Assessing the Networking Preferences and Resource Satisfaction among Engineering Faculty in the California State University System

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Assessing the networking preferences and resource satisfaction among engineering faculty in the California State University system

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Abstract

Given the low representation of women among engineering faculty, it is important to ensure women in engineering academia have networking opportunities and resources necessary to advance in their careers. To this end, an online survey was sent in April 2018 to engineering faculty employed at California State University (CSU) campuses offering a degree in engineering or computer science. The main objective of this study was to evaluate the networking and collaboration needs of women faculty and compare them to their men counterparts. Two primary portions of the survey focused on collaboration with others and satisfaction regarding available resources. A total of fifty-two engineering faculty from ten campuses of the CSU responded. A high proportion of respondents valued collaboration with others and having a network diverse with respect to gender and organization. While having a gender-diverse network was highly valued, using gender to actively seek collaborations appeared to be much less popular. No significant gender differences existed. It was, however, observed that tenure-track faculty were significantly more likely to value collaborating with others and having a diverse network with respect to the organization than tenured faculty. For evaluating the availability of resources, the faculty were also asked to rate their level of satisfaction with resources available for nine distinct aspects of their academic career. Among all respondents, the lowest areas of satisfaction were with industry relations and research equipment. Tenure-track faculty reported significantly higher satisfaction than tenured faculty in five of the nine categories: teaching training, grant writing, professional networking, professional development, and overcoming bias. Gender differences between tenure-track faculty satisfaction were shown to be insignificant, with the exception that women were significantly more satisfied with resources for teaching materials. Four categories ranked in the five lowest areas of satisfaction for each gender (the availability of research equipment, professional networking, industry collaboration, and work-life balance) with teaching materials and overcoming bias rounding out the fifth category for men and women, respectively. Overall, this study highlighted the need for networking and research resources among the tenure-track engineering faculty at the CSU campuses. Finally, strategies to address these needs, particularly as they pertain to supporting tenure-track women, are recommended, the most significant of which is a recommendation for the CSU to apply for an ADVANCE grant to provide inter-campus networking and mentoring opportunities.

1. Background

On the basis of number of students enrolled in engineering programs and number of faculty, the state of California can be considered as the leader in engineering education in the entire United States of America (Wang [1]). However, based on percentage of women among students and faculty in engineering, the state has a lot of scope for improvement. Based on recently published data by ASEE, the state of California is reported to have about 18% women faculty (tenured and tenure-track), which ranks it 13th among the 50 states as far as gender gap among the faculty (Wang [1]). A close look into its own dataset of institutional effectiveness for California State University (CSU) system (CSU database [2]) can give some glimpses about the enrollment details, but the data on faculty is very limited. With most campuses being classified as Hispanic Serving Institutions (HSI), one of the important challenges facing the state university system is improving graduation rates of the students in engineering and one of the important aspects attributed to this challenge could be female enrollment. Many engineering programs in the CSU system lack gender diversity as average female enrollment is approximately 18%, which is less than the national average of about 22%. Interestingly, the six-year average graduation rate of female engineering students is 66% in comparison with 56% for their male counterparts (CSU Database [2]). Therefore, this creates an added incentive for campuses to actively recruit and retain female students. Considering the vital role of women faculty in ensuring success of students especially female students, many CSU campuses have actively hired women faculty in their engineering programs and their success (tenure and promotion) contributes to the success of female students (graduation rates) (Corbett and Hill [3], Bettinger and Long [4]). These women faculty must attain tenure and successfully develop their academic career in order for them to be of the most support to female students. As per the report published by the National Academies Press (NAP [5]), in academia, career development can be considered as research productivity, recognition, leadership positions, and grants. Studies have shown that women are underrepresented in senior faculty positions and in leadership positions [5]. Often, attainment of these leadership positions is based on research productivity and receiving grants. Although, the number of female principal investigators have increased, women are still underrepresented. Moreover, the size of grants varies for the grants in which women serve as principal investigator [5]. Gallagher, et al. [6], pointed out that one of the methods to increase the success of female faculty is by creating network and collaborations among the female faculty. This can be in the form of formal networks, i.e. formally specified relationships such as peer mentoring (Chandler, [7]), or informal professional networks, which involve more discretionary patterns of interaction (Xu et al. [8]; Ibarra [9]) and may include work-related and/or social relationships. Informal professional networks are essential for career development and job effectiveness (Ibarra [9]). Rankin and Caccamise [10] have presented an intervention model to achieve equity in the STEM fields and have recommended some concrete action plans to achieve the desired outcome in regard to reducing gender gap. Gallagher, et al. [6] used the intervention model to show that the number of female faculty in Geotechnical Engineering in the entire United States increased from 8 in 1989 to about 80 in 2017, which is believed to be about approximately 25% of the total number of Geotechnical Engineering faculty in the nation.

Fostering collaborative practices among various disciplines and developing supportive network were found to be important reasons for such growth. Taking cues from the Gallagher, et al. [6], the authors wanted to collect data on networking patterns and availability of resources to assess the need for a support network for female faculty in the CSU system. A survey was administered to collect this data. This paper presents the reasoning and methodology behind the survey instruments and discusses the findings of the survey along with recommendations. It is hoped that this study will provide the necessary insight into the networking needs and preferences of female faculty so that the faculty and administrators can address them.

2. Methodology

Fifteen campuses in the CSU system have active engineering and/or computer science programs. In order to collect the data on networking patterns and resource availability, a survey was administered in April 2018. The survey was sent to men and women of all ranks faculty in engineering and computer science programs in order to compare the results by gender and rank. The survey questions were divided into five categories, as discussed below:

1) Demographic Information – Because this study was all about the gendered experiences of the engineering faculty in the system, collecting the demographic information was the first step. The data in this category included gender and race/ethnicity.

2) Employment Information – The main objective of this study was to evaluate the networking and collaboration needs of women faculty (especially in early career), it was necessary to collect the data to find their tenure status. This data consisted of questions regarding campus, rank, prior experience, and preparation for academic career.

3) Tenure Experiences – In order to qualitatively assess the process of tenure and promotion for the participating faculty, data on typical academic activities was collected. The questions in this category included average time spent on teaching, research and service (typical expectations from a tenure-track/tenured faculty).

4) Networking and Collaborative Experiences –The main focus of this study was about assessing the networking and collaboration patterns that help in advancing the academic career of female faculty. Hence, the survey questions in this section focused on collecting data on networking and collaboration preferences of the participants.

5) Satisfaction with Resources – The authors wanted to assess the level of satisfaction about available resources that help the advancement of the academic career of engineering faculty in the CSU system. Therefore, the questions in this section focused on collecting data regarding satisfaction level of faculty in terms of teaching materials and training, research equipment, grant writing, professional networking, industry collaborations, professional development, work-life balance, and overcoming bias.

3. Results and Discussion

3.1 Demographics and Ranks of the participating faculty

A total of 52 tenured and tenure-track faculty from 10 campuses responded to the survey. These 10 universities currently enroll between 404 and 8006 Engineering and/or Computer Science students (CSU database [2]) and are estimated to employ between 8 to 114 Engineering and/or Computer Science tenured and tenure-track faculty. The sample was evenly distributed between genders with women being slightly more represented (N = 25, 52%) than men (N = 27, 48%) in the overall sample, where N is the total number of participants in each category. Overall, ethnicity of the survey participants was dominated by White (N = 26, 50 %), followed by Asian (N = 16, 31%), in comparison with the other ethnicities, which included primarily African American and Hispanic. Figures 1(a) and 1(b) describe the ethnicity distribution of participating faculty sorted by gender. These figures indicate that the women faculty group was more racially diverse than the men, as none of the men were African American nor Hispanic. It is important to note that most CSU campuses are designated as an HSI, but that ethnicity was not very well represented in faculty responding to the survey.
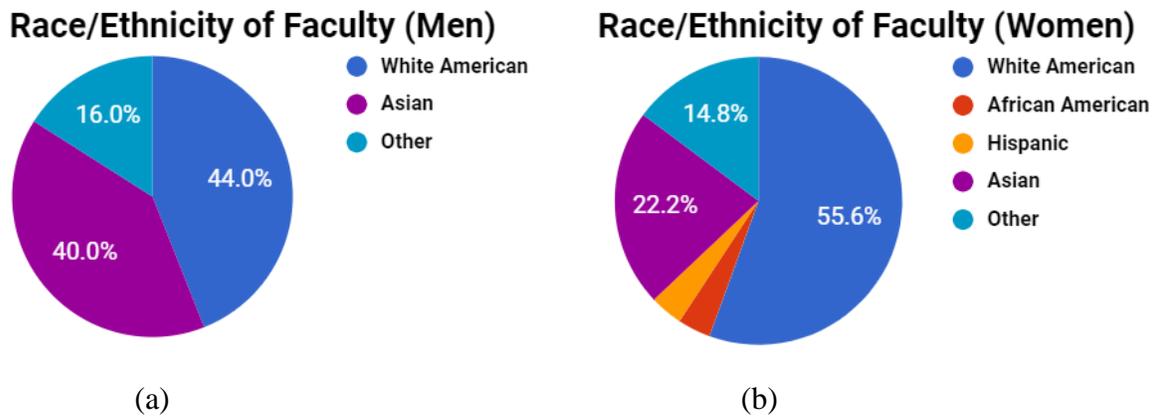

(a)   (b)

Figure 1: Racial distribution among the participating faculty

As far as ranks of the faculty are considered, the number of tenure-track faculty (N = 40) was higher than tenured faculty (Associate and Full Professor, N =12). The distribution of faculty ranks by gender are shown in Figures 2(a) and 2(b).

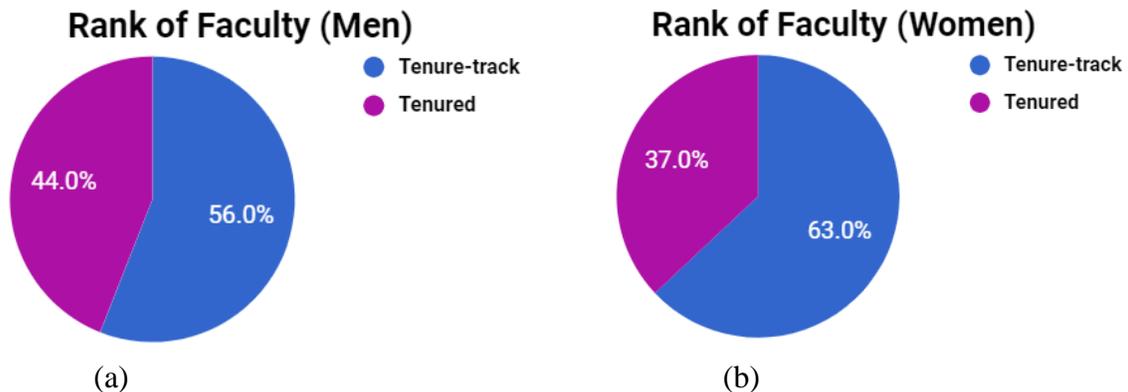(a)   (b)

Figure 2: Rank of the participating faculty

3.2 Networking and Collaborations

It has been reported that women, as minorities in Science, Technology, Engineering, and Mathematics (STEM) disciplines, are often left out of their men colleagues' networks and thereby lose opportunities for advancement in academia by having decreased access to information as well as social and administrative support (Xu et al.[8]). Professional networking provides a safe platform for women faculty to discuss their specific concerns with female colleagues, such as how to maintain balance between family and work responsibilities. Through networking, early career women are empowered to meet senior role models and mentors for successful career development (Barthauer, et al. [11]). As a result of an increased professional networking, women can enhance their opportunities in writing stronger grant proposals, possible collaborative publications, and support for earning promotion and tenure (Barthauer et al. [11]).

In the current study, the participants were asked their opinion on how important it is for them to collaborate with others, with men or women in particular, and to have professional networks that are diverse with respect to gender and organization. The aim was to detect any patterns in networking and collaborations, their preferences for certain type of network, and evaluate any differences within the groups based-on gender and tenure status. A total of 47 faculty responded to this question consisting of 23 women and 24 men. Of these 47 faculty, 29 were tenure-track, while 18 were tenured. Figure 3 shows the distribution of faculty selecting collaborations to be "Extremely Important" and "Very Important".
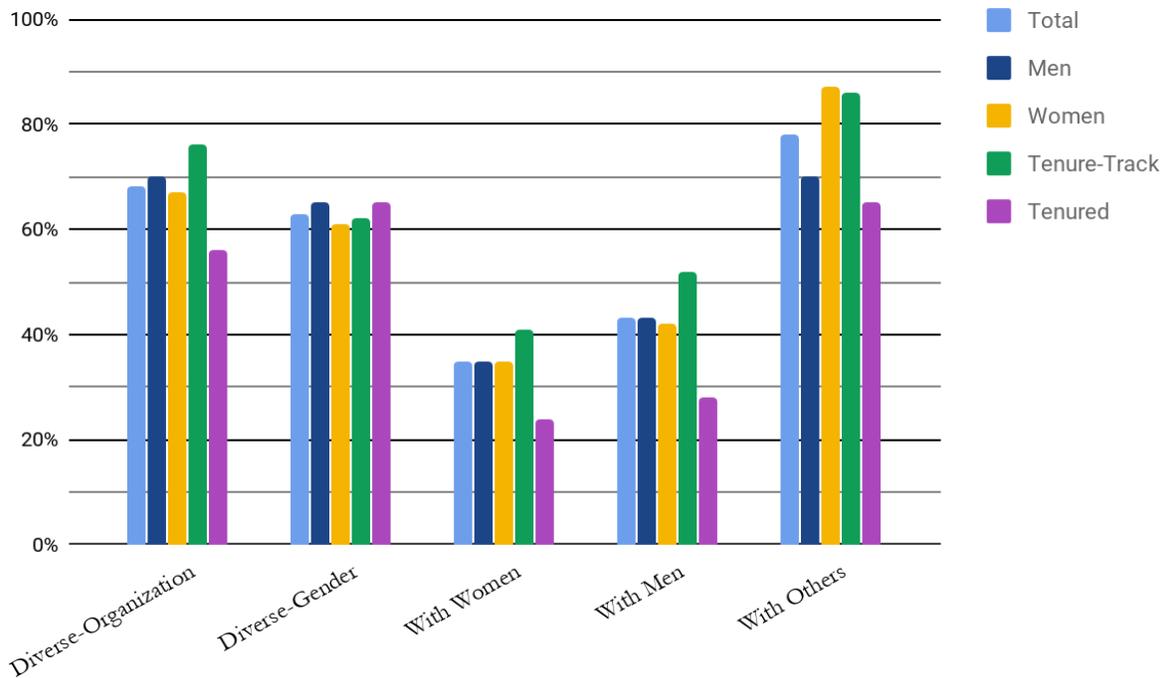

Figure 3. Reported Degree of Importance of Various Types of Collaboration: Percent Indicated "Very Important" or "Extremely Important"

It can be observed that, in general, faculty seem to put maximum emphasis (78% indicating very or extremely important) on collaborating with "others" irrespective of gender, indicating they value the importance of collaborations, but are less concerned about the gender of their collaborators (43% indicating collaboration specifically with men as very or extremely important and only 35% indicating the same for collaboration specifically with women). Nevertheless, having a gender-diverse network was highly valued by 62% of respondents. Following the results from a two-way analysis of variance (ANOVA) of data, including both gender and tenure status differences simultaneously, tenure-track faculty indicated collaborating with others as more important than tenured faculty. Although the ANOVA did not indicate any significant differences between men and women with respect to valuing the collaborations, a noticeably higher proportion of women than men indicated collaborating with others as very or extremely important. However, there were no significant differences between men and women or tenured and tenure-track faculty with respect to their valuation of collaborating with specific genders or gender diverse groups. Overall, 68% of respondents believed maintaining a professional network with diversity of organizations to be very or extremely important, but both gender and tenure status differences emerged in this data. When the effects of both gender and tenure status are considered simultaneously, it was found that men more frequently valued diversity with respect to organizations than women (although the percentages of men and women rating it very or extremely important is similar) and tenure-track faculty more frequently desired diversity with respect to organization than tenured faculty. It is clear from the data that tenure-track and female faculty (irrespective of their tenure status) have a strong desire to collaborate with others. It was also observed that the in comparison with tenured faculty, the tenure-track faculty desire to develop professional networks extending beyond their university. Faculty satisfaction with existing resources, including those for networking and collaborating, will now be discussed.

3.3 Satisfaction with resources

Having access to key resources (e.g., research equipment and professional networking opportunities), is an essential component enabling faculty to successfully and fully perform their jobs and is especially important for tenure-track faculty attempting to earn tenure. This study investigated the level of satisfaction with the availability of resources among engineering faculty in the CSU system. Table 1 summarizes the percentage of faculty who expressed moderate or extreme satisfaction with resources available to them in nine distinct aspects of their academic career: teaching materials, teaching training, research equipment, grant writing, professional networking, industrial collaboration, career and professional development, work-life balance, and overcoming bias. Responses are broken out by both tenure status, i.e. tenure-track versus tenured, and gender. Bolded data indicate a significant difference between comparison groups based on two-way ANOVA at a 0.05 significance level.

Table1. Reported Degree of Satisfaction with Resources: Percent Indicated "Moderately Satisfied" or "Extremely Satisfied" by Gender and Tenure Status

Category	All n (%)	Men n (%)	Women n (%)	Tenure-Track n (%)	Tenured n (%)
Teaching Materials	27 (56%)	**9 (39%)**	**18 (72%)**	18 (60%)	9 (50%)
Teaching Training	19 (43%)	8 (38%)	11 (48%)	**16 (59%)**	**3 (18%)**
Research Equipment	15 (33%)	9 (39%)	6 (27%)	12 (43%)	3 (18%)
Grant Writing	18 (41%)	9 (43%)	9 (39%)	**17 (61%)**	**1 (6%)**
Professional Networking	14 (33%)	7 (33%)	7 (33%)	**13 (48%)**	**1 (7%)**
Industry Collaboration	12 (29%)	8 (38%)	4 (20%)	10 (40%)	2 (13%)
Professional Development	21 (49%)	10 (48%)	11 (50%)	**19 (66%)**	**2 (14%)**
Work Life Balance	16 (35%)	5 (24%)	11 (44%)	10 (34%)	6 (35%)
Overcoming Bias	16 (42%)	7 (44%)	9 (41%)	**12 (50%)**	**4 (29%)**

Note: Sample sizes are adjusted for each category based on number of respondents answering.

From this data, a number of key observations are made. Tenure-track faculty are significantly more satisfied than tenured faculty in five of the nine categories: teaching training, grant writing, professional networking, professional development, and overcoming bias. This may highlight an exerted effort on the part of the CSU system or the engineering community at large to provide additional resources to tenure-track faculty to help start their careers particularly in terms of funded networking opportunities (e.g. NSF [12]) and grant writing, professional development, and teaching workshops (e.g. Guessous et al. [13]), where the greatest disparities in satisfaction are observed.

Although tenure-track faculty reported significantly higher satisfaction than tenured professors in many of the categories, a full analysis of the data based on the satisfaction levels of tenure-track faculty among various parameters was done to get more detailed insights into the parameters that could be responsible for successful attainment of tenure. Given that women are better represented at the tenure-track level than at the tenured level, consideration of this subgroup is particularly important to minimize loss of these women faulty, either due to voluntary turnover or failure to attain tenure (Xu [14]). Based on the survey results, a large proportion of women (72%) seem to

be satisfied with the resources available in regard to teaching materials, while the opportunities and resources regarding industry collaborations were rated satisfactory by only 20% of the women respondents. The data did not yield any significant differences between the faculty based on gender. However, there appears to be a distinctive difference based on tenure status, which will be discussed below.

In order to provide the actionable items that require administrative intervention, an analysis based on the categories that had high negative perception among the tenure-track faculty (i.e. less than 50% of tenure-track respondents expressing moderate or extreme satisfaction) was carried out. Among tenure-track faculty, the areas of low satisfactory ratings were the availability of research equipment (43%), professional networking (48%), industry collaboration (40%), and work-life balance (34%). If a list of five lowest scoring categories (indicating lowest satisfaction) for each gender is to be made, then these four categories would appear on both lists, making them areas that warrant consideration by the CSU system. In addition, men were also found to be least satisfied about teaching materials, whereas for women, overcoming bias was the fifth category. The resulting six categories (the four shared by both genders plus the two that are unique to a single gender) are plotted in Figure 4. Of these six areas of measuring level of satisfaction for each gender, there are only two categories, i.e., teaching materials and work-life balance, in which less than 50% male tenure track faculty reported moderate or extreme satisfaction, with work-life balance being the least favorable resource among tenure-track men. Whereas, among female tenure-track faculty, with the exception of teaching materials, none of the six categories experienced more than 50% indicating moderate to extreme level of satisfaction.
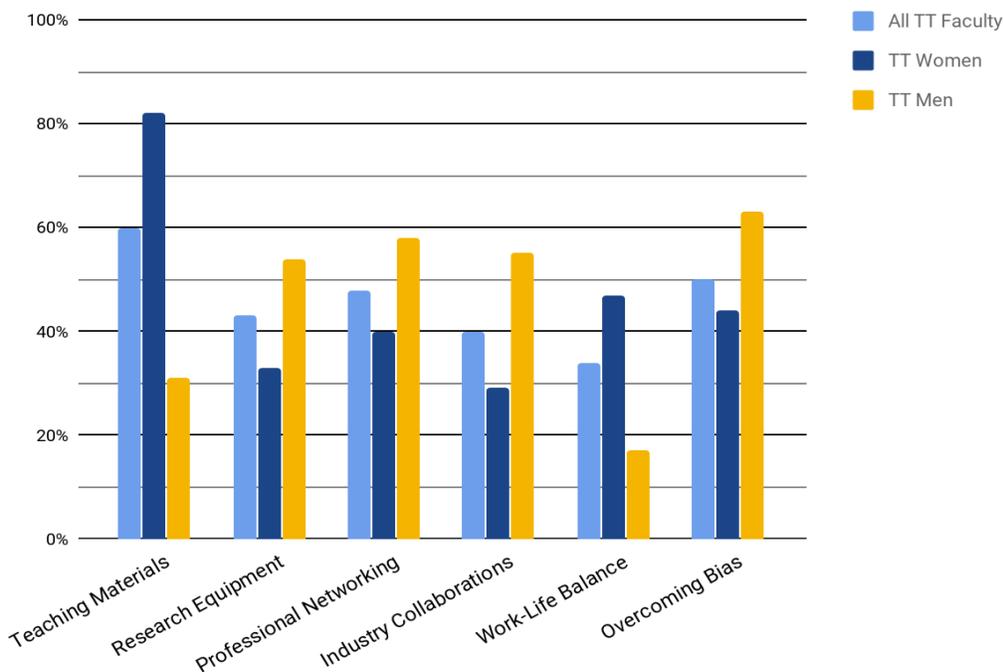

Figure 4. Reported Degree of Satisfaction with Resources among tenure-track (TT) faculty by gender: Percent Indicated "Moderately Satisfied" or "Extremely Satisfied"

It is interesting to point out that tenure-track women are significantly more satisfied than men with teaching materials. While 82% of tenure-track women expressing moderate or extreme satisfaction with teaching materials may indicate that they are having success establishing themselves as teachers, their lack of satisfaction in the three areas closely related to research (i.e. research equipment, professional networking, and industry collaborations), provides a grimmer indication of their establishment as a researcher, which is often the dominant factor in tenure decisions (Wilson [15]), but is in agreement with the findings of Long [16], Park [17], and Fox [18, 19]. Although both genders of tenure-track faculty reported spending the same proportion of their time on teaching (57%), men spent slightly more time on research than women (28% versus 23%). While neither the gendered differences in relation to satisfaction in these three research related categories nor the difference in weekly hours reportedly spent on research rise to the level of statistical significance, this apparent difference is concerning given the key role these items play in facilitating research productivity. The authors believe that the possible reasons behind the reported performance of tenure-track women is beyond the scope of this study and further investigation into tenure decision and voluntary faculty departures would be needed to confirm whether this is the case. Ideas for the CSU administration and faculty to address the five areas of lowest satisfaction experienced by tenure track women faculty (four of which are also shared by their men counterparts) will be discussed in the following section.

4. Recommendations

Of the five categories of low satisfaction among female tenure-track faculty, three relate directly to research (i.e. research equipment, professional networking, and industry collaborations). Given the disparity in satisfaction among genders, it is recommended that each CSU campus carefully monitor the manner in which research space and equipment is distributed to ensure equitable distribution. Startup funds provided to women versus men should also be monitored to ensure that gender differences in negotiating do not unduly influence their research resources. Women should be empowered to voice their equipment needs and universities should solicit this information from all faculty, not just those who express their needs unprompted. CSU campuses can assist female faculty in improving their access to research equipment by helping to foster relationships between faculty and industry and encouraging application for research equipment grants such as the National Science Foundation (NSF) Major Research Instrumentation (MRI) grant and Department of Defense Research Equipment Awards. Another avenue for overcoming a lack of research equipment is collaborating with faculty from other universities. In particular, engineering colleges within the CSU system could develop a database of research equipment housed at each campus to help facilitate sharing of equipment between universities. Hence, the solutions for improving satisfaction with research equipment, depend largely on improving faculty's professional networks including both academia and industry.

As a result of an increased professional networking, women faculty can enhance their opportunities in writing stronger grant proposals, possible collaborative publications, and support for earning promotion and tenure (Barthauer et al. [11]). There is documentary evidence in regard to the Kansas State University ADVANCE Institutional Transformation Project (KSU [20]). This

project, which was designed to address the barriers to women's advancement in STEM at Kansas State University, encouraged establishing a broader network of colleagues among women faculty by their participation in professional society activities and making research presentations. Through this project, university administrators were fortified to assist and support women faculty to invite elite scholars in their fields for a campus visit and presentation. Universities within the CSU system are recommended to apply for the NSF ADVANCE grant to help support the progression of female faculty from tenure-track to full professorship. The use of NSF ADVANCE funds to establish networking and mentoring opportunities for women engineering faculty within the CSU system would help immensely to connect faculty between campuses. Such inter-organization professional network building was shown previously in Figure 3 to be of high value to CSU faculty, particularly among the tenure-track rank. Many of the struggles faced by CSU faculty are distinct to universities with predominantly undergraduate students, and thus collaborating with each other will provide unique opportunities for tenure-track women faculty to be empowered by meeting senior role models and mentors who have demonstrated successful career development within the CSU system. This professional networking initiative would provide a safe platform for women faculty to discuss their specific concerns with female colleagues, such as how to maintain balance between family and work responsibilities and overcome bias, the two non-research related topics of low satisfaction among women tenure-track faculty. This platform for inter-university networking is particularly important given the number of female full professors in engineering disciplines at CSU campuses is quite small, and at some universities is zero. In the absence of an ADVANCE grant, engineering colleges are encouraged to make funds available for faculty, particularly early career faculty, to attend professional society meetings and ensure that female faculty take advantage of these funding opportunities. Departments can assist in women's career development by encouraging senior faculty to either collaborate with new faculty on research grants or to recommend tenure-track faculty to members of their professional network for collaborative projects. Based on homophily in network formation, people are more likely to interact with people who are similar to them (Ibarra [9], Mehra et al. [21] and Borgatti and Foster [22]). This adversely affects women in engineering, which is a male-dominated field. Therefore, it is very essential for women faculty to engage in the informal networks with colleagues in their own departments/colleges [8] and for departments and colleges to encourage such diverse networking.

It is important that women faculty receive proper mentoring and education about the reality of their situation as tenure-track faculty. In order to succeed, women faculty should be informed of the personal and institutional barriers that they may encounter at different stages of their career development. Between the three main responsibilities of faculty members (teaching, research, and service), on average, women faculty spend more time on teaching and service in compare to men faculty (Park [17]). Researchers associate this with the value differences between men and women. They believe that women value nurturing activities such as teaching and advising, while men value competition (Fox [18]). Based on the study by Fox [19], teaching and research have opposite relationships to publication productivity, which is directly related to career advancement. Thus, women, particularly those who are excelling in their teaching responsibilities, should be mentored to be mindful of the manner in which they split their time and efforts between teaching and research. Considering that authoring peer-reviewed publications is a major factor for advancement

to higher ranks (Long and Fox [16]), it is very important for women faculty to focus on research questions that will result in publications and citations, obtain adequate funding to carry out research, build relationships that will help to advance their research, and ask the institution to provide them with advantages that make their success more likely (NAP [5]).

While work-life balance and overcoming bias can be addressed through the proposed peer mentoring and networking as described previously, there are additional steps that may be taken. A major factor that impacts career development is evaluation for tenure and promotion, which can be affected by status and prestige in one's field. Two common types of professional recognition are getting invited to speak as keynote speakers and getting nominated for honors and awards. Studies have shown that due to lesser networks, women are usually self-nominated, while men are nominated by mentors or peers (NAP [5]). Women receive fewer awards in comparison to men, which negatively affects their relative status and prestige (Valian [23]). Administrators should be aware of these gender differences and take care to nominate women faculty for career advancing speaking opportunities and awards. Furthermore, a study by Smith et al. [24] has demonstrated that faculty search interventions including a presentation to inform the search committee on how gender bias often skews the hiring process led to 6.3 times more women receiving the initial employment offer. Therefore, those performing evaluations, such as provosts, deans, department chairs, and search committees, should be educated on how gender-bias affects hiring, tenure, and promotion evaluations, including gender differences in accomplishments.

5. Conclusion

In conclusion, the important findings of the survey are:

1) It was found that the tenure-track faculty were significantly more likely to value collaborations than tenured faculty.

2) There were no significant differences between the networking and collaboration patterns among the genders, but it appears that a larger proportion of women than men place high value on the general idea of collaborating with others.

3) The vast majority of tenure-track women seem to be satisfied about the resources available for teaching, while very few were highly satisfied with resources that help tenure-track faculty establish themselves as researchers. Therefore, the availability and quality of resources intended to promote research activity need more careful attention and warrants intervention of the administrators, particularly from those making tenure decisions.

These findings are of particular importance to the California State University System, but it is uncertain whether they are generalizable to other universities. The level of existing faculty services, university size, a university's Carnegie Classification, and student demographics may affect the generalizability of these findings.

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