Re-fashioning the Field: On Gender and Computer Science

by Jessica Nash

Dramatic changes in the field of computer science over the past century have led to a new technological era that has transformed the way societies think, communicate, and navigate through daily life. From humble origins to economic powerhouse, this technology has experienced tremendous growth over the past century. Computers and electronic devices have become increasingly intertwined with modern life and play a defining role in how people self-fashion and interact with one another. At the heart of this cultural shift are the computer programmers and software engineers responsible for developing the technological field to its current status and numerous, dynamic applications. Undoubtedly, the common perception of the expert computer programmer is a geeky, young to middle aged white man with minimal social skills and average attractiveness. Considering the implications of such a narrow, specific sect of people dominating one of the most influential facets of modern business and life, we cannot help but suspect a one-sidedness in the design of the products and technological applications that have become both ubiquitous and indispensable to our culture.

How did this image of the "techno-geek" become so finely ingrained in western culture? Are the stereotypes of computer scientists merely that—stereotypes— or do they actually provide a reliable snapshot of IT professionals as a whole? The answers to these questions may be surprising, especially when considering the underrepresentation of women in computer science (CS). Although it would be incorrect to assume that any stereotype could accurately portray the entirety of the group it refers to, in this case the overall generalizations about the average computer scientist are alarmingly accurate, particularly in regard to gender. In fact, women are among the most grossly underrepresented groups in the computer science field, earning only about 13.8% of all bachelor's degrees in CS in 2010 (Taulbee Survey Report 2011).

Furthermore, of all US college freshman enrolled in STEM degree programs, only 5.7% of participants were women in computer science compared to 27.1% for men in the same CS programs (Parviainen 88). Steadily decreasing rates of female enrollment and retention in undergraduate CS courses and degree programs combined with an overarching inhospitable atmosphere for "atypical" CS scholars has had a direct impact on women's interests in contributing to this influential career (Beyer 153).

In order to understand the full impact of what this underrepresentation means for the technological community, we must analyze a myriad of factors and phenomena, such as historical trends, current statistics and employment trends across different cultures, the effect of stereotypes on public opinion towards women and CS, and the presence (or lack thereof) and potential importance of female support figures and role models. Understanding the contributing factors for the lack of female presence in the field of computer science is an essential first step in reversing this trend and discovering ways to motivate women to pursue meaningful and fulfilling careers in computer science. Not only does this have the potential to benefit women in western cultures where negative educational and employment trends prevail, but it also spells promise for the improvement of computer science as a whole if the field can integrate the unique perspectives of women into the development of new and innovative ideas, programs, and products that may not have been possible without such diversified collaborative efforts.

Interestingly enough, it was not always the case that women played such a minimal role in shaping the technological scripts of history. Women of the past have made rich contributions to the burgeoning field of computer science, shaping it into the discipline it is today. Nineteenth-century mathematician Ada Lovelace pioneered a prototype of the modern computer as early as 1822, long before John Mauchly invented the Electronic Numerical Integrator and Computer

(ENIAC) in 1942, the first true general purpose computer (Gürer 45). Jean Jennings Bartik and a team of six other female scientists were in charge of programming some of the very first lines of code for the ENIAC. Bartik recalls even then men looking down on her job, with the popular male opinion being that programming was not nearly as important as building the physical hardware of the machines (Gürer 46). Shortly thereafter, Bartik teamed up with Grace Murray Hopper, who wrote some of the very first programming languages while working on projects for the US military. She even coined the term "debugging" after removing moths from a malfunctioning computer (Gürer 46). Lovelace, Bartik, and Hopper are only three examples of how technological science owes many of its brightest achievements to women, demonstrating that they not only have the capacity to contribute to computer science, but also to make groundbreaking discoveries. So why have women fled the field?

In what appears to be a reversal of the American gender disparity among CS professions, different cultures from around the globe have had great success in the employment of women in computer science jobs—in fact, they constitute roughly 50% of IT workers in countries like Malaysia, which is more than double the amount of women working in US computer science jobs (Lagesen 5). Interestingly, the inclusion of women in the Malaysian technology market is not simply a result of a greater cultural appreciation of women's skills. Instead, it is in effect a reversal of the masculine stereotype characteristic of Western countries. In an attempt to protect women from harsh and potentially dangerous workplaces, such as factories and construction sites, women are encouraged to take up office jobs such as those in CS due to the safer environment of the office (Lagesen 5). When perceived as a feminine profession, the climate of CS seems to change entirely, although not for particularly liberating reasons. From this, it may be important to consider a second point in the analysis of factors contributing to the current state

of women in CS: cultural expectations of each gender have a significant impact on each individual's interests and desires to work in fields they perceive as compatible with their own identity.

Keeping the above points in mind, it is possible to effectively evaluate the current state of computer science in the United States and identify corrective steps to mitigate the growing gender disparity. As noted, the face of CS before and just after WWII was not necessarily a masculine one. In fact, the United States experienced a steady growth of women in CS along with other STEM related careers until about 1980, when the numbers of women enrolled in CS programs in college dropped off significantly ("Women's Bureau Occupations"). A possible explanation for the loss of the somewhat "delicate" depiction of the ideal programmer was the increased availability of personal computers around 1984 that manufacturers marketed almost exclusively to young boys. The resulting cultural trend seemed to give boys a competitive programing edge even before arriving at college, leading many female students to believe that they were inadequate compared to male peers and that other careers were generally more suitable for them (Varma 181).

In order to quantify the stereotypical conceptions of computer programmers that have become so widespread over the last few decades, Sapna Cheryan and her colleagues at the University of Washington devised a set of studies in 2013 designed to record opinions about computer scientists among students at various West Coast universities. Regardless of sex, undergraduates described computer engineers as antisocial, unattractive, socially inept, devoted singularly to computers, pale, overweight/skinny, and male (Cheryan et al. 62). Not surprisingly, many of these descriptors may appear unappealing to and incompatible with certain female and even male students who may have otherwise taken a great interest in technology-based studies.

Intimidating computer science classroom settings and media portrayals of computer engineering geared towards men appeared to be driving forces behind a general unwillingness of women to pursue a technology related career. The same factors typically did not sway men's opinions on the topic (Cheryan et al. 62). Images of computer engineers prevalent in the media and society conflict with perceived feminine gender roles, resulting in a general sense that a female's mental ability is inferior compared to male counterparts. The end product is a continuous feedback loop wherein both males and females act to perpetuate current stereotypes.

Overall, one of the most influential factors that was shown to influence a student's genuine interest in computer science was actually taking an introductory class on the subject, regardless of whether or not he or she considered majoring in the field before. Data from the surveys concluded that women who had not taken a computer science course in college were much more likely to provide stereotypically-motivated responses to questions about computer science majors than women who had, suggesting that media and peer-driven perceptions of members of technological fields may play a role in promoting female disinterest in computer science if the individual has no actual experience with CS (Cheryan et al. 63).

A second study by the same researchers aimed to evaluate the influence of media on male and female perceptions of technology-related fields (Charyan et al. 62). A random sample of students at the same two colleges received either an article declaring that computer scientists adhered to current stereotypes or an editorial that portrayed a more inclusive view of the computer science field that was moving away from common negative perceptions. The study found that male undergraduate students were less likely to change their opinions of computer scientists after reading the articles, while women were much more interested in computer science as a career option when they read the article that promoted the breakdown of common CS

stereotypes (Cheryan et al. 63). The data suggest that women may be more likely to discard computer science generalizations that appear incompatible with female gender roles if participation in introductory computer science classes were to increase, since women who had taken computer science courses in the past were less likely to rely on stereotypical descriptions of computer scientists when talking about a typical IT employee. Altering the pervasive image of technology professionals in the media is imperative to making the field more appealing, attainable, and rewarding for women.

A promising effort to effectively and permanently reduce the effects of gendered CS stereotypes early in life is ongoing in Norway, where small villages have opted to host children's coding clubs. By providing exposure to technology and coding techniques during childhood, these clubs have not only introduced computer science as a potential career for various children, but have also better prepared them for life in a technology-driven world, regardless of their future profession (Corneliussen 97). By wiping out the gender gap in prior coding experience between college-age students, coding clubs have the potential to reverse some of the long-standing disadvantages women have traditionally had when entering a competitive, male-dominated computer science degree program.

While the number of females in non-CS STEM degrees has generally risen over time, percentages of both women and men in computer science over the last decade have fluctuated sporadically, with high rates of female attrition in CS programs currently defining the field (20% average attrition rate for women compared to 10% for men in the US) (Cohoon 108). Certain schools' CS programs report female retention rates almost equal to that for males, while other institutions have much less success retaining interested women. Among some of the most notable traits of universities with poor female participation in technology-based courses were a lack of

supportive female faculty members and peer groups, limited opportunities for work after graduation, and an under-supported CS department. These factors, in combination with external forces, have contributed to women earning only about 13-18% of bachelor's degrees in computer science each year (Cohoon 112).

This downward trend has not gone unnoticed. In an attempt to attract women to lucrative careers in computer science, many concerned activists and school officials have asked how to make computer science more appealing to feminine tastes and how to change computer science programs to better suit the female mind (Frieze et al. 426). However, these initiatives, which rely heavily on the perceived differences between male and female personality traits, have experienced limited success. Male and female peers report that modification and simplification of department curricula in order to create a "more appealing" environment for girls with less coding experience is not only detrimental to educational standards as a whole, but also linked to reinforcing stereotypes that girls do not "dream in code," and therefore need special assistance to succeed in CS courses (Frieze et al. 427). Similarly, implementing strategies such as two separate gendered CS tracks propagates the idea that men and women are inherently different—with men preferring hard, fast code and women gravitating towards design and the application of computer programs on everyday life (Blum and Frieze 113).

By contrast, the computer science department at Carnegie Mellon University has adopted an approach to mitigating the CS gender imbalance that focuses much less on accounting for the perceived differences between women and men and more on leveling the playing field for all students regardless of gender. In order to revamp the stereotypical image of the CS program at Carnegie Mellon, the school has introduced high school outreach programs for students and teachers that provide coding and application experience before college (Blum and Frieze 115). In

addition to providing the skills necessary to succeed and uphold a sense of self-confidence and accomplishment in challenging CS coursework, outreach programs have the additional benefit of recruiting a diverse range of students who otherwise may not have felt comfortable or even capable in a technology-oriented career. By advertising and exposing real-world tech career opportunities to boys and girls, programs such as these help to inspire a sense of personal belonging and interest among a wide range of high school students regardless of perceived gender roles or personal values.

In addition, the technology department opted not to change the curriculum at the expense of educational standards but instead implemented a series of seminars for incoming freshman that act to provide multiple entry points into CS coursework for interested students of different backgrounds (Blum and Frieze 116). The institution also altered the admissions criteria, paying less attention to prior coding experience and giving more weight to larger predictors of future success in computer science careers, such as "evidence of giving back to the community" or "problem solving" (117). Additionally, the school hosts a professional organization called Women@SCS that focuses on motivating women to continue their studies in computer science and to contribute their tech skills to a variety of causes on campus (118). Such non-targeting strategies at Carnegie Mellon have been very successful, with a significant increase in the participation of women in bachelor's degree CS programs from the national average (13%) to about 40% over the course of ten years (Frieze et al. 425).

In a survey with a subtle, eleven category questionnaire designed to uncover students' underlying gender stereotypes, upperclass scholars in Carnegie Mellon's CS program responded unanimously with answers that transcended traditional stereotypes. Instead of thinking of computer scientists as antisocial nerds or geniuses, students reported that they thought of these

individuals as “intelligent,” “well-rounded,” “and not the traditional geek.” (Blum and Frieze 113). These surveys also revealed that offering a level playing field to students highlights more differences *among* genders than *between* them. Students of both genders reported a wide range of personal interests, beliefs, and tech skills that were not bound by typical gender expectations. Some females were just as competitive in coding classes as males, while males also had great successes in design and application classes (Blum and Frieze 115). Strikingly, both genders thought of the computer more as a tool for tackling problems in everyday life than as a machine that defined their likes and interests. A male student summed up the effort with grace:

> Computing is going to be affecting our whole society and it probably makes a difference on who is giving input into this, but that's just from the societal point. As far as being fair, that should just be dependent on whether they are interested or not. I would hope that it could be that just traditionally the field hasn't attracted women because it hasn't exposed, hasn't properly recruited them, so let's give it a shot. (qtd. in Blum and Frieze 116)

Similarly, other institutions have addressed these issues and developed successful programs that have boosted the participation of women in technical sciences. Instead of drawing on perceived differences between genders, Harvey Mudd College attributes its extremely high retention rates of women in CS programs to a system of skill-level specific introductory courses that place students with peers possessing a similar level of experience (Voosen 12). This strategy aims to mitigate the far-reaching effects of early male-oriented marketing strategies for computers, video games, and other devices that have left many women behind in hands-on experience as early as elementary school. In addition, Harvey Mudd boasts multiple skilled female faculty members and peer support groups for students to promote a comprehensive understanding of course material for women and men at all experience levels (Voosen 12).

Interestingly, studies show that increased female participation is not the only benefit of including female faculty in computer science programs. According to survey results at schools across the US, both men and women were more likely to ask questions in class if the professor was female, perhaps suggesting that students feel more comfortable and competent when exposed to a diversified teaching staff that students can relate to (Cohoon 112).

With women comprising about 57% of the working population in the United States according to the US Department of Labor, these revamped models of study are not perfect, but certainly display a working understanding of how to correct and address the issues that institutions often experience when attempting to diversify programs of technical study by recruiting more women ("Women's Bureau - Data and Statistics"). Not only do these efforts improve the diversity of the field on paper, they also greatly enhance the outflow of ideas and productivity that were previously limited to a small group of people.

This analysis of the current state of computer science suggests some major reasons for the general lack of female interest in the field that we can correct in order to increase female interest in technology. Specifically, providing a network of supportive male and female faculty members as well as creating a hospitable environment for students of different experience levels are strategies that can have lasting impacts on the retention of women in CS programs. By altering the current antisocial and masculine stereotypes associated with technology, it may also be possible to invoke interest among a wider range of students by promoting and accepting a more inclusive public image of the computer scientist. In the end, the gender gap present among computer science professionals is largely the result of a self-perpetuated belief that the field belongs to a very select range of people who have an innate, masculine and calculating talent. The main aim of CS programs throughout the country should be to wear down the barriers that

have prevented many gifted individuals from contributing their talents simply because they believe they do not possess a certain set of traits and skills that are seemingly trademarks of a majority of those who succeed in the field. Computer science has and will continue to suffer from this illusion as long as western cultural standards continue to divert unique and individualistic approaches to age-old problems to other career paths.

Although we often overlook them, culturally perpetuated stereotypes of what it means to be a computer scientist have played a dynamic role in the shaping of the field, not only in the US but also abroad (and with dramatically different outcomes). Instead of focusing on shifting the stereotype of CS itself to the opposite end of the spectrum, it may be even more useful to recognize the innate talents and skills of a diversified group of men and women working together to produce a holistic view of technology. By addressing the concerns that have prevented women in Western culture from taking on careers in computer science, the realm of technological development has the potential to benefit greatly from a well-rounded and well-trained workforce that reflects the thoughts and concerns of a wider audience than previously possible.

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