges and universities other than R1 Highest Research/ Doctoral granting institutions.** A larger sample of women faculty members in EE, more diversity in academic rank or women faculty members from other male-dominated engineering departments (i.e. mechanical or civil engineering) would provide additional perspectives and applicability to other male-dominated engineering disciplines.
- **Examine experiences of women who entered academia from industry vs. those who started in academia**. By separating these experiences, we can understand their reasons for a career change adding more knowledge to career pathway literature for women faculty members in EE.
- **Conduct a study about women being the "first" in their EE departments.** Topics such as being the first women faculty member hired, first woman faculty member to achieve tenure or the first women faculty member to hold a leadership position (chair, dean, etc.) in their department are some examples of possible research topics.
- **Conduct a study on women of color faculty (WOCF).** WOCF are significantly underrepresented in engineering and EE departments and make up only 5.1% of non-tenure-track faculty and 2.3% of tenure-track or tenured faculty [20]. WOCF perceive that their dual-minority status creates a "double bind"- being both female and non-White [24] and creates unique challenges regarding implicit bias and isolation. Understanding the intersectionality of experiences with being a woman and a racial or ethnic minority is critical to increasing representation and would address a research gap in the literature.

Conclusion

Attracting and retaining women faculty members in EE are essential to the discipline, as well as to engineering and STEM. The women EE faculty interviewed in this study are strong and highly skilled individuals who have endured and continue to endure many challenges. Their values and commitment to the engineering profession allowed them to persevere despite the obstacles or negative environments they encountered. Although the success stories were institutional specific, we can learn from those EE departments who have been successful in addressing the challenges faced by women faculty members and provide recommendations for other institutions interested in improving their EE environments. Attracting and retaining women faculty members is essential because these women help promote the success of female students and encourage the students to follow a path into the faculty ranks. Engineering disciplines benefit greatly from the presence of strong women such as these and utilizing them to their full potential is paramount.

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