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Women's Voices are Missing from Technology

By Dr. Stephanie Nelson

In celebration of the new millennium, a panel of National Academy of Engineering members evaluated and ranked the top 20 technologies that altered American lifestyles over the prior 100 years (National Academy of Engineering, 2002). The chief criterion for ranking was "the significance that each achievement had in terms of its impact on the quality of life during the 20th century." While speaking at a conference of women organizational leaders, I tested the same top 20 list to see if the all-female attendants would rank these technologies differently from the NAE-appointed experts. One motivation for doing so was that out of the twenty-nine Academy members who made this prestigious evaluation, only two were women. I was interested to find out if women leaders would value these technologies differently.

In this article, I use the results of my survey, my findings about women's relationships to technology, and also my own experiences as a woman working in a technical field, to provide evidence for my claim that women's voices are missing from technology, and consequently, that the coming technological future will do little to enhance women's quality of life.¹ Indeed, the quality of life for women is getting steadily worse from a global and even national perspective, in spite of all of the technological advances we celebrate. I believe the reasons to be threefold: (1) women of the world lack access to technology, (2) technology alienates and often exploits women, and (3) decisions about technology are made without women's voices.

As technology educators and organizational leaders, we can play key roles in ameliorating this situation. We must

take an active role in changing the technological future for women—and we must think globally when doing so. The quality of life for all of us depends on this, since women will play a key role in shaping our future, for better or for worse. I provide first evidence of the most pressing problems and then some suggestions about what we can do to improve them.

Women and Technology

Women are no strangers to technology—in fact, according to anthropologist Sally Slocum (1975), we were probably its first inventors. Yet most accounts of the history of technology exclude or downplay the contributions of women. Slocum argues that the first tools of civilization were probably not weapons created by men to harvest game, but instead baskets and other plant-harvesting implements created by women. And these technological inventions were likely more instrumental in the survival of the species, since meat was only an occasional meal for the first humans (1975). Yet definitions of technology, historically and currently, are often male-centered and exclude women's areas of expertise (Koerber, 2000). This is a problem that I have experienced professionally. An engineer at my former workplace once asked me if I knew how to operate any power tools. When I told him I was competent with a sewing machine, he insisted that a sewing machine did not fit his definition of a power tool. My former colleague's gendered view of technology often plays out in the academy as well. The Technology department at my university missed an opportunity to add two tenured female faculty and their many students to our department because of a widely held belief at our institution that an auto-

¹ Others have made this claim as well; see McCorduck & Ramsey, 1996; Akubue, 2001; and Kova, 1996.

mated manufacturing program for textiles and garments belonged in the Art department, not in the Technology department.

Women have always created and used technology. But ironically, far more women than men of the world lack access to the technologies they need to improve their daily lives. Women lack transportation and communication tools; most women of the world have never used a phone or traveled over 50 miles from their birthplace (McCorduck & Ramsey, 1996). Today, women produce nearly 70% of world's food and are the primary keepers of the indigenous knowledgebase about sustainable use of the environment—knowledge about irrigation and crop rotation methods, for example—but most women farm with the back-breaking hand hoes that Caesar Chavez condemned, and cook with wood, charcoal, or animal dung (Huyer & Westholm, 2002). Even when technological development takes place in these sectors, “the proceeds from developmental progress tend to go disproportionately to males” (Pytlik, Frank, & Akubue, 2001, p. 114). The garment and textile industries were built mainly on the inventions of women and are the largest employers of women outside of farm work (U.N. Platform for Action Committee, 2003). But these industries are notorious for being exploitative of both women and children in most parts of the world today, and the disproportionate amount of upper-echelon jobs in these industries go to men.

Women do more work over their lifetimes than men, and are woefully underpaid for their efforts. According to one estimate, one-third of the world's work is done by women for free (UNIFEM, 2003, p. 25). Women in the Third World work an average of 6 hours a day longer than men (McCorduck & Ramsey, 1996). Much of that work occurs in the evenings and on weekends after a regular work shift outside the home. Indeed, in 1995 the United Nations placed a value of \$11 trillion on women's unpaid work globally—enough to lead to “a funda-

mental change in the premises on which today's economic, social and political structures are founded” (Huyer & Westholm, 2002, p. 4). Despite their longer work hours, 70% of the world's poor are women (Pytlik, Frank, & Akubue, 2001). On a national level, American women made up almost 60% of the nation's poor in the 1980s (Solomon, 1985), and twenty years later, the 2002 Census found that this number had not changed; indeed, working women in America were 40% more likely to be poor than working men (NOW, Oct. 9, 2002).

Women have traditionally worked using tools and technology, and the majority of women everywhere have traditionally worked outside the home, mostly in fields or factories (Stacey, 1988). On a national level, while white women came into the wage labor pool relatively late, it is still misleading to think that until WWII, American women worked primarily in the home. As early as the 1900s, a significant population of America's urban centers was made up of single women who worked in high-tech industries—primarily in garment, textile, and food processing factories—often for long hours and in abominable conditions. Today, well over half the employable women in America work outside the home, and that number is expected to rise to 85% in the next 15 years (Stacey, 1998). In America today, women outnumber men in the workplace but are still paid only 78 cents on the male dollar earnings (Bostic, 1999).

The fact is that American women are working more than they ever have out of economic necessity. Real-wage buying power has dropped in the past 25 years, and almost two-thirds of the minimum wage earners in America are women (Akubue, 2001). The 90s job boom turned out to be primarily part-time work, done mainly by women, with no job security or benefits. As McCorduck & Ramsey have warned (1996, p. 11), what if the technological promises of the Information Age pan out to mean “Mom doing piecework at the computer”—no health benefits, job

security, promotion or pension—much like the garment industry of today?

The washing machine, the dryer, the gas stove, the vacuum cleaner, the dishwasher—these are all admirable technologies that save women countless hours of extra work, or do they? Ironically, the amount of time the average American housewife spends on housework did not change from 1910 to 1980—it was still 50 hours a week (Cowan, 1983). In 1988—the latest year for which statistics were available—women who worked outside the home still spent an average of 23.6 hours a week on housework (Geddes, 1998). One reason is that as these new household technologies were developed, the standards of housekeeping became higher. Clothes and bedding were laundered more often, for instance. In the 50s, the TV advertising industry quickly found that they could sell more soap and other homecare products by exerting social pressure on women with advertising phrases like “ring around the collar.” Laundry day was traditionally a social activity for women, as was sewing, cooking, and cleaning up after a meal. But the dishwasher, the washing machine, the sewing machine, the personal computer, and the microwave are all one-person appliances. Despite these modern conveniences, women still handle the bulk of housekeeping during evenings and weekends—performing boring, repetitive tasks alone.

Women and High-tech Work

Most modern technologies have been developed by for-profit corporations and the industrial-military complex—domains that are dominated by men. In 1970, the top managers of major American corporations were 99% male; twenty-five years later, in 1995, 95% of top managers were male (McCorduck & Ramsey, 1996). Although the Carly Fiorina, the new female CEO of Hewlett-Packard is a notable exception, at this rate, it will be 250 more years before women are equally likely to manage top corporations.

High-tech workplaces are often not designed with women workers in mind. I spent nearly 20 years at a federally funded research and development center that grew out of the Cold War space race. The building where I worked had only a third as many restrooms for females, and only the male restrooms had showers, until my organization was federally mandated to install equitable facilities. I worked as a hardware writer and was the only female in my group. Our group served engineering clients who were entirely male. Upon being passed over for promotion in the mid 80s, I overheard my boss telling the less-experienced male he'd promoted instead of me, "Yes, she's a pretty good technical writer, but she's a woman, and women can't think in three dimensions—I really don't understand why women want to work in this field." Happily, I had several inspiring female role models in that organization, and the company offered a tuition support program that funded my higher education. If not, I'd probably still be writing Operation & Maintenance manuals for equipment I'm not supposed to comprehend.

Of course, my boss was wrong, and although some women may need more help with 3D visualization because they did not have as much childhood experience with it as males (see Strong & Smith, 2001), studies have shown that, in general, women not only have more advanced symbolic skills, but that they learn faster than men and are better communicators (McCorduck & Ramsey, 1996). Yet in the main, the high-tech job market still presents women with only limited opportunities. Below, I use the writings of two women social scientists studying the silicon chip industry to provide a poignant example of how high-tech industries, coupled with ongoing political and social biases, combine to limit and exploit women workers.

According to sociologist Judith Stacey (1988), the Silicon Valley quadrupled in population from 1960 to 1980 when silicon replaced citrus fruit as the

region's top product. In its heyday, the Valley was held up as an exemplar of a new post-industrial economy. Factories looked more like college campuses, and challenging work replaced the monotonous labors of the declining industrial age. In the beginning of the industry, nine out of ten silicon technology jobs were held by white males. But as the industry matured and grew, it feminized and minoritized. By the late 70s, almost half its employees were assembly workers—most of them women.

According to Stacey, the electronics industry remained the only non-unionized industry in the U.S., and workers in the 1980s earned less than half the wages of steel or automotive workers. They also faced greater risks and hardships. Ironically, the "clean rooms" where most workers worked were filled with toxic solvents, and the rate of occupational illness was triple other manufacturing occupations. Many firms operated round the clock and required highly irregular schedules, yet they offered no job security and those who worked at the lower echelons of the industry were subjected to frequent layoffs.

Stacey points out that the silicon chip industry also took its toll on the local environment. By the 80s, cancer rates and birth defects had risen alarmingly. Water supplies were contaminated with more than 100 industrial chemicals. Air pollution and nightmarish traffic were everyday facts of life. Yet the cost of living rose even as the quality of life declined. Because of the unprecedented population boom, local housing costs were among the highest in the nation, and there was mounting homelessness, particularly among women. The divorce rate tripled. Abortion rates were nearly twice the national average.

Because it was dependent on defense contracts and highly turbulent global markets, major depressions hit the silicon industry in the mid 70s and again in the early 80s. Faced with the need to drastically cut production costs or lose their market niche entirely,

these corporations began to look abroad for cheaper sources of labor.

Malaysia was one country that welcomed the silicon chip industry by promising cheap labor. Just like in the U.S. today, more than half the wage earners in Malaysia are women. Anthropologist Aiwa Ong (1987) writes that the Malaysian government established a Free Trade Zone in the 1970s to attract transnational capital, and that this opportunity was quickly taken up by the silicon chip industry. Malaysian silicon chip factory workers are predominantly teenage girls. These girls are bussed from their parents' homes in local villages and turn out millions of microchips a day.

Malay factory girls face the social expectation that they will turn over their wages to their parents. Many Malay families are caught in a cash bind since farming is no longer a sustainable livelihood due to large-scale takeover by transnational plantations. Therefore, families need cash and often pressure teenage daughters to work in the factories.

One Malaysian Free Trade Zone investment brochure remarks: *Her hands are small and she works fast with extreme care. Who could be better qualified by nature and inheritance to contribute to the efficiency of a bench assembly line than the oriental girl? . . . Fresh female labor, after some training, is highly efficient. (Ong, 1987, p. 152)*

Factory life in Malaysia in the late 80s does not appear to be much different than it was in the Silicon Valley. According to Ong, factories operate 20 hours a day, and every two weeks workers are placed on a different shift. Female workers are under continual male supervision and must ask permission leave the shop floor, even to use the toilet. Crying is a common response as male supervisors constantly goad girls to meet high production targets. After a day of grueling work at the factory for which they are paid an average of \$3.75 an hour, the girls

return home to an average of 3-1/2 hours of additional household chores. The rapid rate of exhaustion of the girls, coupled with often-permanent eye damage from intensive use of microscopes, causes most to leave of their own accord after 3 to 4 years (Ong, 1987). This turnover rate has disrupted attempts to unionize, since workers with less than 3 years employment cannot participate in unions. Ong's study found that Malaysian women earned less than men in any factory job they performed, and that there were no Malaysian women in any upper-echelon positions.

Women Leaders Evaluate NEA's Top Twenty Technologies

Based on current trends, women may never gain more than token representation in top corporate organizations or in politics (Corner, 1997). How might our priorities about technology differ if women had greater representation and leadership? To gain a small glimpse, I surveyed 91 female organizational leaders attending the 2001 Leadership America conference. I asked them to make their own prioritization of the top 20 technologies that impacted the quality of American life in the last century (Table 1). Not surprisingly, their opinions differed from the nearly all-male panel of National Academy of Engineering experts. The top five results are reported for both groups in Table 2. (For the full NAE prioritization, see www.greatachievements.com.)

It did not surprise me that safe and abundant water, an environmental technology, was ranked most often by women leaders as the top technology most crucial to improving the quality of life. Women have traditionally been the first to speak up for the environment because women are often the first to be adversely impacted by environmental toxins and habitat destruction. Women have led the protest movements against Love Canal, logging in the Himalayas, wetlands deforestation in Ecuador, and toxic waste dumping in the rural South (Mies & Shiva, 1993).

Habitat destruction is arguably the greatest problem facing our planet now and perhaps our greatest technological as well as political challenge. With more of a role to play in technological leadership, women might finally push the values of environmentally sustainable technologies to the forefront.

"Health technologies" was the second most-often top-ranked category by women leaders, and it is tempting to imagine how our woeful national healthcare infrastructure might benefit if women had more of a say. According to the United Nations, good health and well-being are not enjoyed by most of the world's women (2000); in America, 19% of women have no health insurance (BPWF, 1997). One woman leader wrote next to her choice, "including safe birth control technologies." While the pill and other birth control technologies have benefited many women, it is important to note that nearly half the women of the world are denied access to these technologies,

often at the hands of male religious decision-makers. Abortion is still the most common method of birth control in Third World countries, and pregnancy-related deaths total 600,000 a year (UN, 2000). Interestingly, the disparity between the women leaders and the NAE experts was the highest in this category—the NAE experts ranked health technologies only 16th out of 20.

Women too recognize the value of the lifestyle changes empowered by electrification; this category was the third most-often top-ranked category by the women leaders. In particular, electrification of the home in the 20th century was a major boon to the quality of life in our country. But while electricity powers many home technology improvements, electrical and other energy prices have risen sharply in America in the past 25 years just as real earned income has dropped, further taxing the household budgets of many women in America. And there are other problems associated with

Table 1. Top Twenty Technologies Impacting Quality of Life in the 20th Century (NAE 2000)

1. Electrification	11. Highways
2. Automobile	12. Spacecraft
3. Airplane	13. Internet
4. Water Supply and Distribution	14. Imaging
5. Electronics	15. Household Appliances
6. Radio and Television	16. Health Technologies
7. Agricultural Mechanization	17. Petroleum and Petrochemical Technologies
8. Computers	18. Laser and Fiber Optics
9. Telephone	19. Nuclear Technologies
10. Air Conditioning and Refrigeration	20. High-performance Materials

Table 2. Top Five Technologies Impacting Quality of Life in the 20th Century

National Academy of Engineering Experts (NAE 2000)	Leadership America Women Organizational Leaders(2001)
Electrification	Safe and Abundant Water
Automobile	Health Technologies
Airplane	Electrification
Safe and Abundant Water	Automobile
Electronics	Computers

modern home conveniences. For one, “much environmental pollution and destruction is causally linked to modern household technology” (Mies & Shiva, p. 7). Women’s voices in the development of alternate and renewable power technologies, as well as technologies of the home, are vitally needed. Interestingly, although the NAE experts ranked “household appliances” 15th in technologies having the greatest impact on quality of life in the 20th century, not a single woman leader selected this category.

It is also interesting to note that only 8% of the women leaders selected the automobile as the highest valued technological advance of the 20th century, even though it was second on the NAE list. Indeed, the next highly ranked technology by the NAE was also a transportation technology—the airplane—yet the airplane was selected by only two out of 91 women leaders. As I noted earlier, these technologies are beyond the reach of most women of the world, relatively few of whom will ever own an automobile or travel on a plane. As we are increasingly faced with rising personal transportation costs, highway gridlock, and inadequate public transportation systems that are not designed for strollers or shopping carts, it is again tempting to imagine how our national transportation sector might benefit if women had more of a voice.

My survey results showed that the women organizational leaders appeared to have quite different evaluations of the technologies that most impacted quality of life in the 20th century. The fact that women were then and are currently excluded as experts and consultants in the technological domain impoverishes all of us, but appears to hurt women most of all.

Recommendations for Industrial Technology Leaders and Educators

I have five suggestions about what technology leaders and educators can

do to help women attain more representation in technological fields.

First, we must convince ourselves and our present and potential students that technology is a women’s domain too. We must start by prioritizing the recruitment of women into our technology programs, both as students and teachers. The number of females in higher education increased by 17% from 1988 to 1998 and will continue to increase (Chang & Dugger, 2001). Nationally, women represent 62% of the student body—an all-time high. However, one recent study found that women students represent only 16% of industrial technology majors (Kasa & Dugger, 2000), and that Industrial Technology enrollment and programs have decreased over the past decade (Chang & Dugger, 2001). It seems clear that if we want to revitalize our programs, we need to focus on attracting more female students. The majors in my university with the highest female enrollment are child development and early childhood education. While these are important teaching-track fields, what is disturbing is that our female students who are studying to become teachers appear to believe that careers in technology education are not for them, even though job opportunities and often wages are significantly higher (U.S. Bureau of Labor, 2001). Likewise, our female students planning to enter technology-based workforces don’t appear to see a major in industrial technology as a logical choice. Given the long social history of scorn for women’s mastery of things technical (e.g., women driver jokes; see also Solomon, 1985), I don’t think we can really blame them. As Bostic has argued, “society’s idea of what is ‘proper’ work for females may be the most influential factor” in determining women’s choice of a career (1998, p. 2). But many women will end up in high-tech jobs anyhow, and then be limited in their advancement because they lack the educational background needed to achieve positions of leadership. The few women who have graduated from my

department’s programs are doing superbly and love their jobs. We need to get the word out that women can succeed in technology fields. Imagine the impact on our program enrollments if we were able to increase the female enrollment percentages to the equivalent percentage of national female college enrollment. We need to push for female student scholarships and female-targeted recruiting, as well as industry internships for females.

One factor that will undoubtedly attract more female students is the addition of more female faculty. I am the lone female appointed faculty in my department. The faculty population of Industrial Technology departments was reported to be less than 8% female by one study (Kulatunga, Shaw, & Nelson, 1999). A more recent study, which put the percentage of Industrial Technology faculty at the university level at 9.8% (Kasi & Dugger, 2000), also found that gender role typing is at the root of this disparity. It appears that many technology professors still view the profession as one most suitable for a male. We need to develop more female faculty from within our own student body by encouraging our talented female students to consider academic careers and by sponsoring their advanced degree work. I have personally recruited and hired four female adjuncts. Two are now pursuing advanced teacher-track degrees via department-sponsored scholarships.

Second, we need to educate our students and our colleagues by instilling a sense of urgency about the dire consequences of leaving women out as decision-makers about technology. At the Women’s World Conference in 1994, despite fierce opposition from an alliance of male religious leaders, women forged a female bill of rights that included access rights to technologies of family planning (McCorduck & Ramsey, 1996). We must ensure that women can decide for themselves about access to and development of technologies that so profoundly impact their lives.

Third, we can promote women-friendly workplaces that value, reward, and promote women for their contributions. Women do best when they have strong female role models, and I think it is important for organizations where the leadership is mostly male to foster some sort of semi-formal system for incorporating female leadership mentoring into the workplace. Also, since we are training the technology leaders of the future, we need to challenge our students to think long-term about their professional and personal behavior, and to consider how it impacts the quality of other people's lives, both within and beyond their organizations. When I was the lone female hardware writer in my former organization, it was perfectly acceptable for the male clients I served to have pin-ups of bare-chested women on their office walls. Our Women's Council tackled this issue for years before the all-male leadership there finally became sensitized to the demoralizing impact of this practice on its female employees and put an end to it. We need to make sure our students come out of our programs with these sensitivities already in place.

Fourth, we should inform students about the impact of technology on the environment. We should promote sustainable products and practices to our students and teach them about appropriate and alternative technologies. These are issues that women in particular have demonstrated concern about and they need to be a part of our standard curriculum.

Finally, we need to reach out to our female students on a personal level. As I have tried to show with some of my own stories, the few women in our field are here today because we struck out into new territory and persevered, often overcoming significant obstacles along the way. We need to share our spirit of confidence with our female students. I never thought that graduate school was for me until a woman mentor at work, who earned her doctorate degree late in life, insisted that I could do it too. We need to let women know that they can

achieve and succeed in advanced technological areas. Women's voices are sorely missing in shaping the present and future of technology. The world desperately needs more technologically savvy female leadership as it struggles to make technology equitable and beneficial for everyone.

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