



ANITA BORG INSTITUTE  
FOR WOMEN AND TECHNOLOGY

## **Barriers to the advancement of technical women**

### **A review of the literature**

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This report is a state of the research and literature on technical women, the barriers they encounter in their careers, as well as current research on effective practices to hire and retain them. The literature presented here is drawn from social science research on gender and organizations. Where appropriate, the literature is enhanced with quotes from unstructured interviews conducted with women at various stages of their technical careers.

#### **Why focus on technical women?**

Several studies of gender and organizations examine the lack of female representation at the top of career ladders. Indeed, the number of technical women at the top of corporate ladders is low by all estimates. Most studies put the number of women in senior management positions in IT around 3% to 5% [1-4], and contrary to popular belief, the numbers of women in IT have not been growing over time. To the contrary, the proportion of women in technology positions in industry in the US has declined from 41 percent in 1996 to 32 percent in 2004 (Information Technology Association of America, 2005).

Studies of technical careers in various industries (engineering, IT, chemistry, telecommunications) and at various points in time and have identified 4 archetypical career stages from apprentice to executive [5-7]. These stages are corroborated by other studies that describe R&D organizations as typically consisting of a dual-ladder career structure (technical vs managerial) with 4-5 steps [8-11]. Younger and Sandholtz find that the proportion of women in technical careers drops significantly at stages 3 and 4 (See Figure 1).

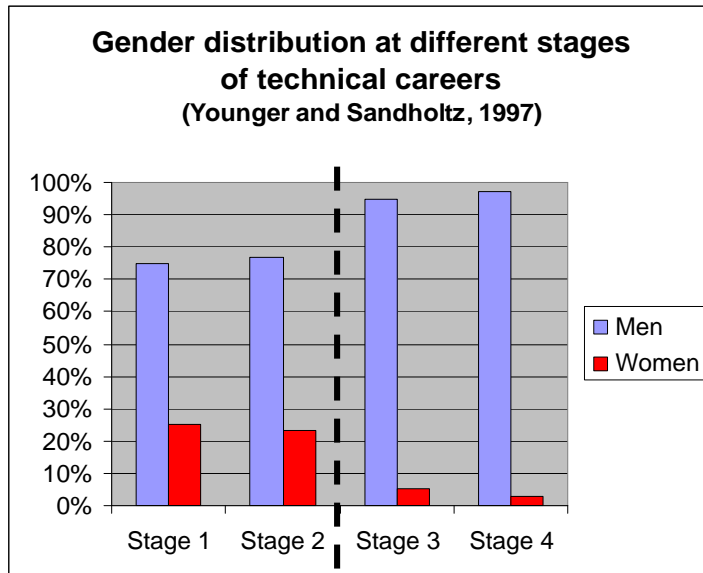


Figure 1: Gender distribution of technical careers

## Why should industry care?

### Growing demand for skilled labor

Despite popular beliefs about the impact of offshoring on technology jobs, numbers show that the demand for high-level information technology jobs (such as software engineers) has increased since 2000 [12, 13] and that offshoring has not slowed job growth in developed countries [14]. The cost of filling the vacancy of a skilled technical employee has been estimated to be as high as 120% of the yearly salary attached to that position [15].

A recent business article suggests that companies are looking for IT workers with more experience and a broader set of skills such as leadership and interpersonal communication skills, and that the competition for these employees, combined with the drop of computer science graduates and the impending retirement of the baby-boomer generation, has led to fierce recruiting competition among firms; nearly 300 IT executives surveyed identified identifying, hiring, and retaining skilled IT workers as their top concern in 2006 [16]. Retention of skilled technical professionals was also cited as a key challenge for 45% of high-tech firms and 50% of around 900 IT leaders surveyed. In Asia, the retention concern jumps to 63% of those surveyed [17]. In the same survey, 22% of leaders of technical employees said they felt ineffective at coaching and developing the technical employees reporting to them.

Furthermore, companies agree that they need more technical leaders with varied skills such as “soft skills” and business skills. 93% of technical leaders in a survey identified the building of collaborative networks in the organization as a crucial component of leadership [17]. Qualitative research suggests that many women in technology find the combination of

technical and non-technical work appealing [18], making them potentially well suited to meet the new competitive demands of technical work.

As companies need experienced IT professionals, they cannot afford to lose the crucial talent they have already invested in and who are facing barriers to advancement along the technical track. Information and expectations received while on the job influences the decision of switching to the managerial path or leaving the field (Bidell and Roberts, 1994). Company practices may help retain strong technical women in the technical path.

### Diversity, Performance, and Innovation

Much attention has been given recently to research linking the presence of women in higher management and financial performance of the organization, as measured to total return to shareholders and return on equity [19]. This research was replicated in the Netherlands and found a similar result for total return to shareholders [20]. What explains this correlation? Little research has explored this relationship but several mechanisms have been suggested. The most pervasive explanation is that group diversity leads to better decision outcomes, a process known as “creative abrasion” [21].

#### Group diversity, performance, and innovation

Social scientists have long posited that groups that are too homogeneous were likely to suffer from “group think” and make worst decisions than more diverse groups. Groups that are too cohesive tend to ignore all possible alternatives and information, and fail to critically question their assumptions, and are prompt to discredit and ignore minority opinions [22]. A famous psychology experiment involved asking team members to evaluate the length of a line. When a group (acting as informants) gave a wrong, but unanimous answer, subjects went the majority opinion, despite that opinion being obviously wrong. This phenomenon, known as “yielding,” exemplifying “the power of the majority”. Lone dissenting voices in meetings are likely to shelve their concerns and potential contributions so as to not disturb group cohesion [23].

In a recent article, professor Margaret Neale says that “in fact, the worst kind of group for an organization that wants to be innovative and creative is one in which everyone is alike and gets along too well” [24]. The benefits of a diversity of opinions on decision making has been found in a variety of settings, occupations, and organizations [25], and also applies to group task performance [26, 27] and to creativity and innovation [28]. Diversity is beneficial because it leads to cognitive diversity and task conflict, that is, that a variety of opinions, backgrounds, and thinking styles and their integration into the solution are what contributes to better outcomes (as opposed to race and gender in and of itself). This diversity is broader than gender diversity and encompasses functional experience, such as having people with experience in sales on the same team as those with experience in engineering. Team diversity leads to enhanced performance in an illustration of why team members are “greater than the sum of their parts”. Therefore, it is likely that the explanatory variable that links gender diversity in top management position and firm financial performance is due to the cognitive diversity benefits brought by gender diversity [29]. Furthermore, researchers disagree on which diversity

dimensions provide the most benefits to team performance gender, race, age, tenure, experience, departmental affiliation, team tenure, education, etc ), and the direct link between demographic diversity (such as gender and race) and the ensuing cognitive diversity that benefits performance has not been clearly established [30, 31].

Diversity is especially important and beneficial for tasks oriented toward problem solving and innovation, as opposed to more routine tasks [31]. Future studies of gender diversity in IT teams may benefit from distinguishing between the types of tasks that are performed. Much IT, engineering, and other scientific work involves creativity and problem solving, and the high-technology industry remains competitive through innovation. There may be other work contexts where technical work may be more routinized and may experience different diversity effects.

#### The Two Edged Sword of Diversity

While diversity is a source of competitive advantage, firms need to effectively manage diversity in order to reap the benefits. Team diversity has been appropriately labeled a “Two-Edged Sword” [32] that can backfire and actually harm team performance by leading to low group integration and lower work satisfaction [33, 34]. Frequency and effectiveness of team communication and internal agreement over team processes has been established as crucial to leveraging diversity [35]. Barring these factors, the diverse team will lack cohesion and diversity will have the opposite effect and impair performance [31]. Some diversity factors, such as status diversity, can also threaten group cohesion and hurt performance [36].

The benefits of team diversity also do not happen overnight. Initially, group performance may suffer, as team members initially have a harder time creating cohesiveness and identifying with other group members [34]. Because gender is a readily perceived difference, teams with gender diversity may initially have low levels of group cohesion and identification [37]. However, the obvious diversity clue afforded by gender diversity can actually be advantageous for teams, because team members expect initial conflict to happen and are more prepared to deal with it to the team’s advantage.

Organizational culture and support for diversity is likely to play a major role in the benefits of diversity [36]. Indeed, a supportive organizational culture that encourages sharing different points of views and an emphasis on all team members having the best interest of the organization at heart has been shown to be a requirement to reap the financial and innovation performance of gender diversity [38, 39]. Team members communicate more cooperatively when the organization emphasizes diversity and collectivism as a cultural value [40]. Another strategy is to help the team find commonality through shared values, shared team culture or a commonly shared organizational goal [31]. Barring that, group members will tend to revert to discussing already commonly known information (to avoid potential conflict) and the benefits of diversity will be lost. This is important because many organizations claim to value diversity and collaboration, yet present reward structures based on individualistic values. An organization that wishes to leverage the positive effects of gender diversity needs to integrate the value at all levels of the organization. Furthermore, situations of

participatory decision-making are more likely to leverage a diversity of opinions than centralized decision making processes [41].

Despite the benefits and the financial reasons to retain women and promote the most talented to the higher levels of technical careers, a multitude of barriers, that we suggest become especially salient at the mid-level, present themselves, making the issue difficult to resolve both for organizations and for technical women.

These barriers can be classified in two broad categories: social psychological barriers, and institutional and organizational barriers. The following section reviews the research on those barriers, and the last section reviews research on promising practices for companies to attract and retain technical women at this level.

### **Social psychology factors**

One set of barriers, which I here label the “social psychology” factors, are due not to the IT context in particular but to the inherent group dynamics involving a minority and a majority.

#### Stereotyping

Stereotyping as a concept triggers a lot of negative reactions. Most people think they do not stereotype or imagine people who do as overtly prejudiced and hateful. However, all human beings categorize others. Categorizing others is a way of simplifying information based on simple and easily accessible cognitive categories [42]. We categorize others on the basis of obvious attributes such as race, gender, or age, and we do so often without realizing it, whether we associate these characteristics with positive traits (such as “women are better at multitasking,” “Asians are hardworking”) or negative ones (“women are emotional”, “accountants are not creative”). Psychologist Henri Tajfel showed early on that the simple act of separating people in groups, was enough to trigger inter-group discrimination [43].

Stereotyping is a more common cognitive strategy in multi-task situations, where people revert to “cognitive shortcuts” [42], and is more likely to be used to categorize individuals as opposed to groups. We are also more likely to revert to stereotyping under conditions of threat to our self image and self esteem [44], situations that can frequently arise in the context of receiving negative feedback in the work setting. What makes stereotyping so pervasive and difficult to change is that not only do we stereotype, we also tend to reject information that dissonates with our attitudes and we selectively recall information that confirms our way of thinking [23].

While it is not desirable in the workplace, stereotyping is a pervasive social phenomenon. Managers of a diverse workforce, then, need to 1) expect inter-group conflict and stereotyping to happen and 2) provide tools and remedial actions to offset its negative effects.

Stereotyping is most likely to occur when there is a clear “out-group” member, such as a single woman in a male technical team, where the sole woman will be the subject of more

stereotyping than the male members will [31]. Tokenism has been identified as the kind of stereotyping that occurs when someone clearly belongs to a minority group, such as the sole technical woman in a group of men [45]. Tokenism leads to the majority group member to treat the single woman in the group as representing all the stereotypical characteristics of the gender. The solo woman sees her work subjected to much more scrutiny than her male peers and her gender becomes a lens through which her work is evaluated. This leads to the work actions, communication, and performance of the woman to be judged through a stereotypical gender lens. In this context, attitudes that reward men who act assertively as leaders punish women who achieve the same successes and exhibit similar behaviors [46]. This represents a significant barrier to women at the upper echelons of the organization, and their performance evaluations are likely to suffer. Recent research confirms that women are not afforded as much of a repertoire of behaviors when it comes to assertiveness, and that women may benefit from self-monitoring in order to match the style of participants in the situation [47].

Women who are in minority status are also more likely to be pushed toward tasks that are stereotypically feminine, such as support work [48, 49]. Similarly, qualitative data in the IT context suggests that women on the technical ladder are more likely to be encouraged to follow a path where “soft skills” are required, such as management, marketing, and PR, a result of further stereotyping and devaluing of soft skills in the technical track [18], which leads to a further loss of women after the mid-level, where the opportunities for advancement may become limited to non-technical track jobs. This phenomenon merits systematic analysis.

For women who also represent a racial minority group, there is a likelihood of being stereotyped on two dimensions, further impairing their technical careers. Furthermore, research shows that out-group members in a work setting have higher levels of absenteeism and are more likely to leave the organization [50], and report lower levels of job satisfaction, potentially shedding light on the departure of women from the technical track at the mid-level. Women are also stereotyped as “family focused” and “unwilling to travel” and therefore tend to be passed up for promotions [51].

Women are also likely to suffer from what has been identified as the “imposter syndrome,” a phenomenon by which highly successful individuals fail to internalize their success and link their achievements to their performance [52], making many women less comfortable with self-promotion.

### Social Networks

Network ties and especially weak ties are key to career opportunities and advancement [53], as they build social capital [54] and this is true in high-tech [55, 56], where research has shown that senior managers with more social capital in the form of network ties that bridge various groups (known as structural holes) are more likely to get promoted [57]. Yet women in IT in lower positions (from entry to mid-level) have fewer opportunities to network outside their immediate department [58]. Because of their minority status, however, women need broader networks for career advancement and successful women tend to find alternative network routes to the top [59]. What company

practices support the creation of those networks for women? Furthermore, are the network mechanisms that support women's advancement in technical careers? This issue needs further research.

Research on a large IT firm shows that women need to use networks differently than men to achieve the same promotion and career benefits. That is, as opposed to only creating structural holes by linking to a wide set of people in a wide set of departments, they especially benefit from having ties to influential others who are hierarchically well placed within the organization and have wide networks. In other words, they need to borrow social capital from key sponsors in order to achieve the network benefits, pointing to the fact that women suffer from a legitimacy problem in this high technology organization [60].

#### Is there a Glass Cliff in IT?

Once women reach senior leadership positions, are they setup for failure? Recent research suggests that women are more likely to be put in precarious leadership positions [61]. They tend to inherit teams and organizations in crises, where performance and financial fortunes have plummeted, putting them in the vulnerable position of getting criticized for poor company or team performance even though they inherited the problems rather than caused them. Women tend to get promoted to positions where success is already unlikely [62]. More research is needed to see if that phenomenon holds true in the context of IT.

### **Institutional and organizational factors**

#### IT culture and worklife "balance"

The IT culture is often associated with strong masculine traits. Sherry Turkle and others have documented that the prevalent occupational culture in IT is one that is masculine, white, and heterosexual in nature, and associated with hard programming, obsessive behavior, and extensive working hours [63, 64].

Within companies, "flexibility" often means staying until midnight, with an expectation of increased productivity and constant availability. Those with children become faced with a 24/7 workload. Employees are also faced with a continuous need to study more and upgrade their technical skills on their own time [18]. More research is needed on where a company culture may interact with occupational culture to counteract some of the barriers caused by culture.

*"I have a family but feel pressure to keep my technical skills up to date on my own time. I took a 2 year leave because I just couldn't make it work. I hit the glass ceiling when I tried to come back. I came back, but there are no resources out there to help women who leave re-enter the technical track and it was really difficult." Mid-level technical woman).*

The academic literature talks about work-family conflict as opposed to “balance”. This pressure hits women at the mid-level especially [65]. The conflict happens when demands of family life are incompatible with the demands of work life, often forcing women to leave the technical track entirely in an “all or nothing” proposition.

Mid-level is also where work-life balance more likely becomes an issue and leads to more difficulty in career growth. There, there is a double push on career women as their time compete between two competing ideal-types of mother and family and devoted worker [66].

More specific to the information technology industry, Wilen-Daugenti (2000) found that even during periods of economic boom in Silicon Valley, over 40% of the women surveyed stated that they planned to exit their organizations. The most dissatisfied group was found in middle managers (58%). The top three opportunities for improvement proposed by women surveyed were: career opportunities (66%), work culture (58%), and improved salary (40%).

In a study of technical professionals (not divided by gender), a consulting firm reported that these professionals place a high value on recognition for their technical contribution, value autonomy in their work and place a high importance on their ongoing learning opportunities and personal development [17]. This is consistent with academic research that finds that technical workers value technical challenges and ongoing opportunities to grow in new challenges and new skills [67]. Barring growth opportunities, technical women, just like their male peers, are likely to leave an organization.

### Organizational structure and practices

The ways in which organizations are structured and the policies and practices implemented have great impact on women’s attainment to leadership positions [68].

There is a large body of literature on the ways in which workplaces are organized around and support men’s work styles and life cycles, even those that appear to be “gender-neutral” and meritocratic [69-72]. Biased hiring, promotion, evaluation practices and salary levels are common across organizations[29]. Organizations engage in “homosocial reproductions” and tend to evaluate people on the same criteria of the existing senior managers –thus minorities and women become evaluated in terms of “white upper middle class men” criteria [45]. The criteria used in hiring and retaining workers is heavily dependent on existing organizational composition [45].

Organizations face difficulty in evaluating employees that have not been there a long time because of imperfect information, hence the tendency to rely on tenure [65]. Hiring practices also tend to reproduce social inequality: new positions and career titles are often created with one individual in mind, not a pool of individuals – one researcher found that 47% of the jobs in a sample of 415 organizations only had one incumbent [65].

Therefore, organization practices and internal labor markets tend to reproduce social inequality within organizations. This has been found to hold true in high-tech companies: Evaluation practices tend to be biased and harder for women to prove their technical credentials [73]. Furthermore, women and minorities are less rewarded in terms of career opportunities for upgrading their skills [74].

## **What works? What needs further research?**

Specific organizational characteristics practices have been shown to make a positive difference in various industry settings.

The perceived difficulty of attracting qualified employees of a certain skillset leads to companies putting more women and minorities in management positions. Organizational growth exerts a large influence on diversity – the creation of jobs created by organizational growth opens up opportunities for minority members [65], especially for women. Organizational growth also reduces the average tenure needed for career advancement and expands the pool at the entry level by forcing organizational “churn”. Conversely, “high-tenure” organizations that rely on seniority for advancement are worst at promoting women because of a stifled opportunity structure [65]. Organizational age make it more difficult to change such stifling career structures [68].

Research suggests that organizations would benefit from training their managers effectively - research shows that at the early career stage organizational success is highly determined by one’s immediate supervisor [65]. This is corroborated by informal interviews with technical women and needs further systematic research in the context of high-technology.

*“As women, we are taught to take guidance and direction. But that can get you stuck if you listen to the wrong manager. If you are not assigned to a top priority project you can’t advance. That’s why getting a good manager is so important” (senior technical woman)*

One study of flexible work practices [75] found that the introduction of flexible schedules led to higher employee satisfaction and reduced absenteeism. When the organization removed the flexibility schedules, absenteeism and satisfaction rates went back to what they were before. This finding needs to be replicated in the context of high technology.

*“My company is willing to work with me – I set my own schedule and work remotely, our team is distributed all over.” (Mid-level technical woman)*

Research across industries shows that promotion practices and rates influence rate of gender integration over time ([76];[77]; [46, 78]). The more women are successfully promoted within the organization, the better the resulting gender integration. The best

promotion practices for women and minorities are those that are not based on seniority [79]. Cohort size tends to influence promotion rates – smaller cohorts of employees have more upward mobility after hiring than larger cohorts [80], presumably because of the availability of advancement opportunities. The clear articulation of path for advancement and clear skill development programs contribute to accession of women to higher positions [68]. One study suggests that career strategy and planning enhances advancement and satisfaction [81].

When it comes to advancing women, success breeds success. Putting more women in senior management position improves an organization's ability to attract and retain female employees [45]. Correcting gender wage differential to send a clear message that women are considered a critical resource also helps retain women [68]. Changing the promotion structures to make them less highly formalized also positively influence gender integration [76]. Therefore, technology companies need to examine their career ladders and see how their structure aids or impinges women. New research suggests that offering more pathways to advancement than the traditional dual career system [82], especially as these employees become increasingly mobile and less committed to a single employer.

Limited systematic research exists on other effective organizational practices to attract and retain women. Organizational contexts and practices are thought to matter [83] in retaining these women successfully, but this needs to be researched more extensively. The research on mentoring as an effective practice is the most developed. Mentoring, whether informal or part of a systematic organizational practice, leads to higher and faster promotion rates and earnings for women [84, 85]

Finally, there is no conclusive research on what are some of the issues specific to technical women versus non-technical women, or no research exploring the differences in factors for women in technical industry sectors versus non-technology sectors. There is also no knowledge how the barriers and facilitators to advancement vary at different stages of a technical women's career. The research agenda of the Anita Borg Institute for Women and Technology seeks to address this gap and focus on the factors influencing the attraction, retention and advancement of technical women at different stages of their careers: entry, mid, senior, and executive.

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