Towards Gender Balance in UC Berkeley EECS

Understanding and Rectifying Severe Gender Imbalances

Yanpei Chen
4th Year Undergraduate
Electrical Engineering and Computer Science

Jooyeon Nam
4th Year Undergraduate
Molecular Cell Biology & Legal Studies

Abstract

This paper tackles the gender imbalance found in Electrical Engineering and Computer Science (EECS) at University of California, Berkeley. We examine enrollment data at various EECS departments and discover that gender imbalance is not restricted to UC Berkeley, but the imbalance at UC Berkeley is especially severe. We analyze gender differences in communication, decision making processes, as well as social and academic preferences. At the same time, we look at how the broader social-cultural environment condition women to shy away from technology, thus aggravating gender imbalance. We proceed to detail how these social-cultural attitudes and gender differences are played out in the EECS academy, deterring women while successfully cultivating generations of male students. We argue that improving the gender balance will lead to better technology as well as a more enriched professional environment due to increased presence of diverse perspectives. Finally, we suggest interventions, both in high school to attract new female talent into EECS, and in the university to retain female students already in EECS.

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Towards Gender Balance in UC Berkeley EECS

1 Introduction:

Two semesters ago, at the infosession for the EECS Honors Program, a student asked "Why aren't there any girls in the room?" The question seemed to have caught the presenter off guard, and the room did indeed hold an all-male audience, except for a female staff. This audience hardly needs reminding that gender ratio is lopsided in the EECS Department at UC Berkeley. The presenter spoke for some time about the issue, outlining how efforts made to ameliorate the problem have yielded little results, and welcomed suggestions and contributions from the audience. Thus was born the impetus for this paper. Something *had* to be done about gender imbalance at Berkeley EECS.

Gender imbalance is by no means a phenomenon restricted to Berkeley EECS. In fact, the EECS academy in general and the entire IT industry has consistently witnessed an under-representation of women. The gender issue is receiving more and more attention, especially after publication of the 1999 *MIT Report*[1] and the subsequent media reporting. However, as late as last year, academic literature reviews complained about a shortage of systematic studies in this area[2]. While it is incorrect to declare a total absence of gender-technology studies, the few papers addressing this issue form an insignificant fraction of the tremendous volume of existing and emerging EECS literature. Likewise, compared with the exponential improvement in technology, the improvement in gender equity has lagged.

To date, gender and technology issues in universities are largely influenced by two non-conscious assumptions: first, that technology, by itself, is gender neutral; second, that technical knowledge is taught and assessed in gender neutral ways. Perhaps the entrenched gender imbalance has something to do with these assumptions and their unquestioned acceptance. Indeed, emerging literature challenges these assumptions[3]. The suggestion of the gendered academy invites an examination of teaching emphasis, course content, rewards and incentives system, and institutional structures with respect to Berkeley EECS. The possibility of gendered technologies means gender imbalance is not just an issue of equity, but an urgent matter with the quality of EECS education, the employability of Berkeley's graduates, and the relevance of future technologies at stake.

The purpose of this paper is several-fold. First, we examine the status of gender related enrollment data at Berkeley EECS and at EECS Departments of other comparable universities. This is followed by a dissection of learning differences between male and female students, and a discussion of various social-cultural forces that condition female students away from EECS. Based on these social-cultural forces and learning differences, we then analyze EECS programs in general and identify some potential shortcomings specific to EECS at UC Berkeley. We argue that such shortcomings lead to technologies that stand at a disadvantage in the global IT market-

1. [MIT 1999]. The MIT Report includes introductory comments by Robert J. Birgeneau, at the time Dean of the School of Science at MIT. Professor Birgeneau is now Chancellor of the University of California, Berkeley.
2. [Beckwith 2005]
3. On gendered technology, [Beckwith 2005], [Faulkner 2000], [Simon 2001], [Trauth 2004]. On gendered academy, [Bailyn 2003], [Chesler 2002], [Farrell 2002], [Faulkner 2000], [Heller 1994], [Krefting 2003], [Mbarika 2003].

place. We continue by suggesting interventions, low budget and logistically feasible, that seek to attract female students to EECS and ensure that female students enjoy a positive experience once they enter EECS at UC Berkeley. Lastly, we explore potential room for long term improvements that benefit both female and male students; these improvements would ensure UC Berkeley EECS remains at the forefront of EECS innovation, achievement, and service to society.

Before we begin, the authors would like to reiterate that the general observations made regarding female students should in no way supercede the fact that each student has individual personality and needs that respond to the social and academic environment in unique ways. However, case-by-case analysis or individually tailored solutions are virtually impossible at a university as large and as diverse as Berkeley. Thus, the discussion and suggestions below, as generalized as they are, provide a useful vantage point.

We should also emphasize that the suggested shortcomings in EECS, both in general and specific to UC Berkeley, should in no way be interpreted as "somebody's fault," or some failures in the organization, design, or instruction of EECS programs. Rather, as we will show, these shortcomings are the result of previously unnoticed and little studied differences, subtle and unintentional, impossible to detect incident by incident, differences that nevertheless cumulate over the decades into gaping imbalances. Of course, we reject the notion that female students lack the attributes necessary to succeed in EECS and make a solid contribution. We also reject the claim that persisting imbalances are a conscious and almost territorial effort by men to preserve EECS as an all-male domain. Such viewpoints find counter arguments in law, public opinion, and reality.

2 Gender Statistics:

We begin by examining the gender ratio at UC Berkeley EECS, and at the EECS departments of two comparable universities — MIT and Stanford. We chose these two schools because their EECS departments, along with UC Berkeley's, are generally considered to be the top three in the nation, if not in the world. Also, the size of MIT and Stanford's EECS departments are comparable to UC Berkeley's.

Data for UC Berkeley is from the UCB Office of Student Research; data for MIT is from the MIT Office of the Registrar; data for Stanford is from the Stanford University Registrar.

2.1 Availability of Data

One could argue that easily accessible and thorough data indicates that a school is serious about student survey and research. Using this standard, we were pleased to find that of the three schools, data for UC Berkeley is most thorough and easily accessible. Statistics dating back to 1983 are publicly accessible, although we only use data starting from 1993[4]. Data for MIT is also publicly accessible, though the data is not as thorough and dates back only to 1998[5]. Online data

4. [UCB 2005]
5. [MIT 2005]

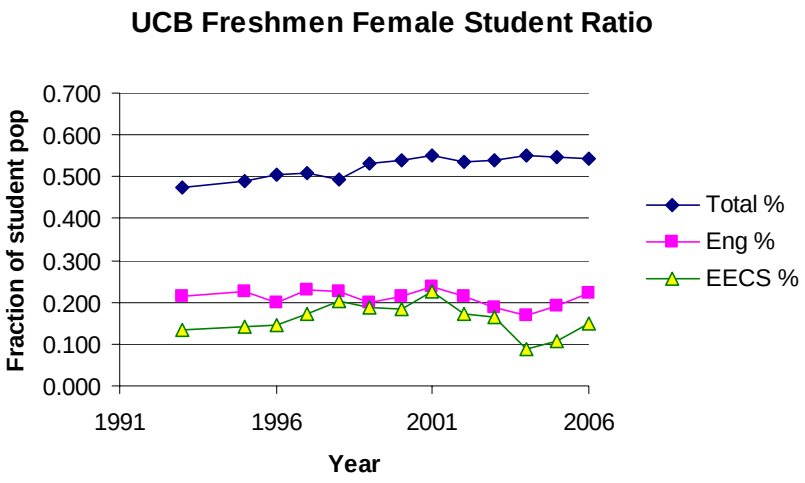
for Stanford has access restricted to Stanford students only[6]. However we were able to directly contact the Stanford University Registrar and obtain paper copy data starting from 1995.

UCB and MIT have data that are broken down for each year level, but Stanford data is available only as aggregate for all four undergraduate year levels. We made a tradeoff in data compatibility and chose to examine data for UCB and MIT Freshmen, instead of the undergraduate aggregate. We believe the freshmen year level is the crucial entry point for new students and in particular new women into EECS and data for freshmen would be more informative than the undergraduate aggregate. All else being equal, data for Stanford would show less variation than that for UCB and MIT, since each data point for Stanford would be affected by freshmen population dating back four years. We fully understand that Stanford data would also be affected by other factors such as retention rate, and this was a conscious tradeoff we made to focus on freshmen data when such data is available.

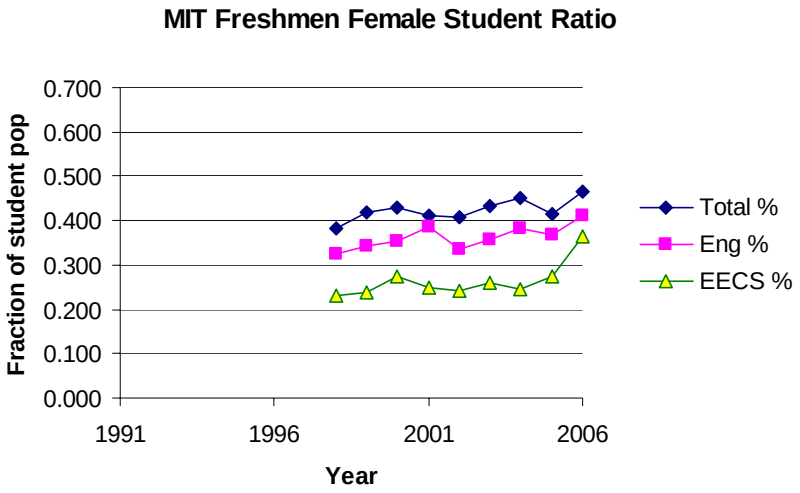
2.2 Gender Ratios within Each School

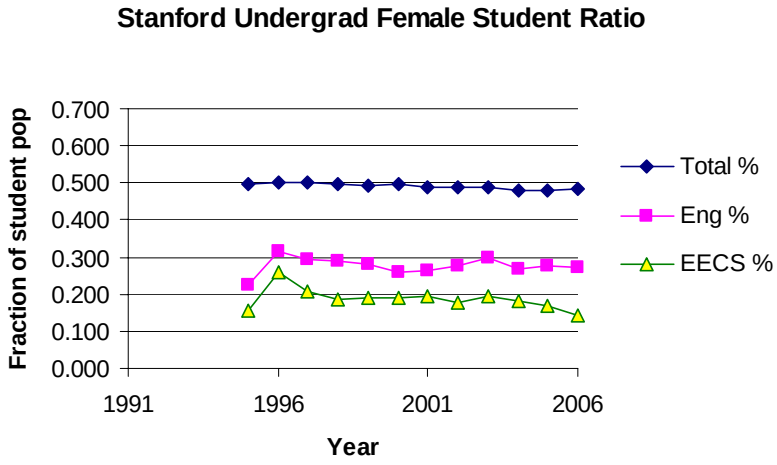
Below are graphs for the percentage of female students in the three schools, broken down as percentage of women in overall student population, in all engineering, and in EECS.

For UC Berkeley, headcounts for "EECS" includes both the EECS major and the Letters and Sciences (L&S) CS major. For MIT, headcounts include all three undergraduate programs under EECS. For Stanford, headcounts include both the EE and CS majors.



6. [Stanford 2005]

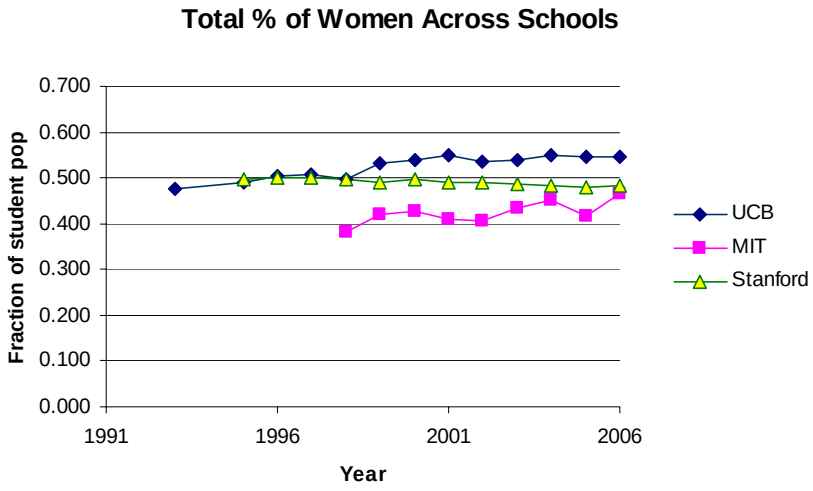




2.3 Gender Ratio across the Schools

Below is the same data presented in a different perspective, with the graphs broken down as percentage of women in overall student population across the schools, percentage of women in all engineering across the schools, and percentage of women in EECS across the schools.

Again, for UC Berkeley, headcounts for "EECS" includes both the EECS major and the L&S CS major. For MIT, headcounts include all three undergraduate programs under EECS. For Stanford, headcounts include both the EE and CS majors.


Total % of Women Across Schools
Fraction of student pop
0.700
0.600
0.500
0.400
0.300
0.200
0.100
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1991
1996
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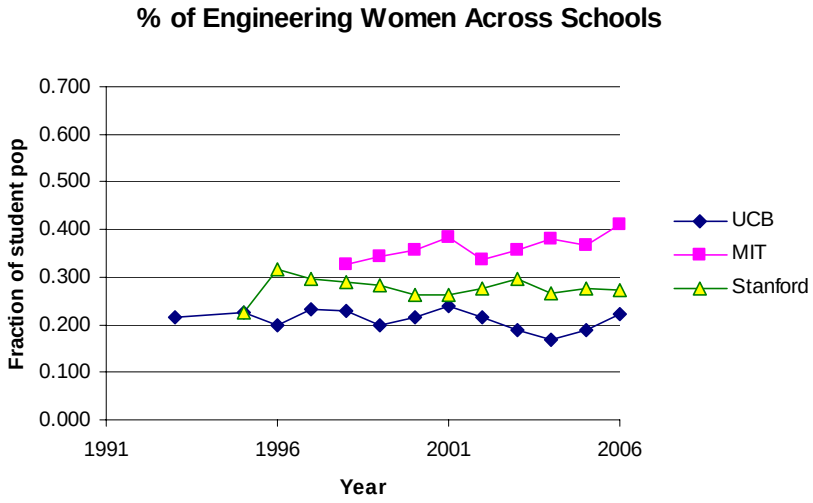
2006
Year
UCB
MIT
Stanford


% of Engineering Women Across Schools
Fraction of student pop
0.700
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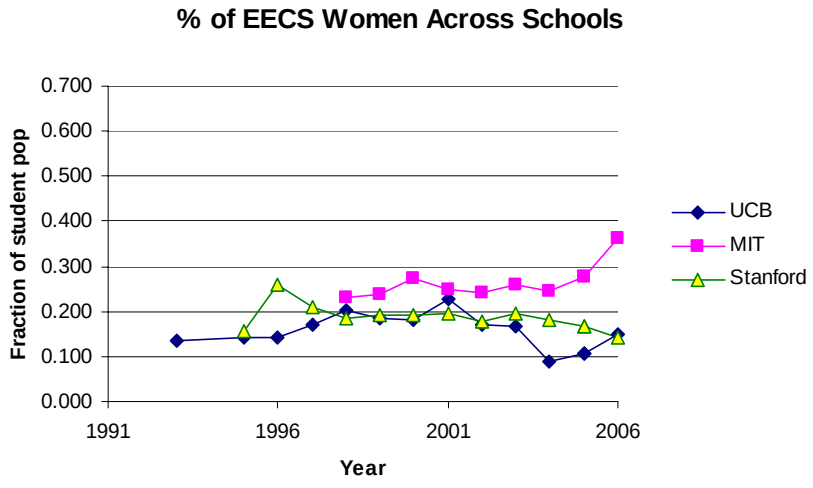
% of EECS Women Across Schools
Fraction of student pop
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
1991
1996
2001
2006
Year
UCB
MIT
Stanford

2.4 Lopsided Ratios

Looking at the first set of three graphs, we can see that for all schools, the percentage of female students in engineering is lower than the percentage of all female students. The percentage of female students in EECS is still lower. For UC Berkeley, there was a gaping difference between the gender ratio for all students, and the ratio for engineering and EECS. We see the same gap in Stanford, but there the difference is not as pronounced. At MIT, a technical school unlike UCB and Stanford, the differences between overall student population, engineering, and EECS are not as large.

Looking at the second set of graphs, we see that in terms of the gender ratio of the overall student population, UC Berkeley leads the way, with over female students making up for around 55% of the student population. Stanford comes next, at around 50%, and MIT is third, at around 45%. The picture is reversed for female student percentage in engineering and EECS. There is perceivable difference between the schools, with MIT leading the way, followed by Stanford, with UC Berkeley last.

We also note that in 2006, the percentage of female EECS students at MIT increased significantly.

Overall, these statistics paint a gloomy picture of gender imbalance in engineering and EECS at all three schools. While the female student ratio is problematic across all three schools and across all engineering disciplines, the picture is especially bleak for EECS at UC Berkeley. Starting from 2004, the percentage of female students in EECS at UC Berkeley has dropped as low as 10%. With ratios of one woman to nine men, it becomes less important to talk about whether the 10% of women do as well as their male colleagues. That ratio, by itself, demands significant and immediate attention. There is much to be done.

3 Gender Differences: Understanding Gender Disparity

To address the lopsided gender gap in EECS, we must understand the different needs of male and female students. We present gender differences in several areas, including communication styles, decision-making processes, learning styles, and other such factors that may impact students' experiences in the EECS academy.

3.1 Communication Differences

Social linguistic studies suggested several gender differences in communication styles. In oral discourse, men tend to seek to establish their social standing, while women tend to instinctively try to create rapport[7]. This difference is cross-cultural and often results in men and women both understanding the same literal meaning from words, but extracting totally different underlying social messages from the conversation.

Numerous works have suggested that this difference translates to other communication forms. In a technology-centered context, the communication difference manifests itself in many

7. [Gefen 2005], [Kilbourne 1997], [Tannen 1995]

ways. For example, men may brandish their technical prowess to underscore their superior knowledge, compared to women who play down their technical skills to emphasize their sociability[8]. In addition, men tend to adopt a blunt and loud style that tends to control the conversation, while women often assume a soft and polite tone[9]. On a more personal note, the authors have both observed and experienced occasional difficulties in explaining technical problems with the opposite gender; these difficulties have also been mentioned in literature[10].

The scenario that epitomizes "men talk" in a technology context would be a one-on-one project status update to a high level corporate executive. Conversation here is marked by pointed and short sentences, using precision question and answers, with the exchange stripped down to its fact-focused minimum[11]. The comparable scenario for "women talk" would be an informal peer group discussion or project brainstorm. Conversation here is usually long and casual, using floating questions and exploratory answers, with no set agenda, and the exchange is filled with tangents, digressions and a wealth of background and context information.

Such communication differences appear almost everywhere — in between students, between instructors and students, both in oral lectures and in office hour conversations, and even in textbooks. Ubiquitous communication differences affect how students absorb the information given. Thus, these often unnoticed communication differences are without doubt a major factor that leads to gendered experiences for male and female EECS students.

3.2 Decision Making Differences

Differences in the decision making process is another major factor. Research has highlighted two areas of contrast.

Studies in web marketing has found that men tend to use heuristics in place of detailed, systematic processing, while women tend to assimilate all available information and base their decisions on a more holistic evaluation. The result is that women tend to be more "catalog shoppers" while men tend to make their decisions after processing only a small amount of information[12]. This finding is somewhat surprising at first, because it undermines the traditional gender view of men as being rational and female being emotional. However, a study specifically in gender and engineering noted that women do indeed favor the holistic approach usually involving heterogeneous tasks, while men preferred a heuristic approach, usually characterized by specialist tasks[13]. Therefore, web shopping is not the only context where we witness the female preference for holistic approaches and the male tendency to heuristics. Rather, with its monetary incentives to drive research, web shopping has been the context in which the holistic vs. heuristics differentiation was most prominently identified.

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8. [Faulkner 2000]. The assumption here is that superior knowledge and sociability are mutually exclusive. We will discuss this stereotypical assumption in more detail later.
9. [Verbick 2002]
10. [Greening 1999]
11. "Precision Questioning" is a style is actually frequently used by corporate executives or upper-middle management in status updates and project reviews. There are presently Precision Questioning training programs at a variety of technology organizations, including Microsoft, HP, Xilinx, Oracle, Stanford Executive Program, and AT&T School of Business [Vervago 2006].
12. [Simon 2001], [Slyke 2002]
13. [Faulkner 2000]

Web marketing research has identified another difference along gender lines. In making decisions, men tend to be risk neutral, while women tend to be more risk adverse. This means that all else being equal, women would choose options that involve less risk, while men is likely to choose any one of the even options, premium for risks included. In the context of web shopping, this difference has translated to more conservative shopping behavior for women and more adventurous shopping behavior for men[14]. It has also led to suggestions for liberal, risk free return policies to accommodate female customers[15]. This time, the differentiation seem to match established gender roles, with males being risk neutral or even risk loving, and females being risk adverse. Nevertheless, we again find correlation to this view outside the web shopping context. A UI (User Interface) study on features for debugging software identifies the same risk adverse behavior for females, with female users significantly less inclined to try out unfamiliar features, with the suggestion being to present "alternate risks" associated with not taking advantage of the unfamiliar features[16].

The decision making differences highlighted here are most prominent in web marketing, but they are by no means limited to it. The differences are rooted in psychology. Here we offered some similar findings in other contexts. Later on, we would find that the psychology of heuristic vs. holistic and risk neutral vs. risk adverse would shed light on many discussions. They affect what students choose to learn in the short term, and what careers students choose to pursue in the long term. Thus, these differences also play a significant role in shaping the different experiences of male and female students in EECS.

3.3 Social and Academic Preferences

A third major factor contributing to different experiences is the different social preferences of male and female students. In the previous section, we have highlighted the heuristic vs. holistic contrast. It turns out that this contrast leads to women viewing technology with a holistic perspective, with technology being intimately connected to social, cultural, and personal dimensions. This view manifests in several ways.

First, women tend to view technology as a social tool[17]. For example, women tend to prefer social games online[18], and they value a social web shopping experience[19]. The authors have also observed from anecdotal feedback that aside from general browsing, web messaging and email seems to be activities in which women spend most of their internet time. In contrast, men often view technology as a recreational tool[20]. This is reflected in a more playful attitude towards technology[21], marked by, for example, frequent participation in competitive online gaming[22].

14. [Simon 2001]
15. [Slyke 2002]. Such policies are usually advertised as some variations of "Keep the purchase only if you are satisfied."
16. [Beckwith 2005]
17. [Verbick 2002]
18. [Verbick 2002]
19. [Slyke 2002]
20. [Greening 1999], [Verbick 2002]
21. [Beyer 2002]
22. [Verbick 2002]. Today, online gaming community does have a perceivable fraction of female members. The author's personal experience in the gaming community has been that female members often express desire to play with friends or as a part of a guild, while male members often express interest to "score high" and "level up".

Second, women place great value on the social relevance of their studies. This is characterized by preference for studies with visible relations to real life, as well as curriculum that emphasize the application of theory by bringing practical, hands on problems into the classroom[23]. In contrast, such preference for the social dimension is not as pronounced in men. Technology-purist attitudes such as "technology for technology's sake" or "technology over money or politics or culture" are more often associated with men[24].

Third, women prefer socialized learning. Women tend to favor working in groups, with projects involving heavy human interaction and collaboration[25]. Women join such groups to offer and receive support[26], with the motivator being acceptance by and identification with the group[27]. In contrast, men tend to favor working individually. Such work often contains elements of competition or challenge, with the motivator being individual achievement or triumph over others[28]. Interestingly, competition and challenge tend to be viewed negatively by women[29]. The female tendency towards rapport and the male inclination towards competition mirror the gender communication differences presented earlier.

Later, when we assess the current status of the EECS academy, we would see that many of these social-academic differences drive women away from EECS.

4 Gendered Environment: The Masculine Technology-Culture

In the previous section, we noted numerous gender differences. Here, we explore the broad social-cultural context in relation to gender and technology. Various studies have identified that cultural barriers and peer pressure are key factors turning women away from EECS[30]. In the following, we will describe the pervasive association of masculinity and technology in mainstream culture.

4.1 Stereotypes — Geeky and Unfeminine

In popular culture, marked by films, advertising, and mainstream media, there are two main stereotypes associated with gender and technology. The first is associated with men in technology, and is known as the "geek" or "nerd". The computer nerd is often eager to parade his technical prowess, antisocial to the point of giving up his social life for technical devotion, even if he does not have to, and sometimes he finds technology to be a refuge from unsatisfying

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Another often observed gender phenomenon has been male members often disguise as female players so that other male players would give preferential treatment or "be nice" to the "female" players.

23. [Farrell 2002], [Mbarika 2002], [Verbick 2002]
24. [Faulkner 2000]
25. [Bailyn 2003], [Chesler 2002]
26. [Gefen 2005]
27. [Chesler 2002]
28. [Chesler 2002]
29. [Verbick 2002], [Zywno 1999]
30. [Beyer 2003], [Heller 1994], [Trauth 2004], [Verbick 2002], [Zywno 1999]

emotional relationships[31]. Women often find the nerd stereotype to be distasteful and in opposition to preferred female gender identities.

The second stereotype is associated with women in technology. She is viewed as unfeminine, unnatural, sacrificing sociability, "too busy being smart to be attractive", and violating traditional care-taking roles[32]. Again, the unfeminine stereotype opposes preferred female gender identities and decreases social attractiveness for the "unfeminine" IT woman.

The stereotypes here are often reinforced in a variety of commercially driven contexts. For example, many marketing strategies target established gender sentiments with regard to technology[33]. This is not surprising, given that gender is easily identifiable, gender segments are accessible, and gender segments are large enough and thus profitable enough to warrant targeted profit strategies[34]. In addition, many popular films also present the gender-technology stereotypes[35]. Granted, these films often try to portray the stereotypes in a positive light. However the very presence of these stereotypes in films would reinforce the perception that technology is masculine or unfeminine.

These gender stereotypes are well entrenched, and are unlikely to change quickly, even in the face of data showing the opposite[36]. The two stereotypes create an IT identity that is completely masculine. This identity suggests that technical devotion and social life are opposites, as are feminine technical knowledge and feminine social attractiveness. The reality, however, is that these dualisms do not have to be mutually exclusive. Work in EECS certainly does not preclude a person from being sociable.

4.2 Popular Perception — No Role Models and No Information

There are two additional barriers to women participation in EECS — lack of female technology role model, and lack of information regarding the technology profession.

The lack of role model manifests in several ways. We have already mentioned stereotypical male-centered technology images in popular media. In addition, the most well known EECS success stories tend to feature males[37], and most of the well known tech companies are associated with a male CEO. Furthermore, the gender imbalance in the entire EECS profession means few women have a chance to see a woman in the EECS profession[38]. Within the university context, studies have repeatedly highlighted the lack of role models resulting from the low visibility of female faculty, female alumni, and even female fellow students[39]. Without such role models, it is hardly surprising that female students shy from EECS.

31. [Beyer 2003], [Faulkner 2000], [Greening1999], [Hazzan 2005]
32. [Farrell 2002], [Faulkner 2000], [Krefting 2003]
33. [Simon 2001], [Slyke 2002]
34. [Simon 2001]
35. Such stereotypes appear in The Matrix, Office Space, Revenge of the Nerds, The Core, and others.
36. [Krefting 2003]. We add that there is very little quantitative data regarding gender-technology stereotypes.
37. e.g. Bill Gates
38. [Verbick 2002] notes that computer equity in the family, i.e. whether computer is shared equally among male and female family members, affects female students' decision to choose EECS.
39. [Chesler 2002], [Hazzan 2005], [Heller 1994], [Muller 1997], [Verbick 2002], [Zywno 1999]

Compounding the problem is the general lack of information about the technology profession[40]. The richness and diversity of the EECS profession is often under presented in media and in popular culture, with the simplistic "computers and silicon" imagery hiding the social and cultural impacts of the tech industry. There have been worrisome incidents where girls' first impressions of electrical engineers are "men in hard hats working on a pole"[41], and there is the misconception of EECS not as a high-end knowledge-based profession, but a low-end "working class" engineering job[42]. Considering the female preference for socially desirable jobs, jobs with social relevance, and the female inclination against risking career success in a profession without visible female role models, it is little surprise that so few women choose to pursue a career in EECS.

5 The Gendered Academy: EECS Programs through the Gender Lens

Notwithstanding the social-cultural conditioning in stereotypes and popular (mis)perception, women may yet choose to pursue EECS, provided that the EECS academy take measures to counter such negative social-cultural conditioning and respond to different gender needs. The abysmal gender ratio suggests that EECS departments at all universities leave much room for improvement in this regard. In this section we discuss several issues that research has widely identified as barriers to a rewarding experience for female university students in EECS. At the same time, we will look at how EECS at UC Berkeley is doing with regard to these issues.

5.1 Academic Rite of Passage

The EECS experience has been described as analogous to a rite of passage, an academic odyssey. This journey is framed as masculine, a solitary rite of passage. Its marking characteristics are competition against other men[43], challenges set by other men and trials to be overcome[44], with the ultimate triumph being the winning of independence and acceptance[45]. The meaning of "merit", derived in these settings, tends to revolve around overcoming theoretical, technical, and intellectual challenges. Likewise, "distinction" tends to imply individual triumph, superiority, going above and beyond fellow students.

These themes, competition, challenge, and individual superiority, are precisely the themes that we identified early as being secondary for female students. In Section 3.3, we outlined that women respond to support better than they respond to challenge. They are motivated by affiliation with others rather than competition. Competition, in fact, is viewed by women in a socially negative light. Combining these concerns with the risk adverse psychology identified in

40. It seems that male students do not suffer from this lack of information. This raises further questions regarding whether there is gender differences with regard to access to or interactions with technology.
41. [Hazzan 2005]
42. [Zywno 1999]
43. [Chesler 2002], [Zywno 1999]
44. [Bailyn 2003], [Chesler 2002]
45. [Chesler 2002]

Section 3.2, we have an unsurprising, observable result — female students fear being disadvantaged in the competition. They do not want to risk low grades, and they have low confidence that they will do well[46]. Low confidence about EECS is repeatedly identified as a key factor turning female students away from EECS, or making female students change majors out of EECS[47]. It seems that female students simply do not need to be heroes on the EECS journey.

With regard to the EECS program at UC Berkeley, the authors can speak from a student perspective, and have general observations from three years' collective anecdotes. The Berkeley EECS curriculum is viewed as fast paced, intense, and intellectually challenging. Professors often assume a "figure it out for homework" approach, leaving students to discover their own paths with few hints and little support. Assessment is largely exam based, a format that demands independence and individual proficiency. Exam results are numerical and comparable, thus leading to natural competition among the students. Grades are curved, and notwithstanding professor assurance of clear cut criteria, students often lament assessment relative to fellow students, and voice fear they risk "losing out to the curve".

The focus on individual achievement is part of another gender criticism of the EECS academy — the lack of a social dimension.

5.2 Lack of Social Dimension

The lack of a social dimension in EECS refers to three problems. First, as already discussed with regard to the "solitary rite of passage", EECS instruction tends to be individually focused, with less emphasis on collaboration and group work. Second, the EECS curriculum tends to take a technology purist approach, with the focus being the technologies and the theories. Consequently, objectivity and pure rationality valued over other "softer areas" such as human-technology interactions, social context, cultural impact, and the like[48]. Third, as discussed in Section 4.2 and as the data in Section 2 shows, EECS programs lack social support, female role models, and a critical mass of female students.

These three problem areas match three deterrents we identified earlier and make EECS especially unappealing to female students. First, we discussed in Section 3.3 female students' preference for group work and collaboration. Second, we also presented in Section 3.3 that female students greatly value the social relevance of their studies. Hence the technology purist approach becomes a well identified deterrent for female students[49]. Third, lack of social support, female role models, and a critical mass of female students all prevent the development of a female community in EECS, contributing to the feeling of isolation, which is yet another barrier faced by female students[50].

We are happy to say that EECS at UC Berkeley is not completely negative in addressing these issues. We do have plenty of opportunities for group projects, professors do occasionally mention issues other than technology, and we have female student groups such as SWE (Society

46. [Brainard 1998], [Zywno 1999]
47. [Beyer 2003], [Brainard 1998], [Chesler 2002], [Verbick 2002]
48. [Faulkner 2000]
49. [Brainard 1998], [Farrell 2002], [Heller 1994]. To emphasis this point, we can compare EECS and the pre-medical school majors. Both areas are challenging and competitive, however the gender ratio in "pre-med" majors is largely balanced. It has been suggested that the immediate relevance of biomedical studies may be the sole factor responsible for its vastly more favorable reception among female students.
50. [Brainard 1998], [Zywno 1999]

of Women Engineers) and WiSE (Woman in Science and Engineering), as well as support channels such as the Big Sister – Small Sister program. However, there is still much room for improvement.

In their current state, group projects are often either artificially formulated projects, or game projects. These projects are a mismatch to female preference for socially relevant studies and their view of technology as social and not recreational tools (Section 3.3). In addition, the abysmal gender ratio in UC Berkeley EECS means that even in group projects, female students often find themselves to be the lone woman, facing multiple male students who often dominate discussion and dictate project direction (Section 3.1[51]).

With regard to social, cultural, and economic impacts of technology, we can say from a student's perspective that professors who do introduce such issues often generate lively discussion. But despite these occasional discussions, the technology purist approach seems very much the norm, and often social, cultural, economic considerations feel like sidetracks to the main curricular, even when such considerations are increasingly key to tradeoffs in technology implementation and development.

With regard to female student groups, SWE and others seem to be doing a good job, and judging from the student groups' websites, these groups do create opportunities for female students to get together, share experiences and network. However, without a more balanced gender ratio, it is not often that female students find enough familiar faces in classes to form all-girl project groups, or mixed groups containing more than one girl[52]. Moreover, the work of SWE and similar groups could receive additional support from more visible role models in faculty and in alumni.

5.3 Above and Beyond the Masculine EECS Academy

Overall, male EECS students seem to respond very well to the technical purist and the "rite of passage" environment. UC Berkeley's overwhelmingly male EECS program is held in high esteem in both academia and industry, perhaps a testimony to how well our EECS program taps into male learning motivators. We have consistently ranked amongst the very best EECS programs in the world, a competitive fact that we are not unhappy to note. However, one wonders how much UC Berkeley's already distinguished program can still improve — a more balanced gender ratio, and a broader approach that looks at technology not by itself, but in relation to society, culture, and economics. With technology pervading almost every aspect of our lives, technology leaders of the future would be those who are able to utilize social and cultural awareness in innovations. With UC Berkeley's top notch programs in economics, psychology, social science, law, cultural discourse and others, UC Berkeley offers an unmatched

51. The authors have found that female students in a male-dominated discussion have quite relevant and insightful contributions, but quite often, female students tend to stay quiet in male dominated discussions, and their opinions have to be solicited usually in one-on-one contexts, away from a male-dominated environment. [Bailyn 2003] further notes that the lone women among a group of men is especially ill at ease, whereas two women in a male dominated group is sufficient to improve the women's confidence significantly.

52. We must caution, however, that there is risk associated with having all-girl groups. Having girls work with each other all the time, or being encouraged to work together all the time, may create something similar to a de facto gender segregation, which would inevitably reinforce existing gender stereotypes and misconceptions. In contrast, gender stereotypes could be slowly removed, and cross-gender confidence slowly established, if we have mixed groups with sufficient women to turn male-dominance into male majority or even gender parity.

combination of world-class engineering and world-class humanities on the same campus. Consequently, EECS at UC Berkeley stands in a unique position and holds a unique opportunity to cultivate the next generation of technology leaders, both male and female.

6 Gendered Technologies: Gender Balance Achieves more than just Equity

So far, we have outlined current gender enrollment data, looked at gender differences, the negative stereotypes in society, and the gendered academy. Our premise all along has been that gender balance in EECS brings equity, and it is a worthy goal in itself. In this section, we build on this premise. We will show that the equity resulting from gender balance is but a starting point. Equity, in turn, will lead to better technology, because technology itself is far from gender neutral.

6.1 Gender Undercurrents in Technology

Given the present lopsided gender ratio in EECS, it needs no argument that the vast majority of existing technologies is created by men. One wonders then, whether the masculine cultural values of the technology creators are subconsciously or unintentionally inherent in the technologies. Studies have identified individuality, independence, and efficiency as assumed values in technologies[53]. These are the same values that we identified earlier as “masculine”. Gender-technology considerations are receiving more and more attention, and there is an increasingly vocal challenge to the assumption that technology is gender neutral. Driving this challenge are findings in two areas – marketing and user interactions.

Marketing studies has already supplied us with insights into value system differences along gender lines (Section 3.3). To recap, a key contrast we identified is recreation versus socialization, i.e. technologies that are more fun versus technologies that let people connect. Another contrast is functionality versus utility, i.e. technologies that are “cool” by themselves versus technologies that solve real life problems. The males are attracted by recreation and “coolness”, while the females are drawn towards socialization and utility. “Masculine technologies” and “feminine technologies” would be differentiated along the same lines. Thus, a successful technology combines both recreation and socialization, simultaneously carrying a sense of intrinsic coolness while solving real life problems. This conclusion is already known. What is new from the gendered technology perspective is that a technology that leans too much on either side of the masculine-feminine spectrum could unintentionally isolate half the users.

User experience, next to value systems, is another channel through which technology is gendered. Earlier in Section 3.1 we have identified communication differences between men and women, with men-talk to establish status, and women-talk to nurture empathy and rapport. The different social agendas evident in oral communication, combined with different values that men and women seek to derive from technology, lead to very different user-technology interactions for men and women. We know of several papers that probe different user interactions for men

53. [Simon 2001]

and women. One paper suggested leveraging gender-specific visual orientations for website design[54], another hinted gender issues with regard to interruption tools[55]. A third study noted that women, more than men, are more aware of user-related issues for both male and female users[56]. These observations point out two things — user experiences vary depending on gender, and gender dynamics in real life are carried into the realm of technology. Consequently, technology is far from gender neutral.

With technology extending to every facet of our lives, key factors determining a technology's success would be the quality of user-technology interactions and the values users derive from the technology. Continued, severe gender imbalance in EECS would create a pool of technology creators that lack first hand appreciation of the values and experiences of half the users. This, perhaps more than the lack of equity, represents an enormous danger.

6.2 Tapping an Undervalued Consumer Segment — Tremendous Opportunities from Gender Awareness

The present lack of gender balance in EECS offers not only enormous dangers, but also enormous opportunities. Present gender imbalance and lack of gender awareness means that various benefits resulting from gender awareness are largely untapped. This in turn implies that the first group of technology leaders to gain gender awareness through a gender balanced environment would also be the first to take advantage of the awaiting benefits. Consequently, these technology leaders would have a huge edge over their competitors.

To give a concrete illustration of what insights gender awareness can bring, let us consider an opportunity in the current PC and console gaming industry. Recent projections from PricewaterhouseCoopers suggest that the gaming industry revenue would grow from $25.4 billion in 2004 to $54.6 billion in 2009[57]. This is a doubling of revenues over five years. Key growth areas are emerging markets in newly developed economies and additional penetration in established markets. It seems that all is well in the gaming industry.

However, the rosy present does not prevent even better opportunities for the future. The vast majority of existing PC and console games are based on violence, competition, racking up ever higher scores, and beating others players. From the gender differences we identified in Section 3.3, we see that these games are highly masculine in nature. Any socializing in the context of these games often takes the form of taunting or comparing statistics to see "who is better". These characteristics make PC and console games fit perfectly into the "geek" stereotype, discussed in Section 4.1. Girls are largely deterred by such games, and game industry advertising only reinforces the male orientation.

Consequently, there exists a huge, untapped female consumer base for PC and console games that begs to be nurtured. Research has identified that the few existing female gamers prefer games with a social dimension, involving making up characters and plot lines, and frequent non-competitive interactions with other gamers[58]. The success of The Sims and Sim City suggest that such games are not beyond the imagination, and the authors personally know numerous friends,

54. [Simon 2001]
55. [Beckwith 2005]
56. [Faulkner 2000]
57. [Feldman 2005], quoting PricewaterhouseCoopers, includes revenue from hardware, software, and peripherals.
58. [Verbick 2002]

both female and male, who enjoy these games. The enormous opportunity is that the first platform or game maker to create more games of this genre and push it with appropriate advertising to the market could potentially double the existing consumer base for PC and console games. It is hard to overstate the potential for long term industry growth from creating such games, not to mention the implications for revenues.

Opportunities like this await in all tech industries. Such opportunities are not yet identified because gender balance and awareness are still lacking in most tech industries. Thus, it seems not far fetched that fostering gender awareness from creating gender balance in the EECS academy would translate to nurturing the next generation of technology leaders, who would pursue such opportunities and stimulate all tech industries to a new level.

6.3 Competing to Lose — Stymied Knowledge Production in a Masculine Culture

Gender balance is more than just a business case. Otherwise, the tech industry is already doing fine with a predominantly male workforce. The tech industry is able to pull in advertising, psychology, and behavioral experts, and get second hand analysis on user values and experiences. While these experts can intervene to guide what technologies should be, they have little influence on how technologies are made. They cannot rectify problems associated with methods of knowledge production that are carried over from the hyper-masculine culture of the EECS academy.

A key characteristic of the masculine culture, as we discussed earlier, is intense competition between individuals. Competition has driven innovation in both academia and industry, and accomplished individuals are appropriated rewarded for their achievements. Few would argue competition and individualism are bad per se. By the same token, few realize the potential dangers associated with too much competition and too much individualism.

The cost of over-competition is missed opportunities for cooperation. In abstract, this cost is best illustrated by the Prisoner's Dilemma, a concept from game theory often used in economics, law, environmental policy, and a variety of other contexts. More concretely speaking, in industry, the Prisoner's Dilemma often translates to competing to "kill" the other technology, lavishing unnecessary advertisement costs, without realizing overlaps in technologies, thus diverting resources from creating new value for users and missing out on profit-sharing partnerships. In academia, the over-competition costs may translate to fighting for limited funding, competing for limited talent pool, again without realizing overlaps in technologies, missing out on opportunities for joint projects and breakthroughs in new research topics. Our point is not to say that there is no cross-technology cooperation in industry, or that there are no joint projects in research. What we are saying is that with a less hyper-masculine, less competitive EECS academy, both in culture and in gender ratio, the next generation of EECS leaders would become even more perceptive about opportunities for cooperation and collaboration.

The lack of collaboration highlights the cost of too much individualism. It needs little arguing that technology is becoming more pervasive and more diverse, and that technology products are becoming more sophisticated and complex. These trends all suggest that technology workers of the future would work predominantly in groups and rarely in isolation. Also, they would frequently be compelled to look at several technologies in concert and rarely deal with

just one technology. This environment lends itself to the social learning style and the holistic approach especially favored by female students (Section 3.3 and Section 3.1). With so few women coming out of the EECS academy, and with such a focus on individual achievement in the EECS academy, one wonders whether knowledge production in the future would be slowed or even stymied by the present hyper-masculine, individualistic culture.

Competition and individualism would always be around, because they are the basis of the economic free marketplace. We certainly do not argue for "feminizing" EECS. What we do firmly believe is that within the technology drive towards pervasiveness, diversity, sophistication, and complexity, the process of knowledge production itself would be a key benefactor from gender balance in EECS.

7 Interventions: Attracting Female High School Students

Previously, we have examined the status of gender imbalance in EECS, laid the ground work for understanding the problem, analyzed the problem both in the wider society and in the EECS academy, and outlined the benefits of rectify the problem. Now we are in the position to suggest interventions to correct the problem. Interventions, we believe, begins in high school.

7.1 Why Begin in High School?

There are several reasons to begin our interventions in high school. First and foremost, interventions in high school represent an active strategy to attract more female talent into EECS. Increasing the gender ratio through attracting new female talent certainly seems easier than convincing established female talent in areas other than EECS to change career paths to EECS.

Second, universities have influence in high schools. Most high school students have universities "on their radar". Thus universities' voice would be relevant to students, and any messages the universities project would likely find resonance and reception among students. In addition, high school counselors have incentives in a high admission rate of their students into top universities. Thus any messages from top universities such as UC Berkeley would likely have the support and cooperation of high school counselors.

Third, social attitudes about various careers are formed as early as Grades 9-10 or even junior high[59]. Thus any interventions should occur as these social attitudes form, and any course correction on misconceptions due to stereotypes should take place before social attitudes become ingrained in Grades 11-12 in high school. Interventions should certainly begin before students select majors and enter college, where career attitudes are less fluid.

Fourth, interventions earlier than high school are less effective. Students before high school are likely to be more concerned with high school and less with universities. Thus message from universities would have less resonance and less reception. Conversely, universities require more resources to discover the needs and motivations of younger students, not to mention much more effort to reach and engage the younger students.

59. [Heller 1994]

Overall, high school represents the right time for universities to engage and influence gender attitudes towards EECS.

7.2 Deterrents from a Career in EECS

Research has identified a variety of factors driving female high school students away from EECS. Most of these factors we have already discussed earlier.

Our interventions need to counteract possible negative experience in high school EECS courses, as well as the resulting disinterest and lack of confidence with regard to EECS[60]. In addition, we need to undo damage stemming from sexism of male peers or pressure from female peers[61], as well as rebuff negative stereotyping of EECS (Section 4.1). Furthermore, we need to repel negative social and public misconception of the EECS profession, at the same time provide career information regarding EECS and establish female role models in EECS (Section 4.2).

7.3 One-Day "Discover EECS" Program

The centerpiece of our suggestions is a one-day "Discover EECS" program, ideally run at selected local high schools that form large fractions of the university recruitment base. For UC Berkeley, this would be Lynbrook High School, Monta Vista High School, and other comparably reputed schools in the San Francisco Bay Area. For additional reach, Troy High School and equivalents in Southern California also represent good sites for such a program.

We choose a one-day program at high schools for four reasons. First, similar programs have found that student perceptions of EECS can change in a very short time[62]. Second, the very presence of a program can change students from "No" to "Undecided" with regard to EECS[63]. Third, a one-day program is economically less demanding and logistically more feasible than longer programs. Fourth, taking the program to high schools would certainly draw greater participation from high school students[64].

Such a one-day program should not be conducted as an aggressive recruitment event, but more as an information and "Discover EECS" event. In a large part, this is to cater to the mild over blunt communication style preferred by female students (Section 3.1). UC Berkeley EECS still would derive significant direct recruitment benefits, just by mere identification with the program. There is always the possibility that female students influenced to pursue EECS would choose to attend other universities. Even then, our program would be fulfilling the Department and the University's missions of professional and public service, thus enhancing the public image of the Department and the University.

The "Discover EECS" theme should respond directly to the deterrents outlined in Section 7.2. There should be speeches by female professors, students, and alumni. They will serve as

60. [Heller 1994], [Verbick 2002], [Zywno 1999]
61. [Heller 1994], [Zywno 1999]
62. [Zywno 1999] describes a week long summer camp, [Hazzan 2005] details a day-long program.
63. [Hazzan 2005]
64. Having programs located at the university would force the participating students to devote time and resources. This would draw only local students with strong interest in EECS. We are trying to attract students who may not have existing interest in EECS. Hence we suggest bringing the programs to high schools.

visible and tangible female role models in EECS. Program content should showcase the social relevance and social influence of EECS, at the same time emphasizing the teamwork aspect of a career in EECS. In addition, presenters should not portray EECS as cut-throat competitive or overwhelmingly challenging, and should highlight the existing support structure for students in EECS. Furthermore, there should be opportunities for close up interactions between presenters and students, with personal bonds and potential networking contacts the intended result. Lastly, there should be pointers to additional information about EECS and in particular EECS at UC Berkeley[65].

The authors leave open the question whether such a program should only involve female students or be open to a mixed audience. The authors feel strongly that an all female audience should be preferred, because the negative social dynamics against females in EECS may also be present in a mixed audience. For example, the program may have one or two girls sitting in a room full of boys, no doubt an awkward situation for the girls. Thus an all-female audience would create a comfort-zone in which a favorable impression of EECS is more easily established. Nevertheless, there are equally strong arguments for involving a mixed audience. Male students would certainly benefit from the same content, the same perspectives of EECS. Also, a mixed audience can directly and immediately counteract any subconscious sexism or stereotyping against female students in EECS. The theme "Discover EECS" itself is deliberately worded to be gender neutral and flexible enough to fit to both all-female or mixed audiences.

7.4 Recruitment Literature

Our efforts in the one-day program should be complimented by improvements in recruitment literature such as brochures or websites.

Recruitment literature should paint a diverse picture of academic and social life of EECS students at UC Berkeley. Our university and departmental rankings, however impressive, should not be the only focus. This is to cater to the holistic decision making process of female students and a response to their social needs (Section 3.2 and Section 3.3). We suggest that rankings should still make an appearance, to retain appeal to competitive instincts of male students, who would likely use rankings as heuristic assessment of a university (Section 3.2).

Brochures and websites could also take advantage of the tremendous amount of commercially driven expertise in gender specific graphics design, website design, and user interaction design. There could be websites customized for female students, with targeted content and layout specifically designed to take advantage of female visual orientations, female communication styles, and the like. At the very least, if such dedicated websites are not possible, share websites could incorporate these considerations.

In addition, the "she" pronoun should be universally used in recruitment literature targeting female students. The "she" pronoun is a subtle but immensely powerful action point to implant the image of female participation, engagement, and role models in EECS. The authors have

65. Such pointers could direct students either to more direct recruitment material, or to more generic EECS career websites. [Verbick 2002] suggests Role Model Project for Girls (www.womenswork.org/girls/compsci/), Advancing Women (www.advancingwomen.com), and Women in Technology International (www.witi.com).

personal experience with textbook in which the “she” pronoun is universally used. The effect “she” has on the professional image created by the text is quite surprising and memorable[66].

These improvements in recruitment literature offer a major side benefit. Female students already in EECS can be invited to participate or to at least give feedback. This in turn, will create for the female EECS students a sense of involvement, visibility, and institutional support.

8 Interventions: Improving the Female EECS Experience

Improving the experience of female students already in EECS is the cornerstone of improving gender ratio in EECS. Attracting female high school students focuses on bringing in new female talent to EECS; in comparison, this section would be focused on retaining female talent already in EECS. After all, there would be no improvement in the gender ratio if all the incoming female students decide to change majors out of EECS soon after they enter college.

8.1 Barriers to Success in EECS

The barriers facing female undergraduate EECS students are very similar to the deterrents preventing high school students from selecting a career in EECS. Research has cited lack of confidence, feeling of isolation, loss of interest, and low grades as the most common factors[67]. Some of these factors we have already discussed in depth earlier (Section 5). In addition, lack of role models and stereotyping remain problems (Section 4). We have also identified as barriers competition (low grades), lack of social support, and technology-purist curriculum (Section 5).

8.2 Institutional and Instructional Support

Many of the barriers can be overcome with action from the EECS departmental structure. We outline several possible improvements for UC Berkeley.

First, EECS instruction can do more to present social context and social impact of technologies. This is not to say present courses are totally lacking in a social dimension. We are certainly not advocating for a drastic curriculum change. We are merely suggesting that social, cultural, economic, and user related considerations can take on a more prominent role in course content, instead of being tangents and digressions. Such a change would boost interest by catering to female students’ preference for studying socially relevant material (Section 3.3), at the same time benefiting male and female students alike by translating technology from the theoretical vacuum into real life scenarios.

Second, group design projects in EECS can be improved. Present projects often involve designing competitive games (this is often the case in CS61A or CS61B) or bland, “design for the purpose of the course” projects that seem to have little immediate user impact. In the

66. This textbook is “Law and Economics”, the text for Legal Studies 145 and 147, of the same title, by Professor Robert Cooter of UC Berkeley’s Boalt School of Law.
67. [Brainard 1998], [Chesler 2002], [Muller 1997].

introductory CS61A-B-C series, there is certainly room for a "Mini Sim City" project, or similar other projects involving character creating and story simulation games. Such projects lend themselves to explorations in Object Oriented Programming, cater to female students' interest for games of this genre (Section 6.2), as well as engaging male students who no doubt would have great fun making up mischievous characters and stories. In upper division classes, design projects can be framed with more explicit, user driven motivations. Again, this caters to female students' preference for socially relevant content, as well as benefiting all students by removing the reliance on students to figure out for themselves how their project relates to real-life scenarios.

Third, female networking and role models can be established by giving female students more "face time" with female faculty, female senior students, and female alumni. This could take place as semi-regular, informal social gatherings for female students, faculty, and alumni. Such gatherings would be opportunities to network, bond, share experiences, exchange tips, and communicate information and opportunities for female students in EECS. Also, willing female alumni may be invited to be correspondence contacts for present female students, and the present female students can be encouraged to email any academic, career, or even personal concerns to their alumni contacts. Such networks would ensure female students would not feel isolated.

Fourth, female faculties can be invited to be mentors for female students. Female students already have a faculty advisor by default, who usually assumes mentoring and advisory responsibilities. Due to the small number of female faculty[68], female students often have a male faculty advisor. Although this setup has the advantage of making male faculty more aware of the experiences of female students, it also carries the drawback of gender gap in communication techniques, value systems, academic experiences, and personal priorities. Thus we advocate a female mentor in addition to the regular faculty advisor, so that mentor and mentee have experiences, communications, and values that are more aligned. This kind of mentor system does not have to be formal. In fact, it can be solely informal drop-in sessions, with frequency and session duration to be determined by the schedules of the mentor and mentee. Also, it may be more persuasive to invite female faculties by presenting the value their time can create for the students, instead of pressuring female faculties to be mentors. In addition, female faculties so involved may prefer to be exempt from their regular faculty advisor duties to focus energy on helping the female students[69].

Fifth, first and second year female students can be invited to undertake apprenticeships/internships in either research or in the industry. Studies have found that such apprenticeships or internships can tremendously boost confidence in EECS[70]. Such program does require thought and resources to create projects meaningful and approachable for lower division students. However the payoff in female students' increased confidence, additional experiences, network contacts, and likelihood of retention in EECS are certainly going to make the effort worthwhile[71].

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68. Gender imbalance in faculty is another facet of the broader gender imbalance problem in EECS. However, as far as the scope of this paper is concerned, gender imbalance in faculty would *not* be our focus.

69. [Chesler 2002] notes that one difficulty faced in establish women-women mentoring is that female faculty often have already overloaded agenda. Exempting female faculty involved in women-women mentoring from their other student advisory duties can help ameliorate this difficulty.

70. [Muller 1997]

71. Dedicated programs for female students are potentially controversial. Therefore such apprenticeships/internships could be open to all students, and female student groups could be encouraged to take a lead role in publicizing such opportunities.

Lastly, we should examine in greater depth how do gender factors play into experimental courses, such as those under UC-WISE[72] (University of California Web-based Instruction for Science and Engineering). UC-WISE courses have a lab based instructional format, very different from the traditional lecture based format. A recent project description handout for UC-WISE[73] noted that there is some evidence the program differentially benefits female students, and leaves as an open question whether this is indeed true and why differential benefits arise. The insights we outlined earlier directly answer this question. From the project description, UC-WISE courses create tremendous opportunities for collaboration and social interaction in lab. The authors have visited these courses and have observed first hand the very collegial and social atmosphere in the labs. Given female students' preference for a social learning style (Section 3.3), it would be entirely unsurprising that female students derive significant benefits from the program. While we do not believe UC-WISE should completely displace the traditional lecture, we are quite confident that UC-WISE courses can potentially play a key part in addressing the gender imbalance at UC Berkeley EECS.

8.3 Creating a Positive Community for Female Students

In addition to institutional support, a positive community for female students is also needed. Again, there are quite a few suggestions for UC Berkeley.

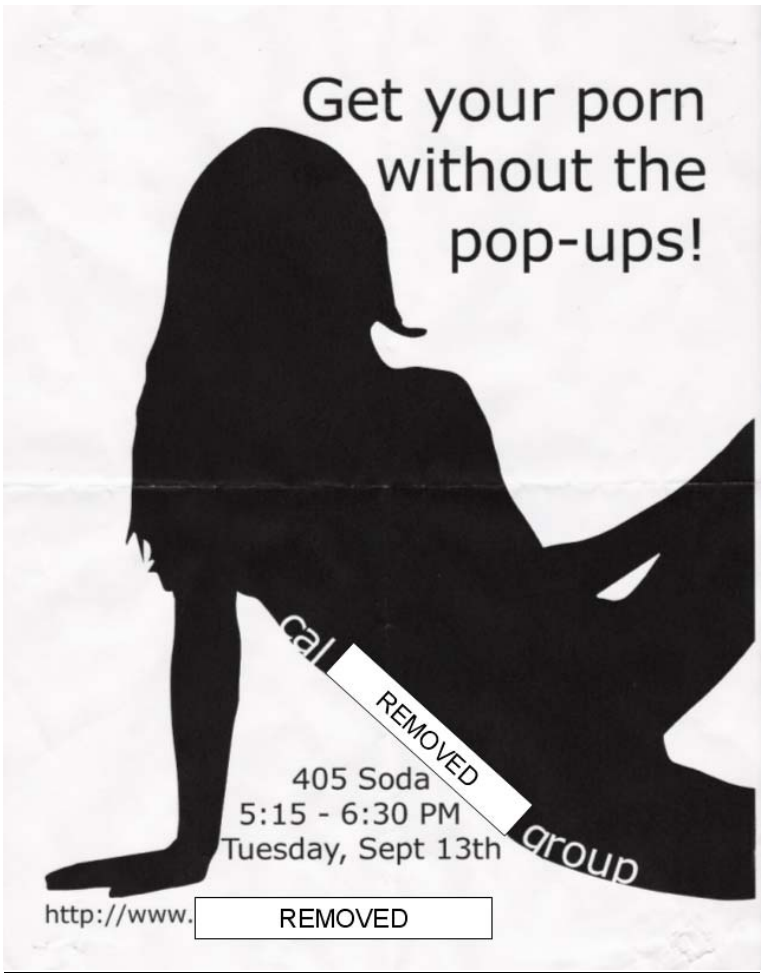
First, we need to ensure a supportive peer environment by addressing unintentional sexism or stereotyping as soon as they come up. UC Berkeley is well known for an open and tolerant student atmosphere, within which deliberate sexism or stereotyping is rare. However, because the male-technology association is so culturally pervasive, unintentional sexism and stereotyping still exist. Such sexism and stereotyping often come up as either poorly phrased jokes, or well intentioned offers of help or support which unwittingly gender-cast the female student as the "helpless maiden" in EECS, and the well-intended male as the knowledgeable "chivalrous knight."

In particular, student advertising flyers like that on the next page should not escape notice and action from the EECS Department. This flyer is an advertisement for a student group in EECS, and was found posted in Soda Hall, Cory Hall, and Evans Hall. It does not carry the approval stamp from the Office of Student Life. The flyer is no doubt made with good humor, but it reaches a large, cross discipline audience[74], and it firmly implants or reinforces existing gender stereotypes about gender discrimination in EECS. The damage done to the EECS community, from even a single flyer, is hard to overstate. The authors suggest that in the future, the EECS Department should fulfill its oversight and advisory responsibilities by sending a stern and firm, but nevertheless forgiving message to any student groups involved.

72. [UCB EECS 2006] is a description of the UC-WISE program.

73. [UCB EECS 2006]

74. The poster itself is a first class advertisement, either by intent or by coincidence. There is a simple, witty, and highlighted catch phrase, accompanied by a provocative sensual image. The location of the student group's name highlights the lower curve of the female body, and the upward pointing breast directs visual attention back to the catch phrase. This flyer is effective enough to stand out, and visible enough to reach students across many majors, and simple enough to do tremendous damage by associating pornography not just the EECS student group, but also all EECS students, the EECS Department, and indeed the entire EECS profession.



An advertisement flyer from an EECS student group at UC Berkeley. The name and website of the group have been deliberately removed.

Given UC Berkeley's overall atmosphere, the authors are certain the student groups involved would be more considerate once they are aware of the issues involved.

Second, we could consider organizing all existing female student groups under a large, Departmental supported umbrella. Presently, there are quite a few female student groups or programs in EECS, including the Big Sister Program, SWE (Society of Women in Engineering), AUWICSEE (Association of Undergrad Woman in CS and EE), WICSE (Woman in Computer Science and Electrical Engineering), as well as the WiSE (Woman in Science and Engineering) residential program. The potential downside to having so many groups is that new female students looking to join a student support group would experience information overload, compounding to any existing sense of being overwhelmed in a competitive, male dominated environment. Organizing all the female student groups under a large umbrella could potentially by-pass information overload by presenting only the umbrella program to new female students, who can then involve within the umbrella as they please. At the same time, having an umbrella group can bring together the faculty sponsors of all the individual student groups, thus creating a

small faculty forum where several faculties can mix with female students, discuss the female students' experiences, and offer their join expertise and advice to the female student groups. Most importantly, having an umbrella group create opportunities for the groups to share resources and coordinate events, not to mention giving female students additional opportunities to network and exchange experiences. With the groups sharing resources, the umbrella group can potentially host events or present programs that are beyond the resources of any one of the individual groups. Thus the impact of the umbrella group could be potentially far greater than the impact of the disparate groups combined.

Third, we could consider expanding the WiSE residential program from Unit 4 to the Southern Units. The program itself it a great idea, and the location in Unit 4 carries the benefit of physical proximity to the EECS Department. However, Unit 4 tends to be the quietest of all the residential units. Thus placing WiSE in Unit 4 may actually compound any feeling of isolation female students may experience. The authors know of two or three anecdotal cases where female students want to participate in WiSE, but prefer the social atmosphere of the Southern Units. Expanding the WiSE to include the Southern Units would immediately by-pass this unnecessary dilemma. Within a much more social atmosphere, any feeling of isolation can be alleviated, and the location of the WiSE program can cater more to the social preferences of female students.

Fourth, we could consider a special orientation for entering female students. This should be in addition to the regular student orientation, to allow the female get welcomed along with the male students, at the same time to receive orientation information catered to female students' needs. At the special orientation, there could be welcome messages from female faculty and female upper division students, in addition to information about support groups, female student organizations, and other support resources available. Such special orientations would immediately expose incoming female students to female role models in EECS, at the same time address any sense of isolation that new female students may feel sitting in an orientation with a room full of male students[75].

Fifth, there should be a focused effort to recruit more female students into leadership programs such as the EECS Honors Program. The breadth requirement of the EECS Honors Program in fact lends itself to the holistic learning and socially-relevant learning preferences of female students. The authors suspect that many eligible female students do not apply because either the lack of confidence that they are indeed eligible, or aversion to the (mis-)perceived competition within the Program. A confidence-booster invitation, combined with thoughtful presentation of the Program should overcome both barriers[76]. Achieving gender balance in leadership programs would boost confidence and establish role models for female students, at the same time creating a leadership effect on the gender attitudes of the entire EECS student population.

Last but not least, there should be a clear and direct communication channel between the EECS Department and the female EECS students. An email distribution list for female students should be established, if such a list does not already exist. The list should have semi-regular announcements from the EECS Department, advertising events and opportunities for female

75. Again, we acknowledge that programs dedicated to female students are likely to be controversial. If such programs divert too much attention away from our goal of improving female student experiences, it may be better to incorporate elements of the suggested program for female students into the regular program open to all students.

76. The authors feel that we should not lower entry standards for women in order to achieve greater female involvement in leadership programs. Doing so may reinforce male sexism that females are somehow "unequal" in EECS.

students, at the same time offering confidence boosters, and demonstrate Departmental attention and engagement with the female students. The list should also offer periodic surveys to solicit organized feedback from female students, as well as offer constant opportunities for female students to voice any immediate concerns and get prompt advice. In addition, care should be taken such that there would be no sense of "special treatment" for female students, otherwise the list may actually amplify any existing sense of "separation" faced by female students.

9 Moving Forward: Away from a Hyper-Masculine EECS Culture

The interventions we suggested involve short programs, re-inventing existing programs, or new initiatives based on established ideas. We have deliberately shied away from long programs, or any radical changes. Our goal is to cast gender imbalance in EECS not as an overwhelming defect requiring radical and expensive overhaul, but as an approachable problem, with immediate mitigations that are economically and logistically feasible, mitigations that can bring visible improvement in a relatively short time.

In the long term, we need sustained institutional support for the female student community, and for the larger goal of improving gender balance in EECS in general. We believe there are two key pieces to a long term approach to address gender imbalance. First, we can take advantage of the tremendous wealth of cross-disciplinary student talent found in the EECS Honors Program to contribute to the emerging body of knowledge on gender-technology issues. This project may potentially expand to include passionate students in other majors, such as gender studies, psychology, economics, sociology, rhetoric, and linguistics. It is hard to overestimate the potential for new ideas, new perspectives, and new opportunities to emerge from such an interdisciplinary project. Given the strength of UC Berkeley EECS and humanities programs in general, and the tradition of student participation at UC Berkeley, we have the critical mass of student talent and passion on campus to make such a project successful.

Second, and more importantly, any long term plan to address the gender imbalance in EECS *must* have the involvement and support of faculty. Faculty involvement may require several simultaneous efforts. There would be faculty members unaware that gender imbalance is problematic, or skeptical that there is room for improvement in present EECS programs, or unconvinced that there is much to gain from correcting gender imbalance[77]. We can win over these faculties by presenting empirical data, research from a wealth of sources, and reasons why gender balance leads to better technology. This paper tries to deliver in these areas. In addition, we can utilize faculties' passion for technology and for teaching by giving faculties opportunities to explore new teaching methods, new merit assessments, and new reward-incentive systems. The motivation, once again, is new and better technologies. Furthermore, we can again take advantage of UC Berkeley's immense strength in the humanities by creating opportunities for EECS faculties and faculties in other departments to interact, exchange ideas, and explore improvements in EECS instruction. Potential departments to be involved in such a forum include

77. Like all responsible professionals, faculties form their opinions cautiously, and tend to resist temptation to follow the latest fads.

education, psychology, sociology, rhetoric, gender studies, and linguistics. Dialogue in such a forum would bring immense benefits reaching far beyond the gender topic.

Our discussions have revolved around several persistent themes. In particular, male and female students have different needs, and the EECS academy is not gender neutral. With the present EECS focus on challenges, competition, and achievement, one wonders if there are victims other than the student gender ratio. Should competition really be placed above curiosity? Does beating others distract from the true goal of learning, namely, beating ourselves? Would the fear of "losing to the competition" prevent students to take the risks necessary for true innovation? Would students, both male and female, look upon the EECS journey with no direction, no hints, no help, and feel apprehensive about the solo journey? Does independence and individualism sap opportunities for synergy and creativity that comes from collaboration learning and mutual support? The truth is that technology itself is far from gender neutral, and creating gender balance leads to better technologies. We emphasize once again that it is not far fetched to equate striving for gender awareness with nurturing the next generation of technology leaders.

The current statistics paint a bleak picture of severe gender imbalance in EECS at UC Berkeley. There are many possibilities for immediate improvements in a short time. In the long term, given UC Berkeley's unique campus encompassing both world-class EECS and world-class humanity programs, and given UC Berkeley's tradition of creativity, innovation, and openness to new ideas and approaches, there are boundless opportunities for UC Berkeley leadership at the gender-technology interface.

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