Gender Related to Success in Science and Technology

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Despite efforts over the past few decades to attract and ultimately recruit more young women into the traditionally male-dominated fields of science, technology, engineering, and mathematics (STEM), the numbers of successful female scientists and technologists remain discouragingly low. In 1993, women accounted for a mere 16% of the students who earned undergraduate engineering degrees in the United States (Zachary, 1994). Data assembled by the U.S. Department of Labor in 1996 report only 8.7% of this country's electrical engineers are women. Earlier statistics summarized in Barinaga's (1994) international study reported that countries maintaining large physics establishments, high levels of industrial development, and strong women's rights movements (i.e., USA, Britain, Canada) have among the poorest records, with women representing fewer than 5% of physics faculty and less than 12% of physics students who receive PhDs. Stated differently, technologically advanced nations are not all that advanced in their provision of opportunities for aspiring female scientists.

Other studies report similar statistics that reveal paltry percentages, ranging from 4% to 25%, of women graduating with academic degrees in technology-based majors (Brooks, 1994; Jagacinski, 1987; National Science Board, 1993). Studies designed to reveal and analyze the obstacles girls and young women encounter when studying and entering fields of science, mathematics, and engineering have appeared in the literature with some regularity in recent years (Brooks, 1994; Gammie, 1994; Geppert, 1995; Jagacinski, 1987; Murray, 1994). A lot less attention, however, has been directed toward the status of women in the top ranks of science and technology and the difficulties they face in breaking through the "glass ceiling" to gain entry into higher levels of influence (leadership) in their profession. Not surprisingly, women scientists and engineers in fields traditionally dominated by men lack the support and recognition needed to advance into leadership roles. Maney (1996) noted that Hewlett-Packard, IBM, and Silicon Graphics each reported that although 10% of their engineers on staff were female, none of the top five company executives were women.

A significant number of stubborn forces in the STEM workforce environment discourage women and cause them to gravitate toward the fields of law, health care, journalism, social services, and business where they perceive the climate to be less adverse (Shipman, 1995). The National Science Board (1993) concluded that one of the most obvious reasons qualified women choose careers in medicine, law, and business over those in science and engineering is that salaries are higher. This essay is the product of my own continuing interest in a more precise understanding of the barriers (both real and perceived) that (a) prevent women from ever entering STEM professions; (b) erode the confidence of young girls who may actually like their science, mathematics, and technology classes in grade school; and (c) do not allow women to get beyond mid-level or "maintenance-level" positions in organizations to achieve levels of influence and control in their STEM career paths. This discussion is another attempt to stress that success and influence in STEM positions need not be gender linked.

Status of Women in Science, Technology, Engineering, and Mathematics (STEM)

If we attempt to conjure up a visual image of a typical scientist, technologist, or engineer, chances are a few stereotypical features will emerge. Hill and Wheeler (1991) looked for examples of such imagery in their study of grade school students' reactions to illustrations of scientists and technicians. Their work produced findings similar to those of Hassard (1990), whose earlier research revealed the following stereotypical profile:

1. The scientist is usually a male Caucasian.
2. The scientist is either bald or has frizzy, wild hair. On the rare occasion when the scientist is a woman, her hair is in a bun.
3. The scientist wears glasses and is dressed in a white lab coat.
4. The scientist is shown working alone rather than in nature or in the field.
5. The scientist is shown mixing chemicals or doing some kind of chemistry or physics-related experiment.
6. The scientist is shown experimenting with dangerous things and is sometimes shown experimenting on people. (p. 10)

These are the innocent perceptions of children whose ideas about personal career choices were not anywhere near definitive. What, if anything, about this description of the scientist at work might convince a fourth or fifth grade girl to pursue an academic degree and ultimately a career in STEM? How many young girls will say, "I want to look like that"?

The commonly agreed upon profile of en-

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gineers among themselves is not any rosier. Engineers seem to have an absolutely lousy image of themselves—"maybe women in engineering find it so tough because male engineers have very low self-esteem, so somebody has to be even lower" (Geppert, 1995, p. 44). During all the years I worked in Silicon Valley, it was interesting to notice that engineers who do exceptional things in their lives tend to refer to themselves as entrepreneurs or inventors as opposed to engineers.

As a graduate student, I attempted to formulate a very basic assessment of why women do not strive for or attain high status research positions in science and technology (Markert, 1981). This work revealed three major issues:

> 1. a lack of awareness among school-aged girls of the significant female role models in science and technology
> 2. social rejection in university graduate programs and numerous sexual pressures on the job itself
> 3. an apparent lack of technological literacy among women." (p. 14)

It seemed that women were not being counseled early enough to prepare themselves for careers as scientific or technological researchers, and those who did persevere to receive the necessary academic preparation were confronted with both intellectual and emotional pressures in the industrial environment. Ten years later, the works of Hill and Wheeler (1991) and Hassard (1990) regarding students' visual representations of scientists as predominantly male confirmed my belief about the need for much earlier STEM career counseling among grade school children.

The culture of science and technology that causes women to lose interest is replete with outmoded stereotypes, an emphasis on scientific knowledge independent of real-world applications, and an image of research scientists obsessed with science to the exclusion of other human endeavors. Let me cite a few examples from the literature: Alper (1993) suggested a chief deterrent to long-term success and influence in science and engineering is the poor preparation in mathematics most girls receive in high school; and further, by the time young women graduate from high school, "they have taken so many fewer math and science courses (than their male classmates) that it precludes significant numbers of them from pursuing college science and engineering majors" (p. 410). In a study conducted among women scientists in Great Britain, Verrall (1994) found that while "70% of the women had decided between the ages of 11 and 16 to study science, a stimulating or challenging first college degree course was a major factor in reinforcing such a decision" (p. 88). The work of Garrod and Taber (1991) at Purdue University revealed that women do not pursue nontraditional degrees in technical fields due to

> a lack of knowledge of career opportunities, gender issues in the workplace, the continued existence of sexual discrimination and harassment in male-dominated professions, the pressure of meeting the responsibilities of family and personal commitments while engaged in a technical career, and the long term prospect of professional growth in a male-dominated field. (p. 20)

Despite initiatives and incentives within industry to recruit and retain women scientists and engineers, women are still less likely than men to be found in higher level industrial jobs (Fox, 1994). And, when we look to the academy as the predominant employment sector for doctoral-level scientists and engineers, we find a lower proportion of women than men in research universities versus 2-year and 4-year colleges (Fox, 1994). It is no secret that university-level institutions tend to attract more external funding, feature well-outfitted (modern) laboratories, enroll higher numbers of graduate students, employ a significantly higher number of graduate teaching assistants, and require lower teaching loads of their tenured faculty members. It is for these reasons that scientist and technologists who work in universities are more likely to be engaged in collaborative research endeavors that will lead to publications in the more prestigious journals. This fact alone may offer some explanation for the persistently lower status of female scientists, technologists, and engineers in their professional communities.

These reports reflect the realities of contemporary society. Without question, barriers and obstacles still exist that cause women with scientific and mathematical aptitude to get diverted into other careers. As a direct result, women remain seriously underrepresented in the higher ranks of employed scientists and engineers.

The culture of STEM disciplines is not one that welcomes women, unconditionally, with open arms. There are all sorts of barriers to entry and a variety of gate-keeping activities that make it hard for women to make their mark in STEM positions. If we stroll the halls and glance into the conference room of a university department of technology, or into the board room of a high-tech manufacturing firm, or into the lunch room of a STEM research institute, chances are the BOWGSAT (i.e., Bunch Of White Guys Sitting Around a Table) syndrome discussed by Delatte and

Baytos (1993) will be staring us in the face. This oppressive work environment is often difficult, if not impossible, for newly hired female STEM professionals to penetrate.

Women who work in technological settings—academic, government, or corporate—are commonly challenged to work in centers structured like college fraternities and are expected to acquire information through an old boys' network. Bailyn (1987) concluded that much of this sort of role conflict and overall professional ambivalence about career development experienced by female STEM professionals will only be reduced when organizations restructure their expectations about women, technology, and organizational policies by fostering flexibility and diversity. In a similar vein, Liedtke (1995) surmised that "an examination of the organizational culture of technology education, the profession's attention to cultural diversity, and the change process itself requires a serious commitment from everyone in technology education" (p. 14).

Without question, organizational work environments do not operate neutrally, uniformly, or consistently for men and women. The availability of resources and professional development opportunities is commonly influenced by gender. In her national survey of social scientists employed at BA- and PhD-granting institutions, Fox (1991) found that women recounted less interaction with and recognition from department colleagues, fewer laboratory/financial resources available to them, and significantly higher undergraduate teaching loads. Each of these environmental factors correlate with a faculty member's level of academic productivity. In another study of scientists appointed as assistant professors at the University of Michigan, Feldt (1986) found that the men typically received more start-up monies for their labs, better physical facilities, and better placement within existing projects with funds and equipment. And, in the non-academic world, the reported salaries suggest that for female engineers to prove themselves, they must work harder than their male co-workers who have equal or less education and experience and still accept lower salaries (Garrod & Taber, 1991).

The null academic environment seems to present another barrier to entry for women who may have an interest in STEM degree programs at colleges and universities. By definition, a null academic environment exists when faculty members do little to support or encourage their students; these individuals subsequently feel devalued and are forced to seek feedback regarding their progress from other sources (e.g., classmates, parents, peers). Matlin (1993) presented the concept of the null academic environment as a possible explanation why relatively few women pursue education in the natural sciences. The Society of Women Engineers found, through interviews with female student members, that college engineering professors can be downright denigrating. They have been heard to say things like, "You know, you can take this (STEM) class, but you're never going to get a job because you don't have the skills that it takes" (Geppert, 1995, p. 43).

Two other gate-keeping methods that fit the description of a null academic environment for women as both students and faculty members include the chilly classroom climate and fewer opportunities for collaboration. Matlin (1993) provided her sense of the chilly classroom climate as a scene where faculty members treat men and women differently in the classroom, to the point where women feel ignored and devalued. Overt examples of this sort of discriminatory treatment include sexist comments or jokes, a tendency to call on male students while ignoring the females, more encouragement or praise for males, the use of higher standards to evaluate work submitted by female students, longer waiting periods (more patience) for males to give a verbal response, and specific remarks about the physical appearance of female students that are not made to male students. These kinds of behaviors may partially explain why women seem to participate less often than men during interactive classroom discussions.

Campbell (1990) found that males attributed their success in the use of computers more to their own abilities than did females. The females in Campbell's (1990) study "attributed their successes in using computers more to environmental factors, such as the effectiveness of the teachers and helpfulness of other students in the class" (p. 495). In my own experience, women classically internalize their failures while men internalize their successes. Stated differently, if a guy fails an exam, he'll say that "the test was unfair" or "the professor didn't prepare us for it." When a female student scores poorly, she is more likely to say that "I didn't study hard enough" or "I knew I shouldn't have gone to the game this weekend." These realities seem to imply the need for warmer classroom climates if females are to succeed in STEM courses on par with the males in their classes.

A second null academic environment factor related to the professional status of female scientists, technologist, and engineers in the academy may lie in the frequency of opportunities for collaboration. Fox (1994) reported that the sciences, by comparison to the humanities, are more likely to be "performed in teamwork than solo, to be carried out with costly equipment, to require funding, to be more interdependent enterprises" (p. 220). It is for this reason that collaboration is so important if a faculty member wants or expects to advance in rank—solo research is very difficult, if not impossible, to initiate and sustain.

In the STEM community, there is a lesser likelihood for women to have connections on editorial boards, to be officers in technical associations, or to be invited speakers at national conferences. These as well as other realities result in fewer opportunities for collaborative research.

Collaboration with a faculty mentor is especially critical for graduate students—it affects their academic productivity, job placement, future respect in the field, and postdoctoral productivity. Berg and Ferber (1983) found that women tend to regard themselves as students (subordinate to) rather than as colleagues of their professors and also say that their views are taken less seriously than those expressed by men. One can easily conclude that the relationships between the predominantly male STEM faculty and female students are far less relaxed and egalitarian than those that exist for male students. Male professors commonly say that they can "safely" accompany their male students to places they would not dare go with their female students. Here is yet another reason why opportunities for women to collaborate on significant STEM research projects are not plentiful.

On the other hand, some female scientists and technologists experience the other side of the coin regarding inclusion—they are often appointed to committees, boards, and prestigious projects because a woman is needed. This reverse discrimination has a price as well—tokenism is exhausting! Just ask any female person who felt under the gun to think three times before saying anything of substance at a meeting because she knew her words would be resented an/or disregarded unless they were packaged in exactly the correct manner (Shipman, 1995).

Finally, Jones (1992) reported that additional barriers which keep women from utilizing fully their technological skills for the benefit of themselves and the economy include "the lack of flexible working arrangements offered by employers, together with the widespread inadequacy of childcare provision" (p. 39). Even as we approach the end of the 20th century, the demands of the family and household environment compete with those of work-related obligations much more so for women than for men.

And, as women struggle for the type of recognition so readily attained by their male colleagues, they need to get past what Bartusiak (1994) labeled the "women-in" syndrome. You've heard the stories—women in technology, women in business, women in science, women in government. These types of reports only prolong the prejudicial notion that women should be spotlighted as one-at-a-time performers. Their contributions should be reviewed as fully integrated into their disciplines as opposed to being illustrated as Bartusiak (1994) portrayed them "like so many ornaments on a Christmas tree, as mere appendages to the scientific enterprise" (p. 6).

Success & Influence Need Not be Gender Linked

In continuing reviews and assessments of women in STEM careers, perhaps it is time to get past the issues of "numbers," "percentages," and the "why so few" questions. Since the 1970s, women have visibly increased their proportions of doctoral degrees awarded in science, technology, and engineering and, thus, their proportions of professionally trained STEM personnel in education and industry (Fox, 1994). Regardless, these improved numbers still do not guarantee significant participation and leadership status. Gender does indeed seem to influence location, ranks, assignment to projects, rewards in the scientific community, publication productivity, salary rewards, teaching loads, opportunities for collaboration, and promotions (Fox, 1994). "In a male-dominated profession, the attitudes of men that women are less capable not only in their careers, but also in their home lives creates adversity in the workplace" (Garrod & Taber, 1991, p. 20). It is no wonder that women feel intimidated as they attempt to achieve promotions or forge congenial friendships with male coworkers.

Are there specific coping mechanisms that seem to be necessary for survival in male-dominated work teams in STEM organizations? Are there effective strategies that have been devised by female scientists, technologists, and engineers to overcome the types of barriers discussed here and ultimately achieve success? Can female STEM professionals get beyond the BOWGSAT mentality/methodology and secure leadership roles whereby their work will be applauded? The answer to all three questions is probably yes, but it remains a challenge to identify and define these prescriptive tactics.

Regardless of the discipline, successful people get ahead because of their intellect, energy, enthusiasm, determination, character, communication skills, charisma, and a modicum of luck. None of these traits is a gender-linked phenomenon. The moment we add technical skills to the list, we supposedly enter a world monopolized by men. The process of scientific inquiry encourages questioning, exploration, discovery, learning from failure, and risk taking. It is unfortunate that girls' socialization in our culture inhibits the development of these traits (Travis, 1993).

Our deep-rooted social conceptualization of men as strong and technologically able and women as physically and technically incompetent is not likely to disappear overnight. According to Wajcman (1991), these gender profiles are "the result of different childhood exposure to technology, the prevalence of different role models, different forms of schooling, and the extreme sex segregation of the job market" (p. 42). Pereira (1994) echoed a portion of this contention in his recognition that a growing number of psychologists and educators believe girls may be at a disadvantage because they do not play video games as often as boys. Even though the applied research on the practical benefits of playing Nintendo or Sega is in its infancy, "some experts wonder if a passion for video games early in life lays a foundation for a career in technology" (Pereira, 1994, p. B5). Another perception expressed in Alper's (1993) work is that scientific talent and interest come early in life—"If you don't ask for a chemistry set and master it by the time you're 5, you won't be a good scientist. Since far fewer girls and women display these traits than boys and men, you end up with a culture that discriminates by gender" (p. 411).

Another perspective on this issue is found in the work of Fox and Firebaugh (1992) who discovered that while "women may not think science is bad—they just don't think it is as useful as men do" (p. 111). In a similar vein, Alper (1993) noted that "women aren't so interested in engineering as a technical matter, but as a practical matter" (p. 410). While males might often say they are interested in engineering problems no matter what, women seem to respond more enthusiastically if they see the relevance of solving the problems to helping people or the environment. In their research concerning society's fear of technological hazards, Pilisuk and Acredolo (1988) revealed that women exhibited greater concern over the technological dangers in our high-tech world. Since women are generally credited with the unique capacity to bring a human side to science, technology, and engineering, this research should not be a great surprise. A different strand of this discussion is related to our receptivity to new technology, which is influenced by how well informed we feel and by our willingness to learn the skills required by new technology. Hackett, Mirvis, and Sales (1991) found that men judged themselves to be significantly better informed about STEM topics than women judged themselves to be; however, both male and female employees were nearly unanimous in their willingness to learn new skills.

Perhaps a partial formula for overcoming some of the barriers to success in STEM disciplines can be stated in this way:

Early Exposure to Technology + Supportive Mentors and Role Models + Information + Willingness to Learn New Skills + Perseverance and Tenacity = Tools Required to Embark on a Successful STEM Career

Some of the components in this formula are loosely aligned with an operational definition of technophobia. It is altogether possible that this phenomenon is partially influenced by gender. If so, it seems likely that a person afflicted by technophobia may be less inclined to declare a career interest in STEM. The final segment of this discussion focuses briefly on this topic of technophobia and the extent to which it has relevance to the persistent gender gap in STEM professions.

Is Technophobia to Blame?

Is technophobia to blame for the small number of women who are entering applied science and technology fields? While a straight literal interpretation of technophobia suggests a general fear of technology, Markert (1993) defined technophobia as "a general fear of technology, science, or the changes associated with these disciplines; it is related tangentially to the anxiety caused by social pressures to accept and make use of new technology" (p. 25). A person who is technophobic is afraid of technology. This person may be called a technophobe. Variations of this theme can be found in two related concepts labeled technofear and technostress. Technofear was first found in the popular consumer literature in the 1960s and was used to refer to a person's fear of commitment to purchase anything too soon in case the technology changes. The notion that "if I buy something now it will be obsolete in six weeks" is certainly more pertinent to technology-intensive products than it is to, let's say, towels and linens for the home. On the other hand, technofear might also be used with reference to one's difficulties accepting and using high-technology products in the home.

Moving away from the household consumer perspective, we encounter technostress in the workplace. Brod (1984) introduced this construct to label the modern affliction where "a person is unable to adapt or cope with new computer technologies in a healthy manner" (p. 16). From personal observation, technostress can manifest itself in two distinct but related forms: (a) in the actual struggle to accept computer technology and (b) in the more specialized form of overidentification with computer technology. Recall the early days of the word *hacker* as the name of persons who contracted the latter of these adaptation sicknesses.

These considerations result in an operational definition of technophobia as a construct that could be studied and ultimately quantified as a function of gender. Thus:

- Technophobia refers to a general tendency to shy away from or refrain from using the artifacts of technology due to (a) a lack of faith and/or trust in technological systems; (b) a low level of personal confidence regarding the use and/or operation of technology intensive products; or (c) a perception that one is not technologically literate.
- Artifacts are the human-made elements of a technological culture including machines, devices, jargon, techniques, documents, designs, schematic diagrams, procedures, knowledge, tools, applications, and so forth.

These considerations also suggest the multifaceted nature of what seems to be an increasingly common psychosocial disease. People who fear technology may not fear all technological artifacts. Conversely, people who place their trust in technological systems may have little, if any, faith in the scientific/technological community.

Stated differently, *trust* is a confident belief that technology will work the way it is supposed to, when it is supposed to (e.g., anti-lock brakes on your automobile; programmable VCRs, thermostats, and ovens; timed back-up systems on personal computers; automated bank teller machines; air-bag systems; fire extinguishers). On the other hand, *faith* is an intrinsic belief that does not necessarily rest on logical proof—it has more to do with honesty and sincerity among the scientist, technologist, and engineers who design, develop, and introduce us to new technologies. If one has faith in science and technology, then that person believes that the persons doing the basic and applied research are doing their jobs correctly and report the results of their research in an honest, timely, and forthright manner. This sort of emotion is depicted by the person who feels safe from the potentially harmful side effects of modern technology (e.g., threshold limit values established by OSHA; air quality standards set up by the EPA; stamps of approval issued by the FDA).

The second aspect of technophobia is related to one's personal confidence and skill in the use of technology intensive tools, machines, and other devices. A high level of expertise in any manipulative task does not occur overnight. Skill comes with repeated exposure and practice over time. Confidence also increases over time, especially when improvements in how well the task is accomplished can be observed and evaluated. If we use the computer as an example, a technophobic individual may be afraid to strike a key on the keyboard for fear the machine will break, shut down, or destroy all of its files. With a small amount of applied instruction and repeated tutorials on the use of software packages, the prognosis for curing this technophobe is very good.

The third strand of technophobia is linked to a perceived opinion that one is not *technologically literate*. It is related to the belief that an information explosion has made it next to impossible to keep up-to-date with all of the latest technological breakthroughs and jargon in the media and in our lives. An abundance of information can only be considered useful to the extent that it can be received, digested, and utilized by the recipients who are most directly affected by it. *Explosion* implies confusion and lack of control. It is no wonder that this information explosion concept carries such a negative connotation in our society. It forces us to envision a technophobic social environment where persons do not possess the capability to make efficient use of the scientific-technical information available to them.

If we assume that each of us experiences a pang of technophobia from time to time, we may question the extent to which gender influences both the frequency and the severity of such emotional spasms. And this can lead to the question, Is technophobia one of the contemporary barriers to women who may want to pursue a career in science, technology, engineering, or mathematics? Stated in just a slightly different way, Are women more technophobic than men?

Some of the previous citations suggest that women lack intrinsic confidence in their competency to use and operate technical tools and machines (Campbell, 1990) and tend, more so than men, to perceive themselves as not being technologically literate (Geppert, 1995; Markert, 1981). A recent study conducted among college students at SUNY College at Oswego attempted to assess gender differences as related to the three aspects of technophobia (Brand & Markert, 1995). A survey instrument asked men and women (a) to rate themselves on their level of trust, capability, and awareness with regard to technology and (b) to respond to the same set of items while indicating the extent to which they felt either men or women were significantly more trusting, capable, or aware with regard to technology. The findings (Brand & Markert, 1995) are briefly summarized:

• Trust in technology: There were no significant gender differences as males and females rated themselves, nor were there any differences in how they evaluated each other.

• Faith in technology: Men were significantly higher in their levels in the safety of technology, but there were no significant differences in how the males and females viewed each other on this aspect of technophobia. This finding echoes the work of Pilisuk and Acredolo (1988) cited above, which suggested that women express more emotional concern over technological dangers than men do.

• Technological knowledge: The males rated themselves significantly higher in their level of technological literacy than did the females, but there were no significant differences in how they rated each other.

• Capability in using technology: This aspect of technophobia was categorized into seven areas of skill (computers, audio, video, communications, automotive, general, kitchen). With the exception of communications and kitchen technologies, the males rated themselves significantly higher in their level of skill in using or working with technological artifacts than did the females. The findings were mixed when responses regarding how males and females assessed each others' skill levels were reviewed.

While these results may show that women have just as much trust in technology and its artifacts as their male colleagues, there is a persistent tendency for women to be harder on themselves than men are. The males in the study did in fact rate themselves higher on items designed to measure technological literacy, but they did not report that they believed women to be less knowledgeable. When the students were asked to evaluate their levels of skill, there were only a few cases when the males and females both felt that men were more capable in their use and operation of technology (i.e., audio, video, automotive). As we continue our research and study gender differences with reference to specific behaviors related to technophobia, it will be interesting to see whether or not we find even fewer differences between males and females.

Projections and Recommendations

Female college students who matriculate in the 1990s have grown up in a world in which women have had numerous opportunities to achieve success in careers traditionally pursued by men. Conversely, their opportunities to obtain leadership positions where they can truly control and influence the development of technology or the direction of science and technology policy in this country have not been plentiful. Garrod and Taber (1991) reviewed job titles and descriptions provided by the respondents in their longitudinal study, who represented nine years of female engineering alumnae, and concluded that only 4% were holding any type of technical management or supervisory positions.

What then are the strategies that can be recommended to encourage more females to first of all enter and then forge ahead to make a memorable difference in the STEM disciplines? Can this essay close on a note of optimism for those women who aspire to obtain a leadership position in a STEM job? What useful tools for survival can be prescribed for young female scientists, technologists, engineers, and mathematicians who are just now finishing their college degree programs?

The previously described formula for success offers several of the key tools such as early exposure to technology, confidence in using technology, information to enhance technological literacy, willingness to learn new skills, and higher levels of faith and trust in technology (i.e., reduced fear). If we ever expect to convince female students to pursue STEM careers, it is obvious that their early academic foundation must at least include practical activities related to an understanding of and appreciation for these subjects. All of the current curricular initiatives designed to integrate mathematics, science, and technology (MST) show promise. The desire among some educational leaders to infuse MST courses in kindergarten through grade twelve, if realized, will also have a positive impact on the recruitment of females into the STEM workforce. Beyond these efforts:

1. Educators, parents, and journalists need to do whatever it takes to dispel the notion that MST courses are just too hard for girls.
2. Business organizations and academic institutions alike need to recognize that female career paths are just as essential and highly regarded as those pursued by men. Spousal hiring assistance programs should no longer be the exception to the rule in today's corporations.
3. Mentors are critical (male or female) to ensure that a younger person's accom-

plishments are publicized and showcased for management's attention. It is difficult for women to demonstrate their talents if they do not have the assistance of a mentor—especially if they don't fit the typical STEM mold.

4. Successful female STEM professionals must not let themselves become isolated. They must network, maintain professional growth activities, and be willing to act as mentors to their younger female colleagues.
5. Educators at all levels (both male and female) must be mindful of a wide assortment of behaviors they may unknowingly display that create a chilly classroom or null academic environment for their female students.
6. While careers in STEM are not generally perceived as glamorous, the disciplines have the responsibility to promote themselves as dynamic, exciting, aggressive, and eminently challenging areas of human endeavor.
7. Career counseling and opportunities for industrial/business internships and partnerships must occur well before high school. Young girls (and boys, too) should have a chance to experience real-life STEM in action while they are still formulating career decisions.
8. Corporate executive officers and heads of government laboratories should make it a primary mission to recruit, appoint, and retain women in senior-level management and research scientist positions. They must do what is necessary to reduce the rate of attrition of female scientists and engineers who work for them.
9. Working STEM professionals are the only persons who can effectively change the culture and work environment of their disciplines from within. And this, my friends, is perhaps the most challenging call to action we face at this point in time.

Finally, it seems that some females who have achieved success and influence in science and technology have somehow managed to make themselves genderless. This is not to suggest androgyny, but simply a more distant attitude toward the issue of gender as an independent variable. Women who are effective leaders are self-confident and view themselves and wish to be viewed by others as successful and professional technologists, engineers, scientists, and academicians. On the other hand, the ability to maintain a somewhat insouciant attitude about one's own accomplishments is a trait that ultimately inspires the respect and trust of male colleagues in technology professions. Although we continually need to recognize and applaud the significant contributions women can, have, and will continue to make to lead the future course of scientific and technological progress into the next century, we ought not idolize them as "superstars." It is far easier to emulate persons who make their accomplishments look effortless than it is to see yourself winning a gold medal. Stated differently, young girls (and boys) must be able to perceive female role models in science and technology as real persons. Those few women who have managed to penetrate the glass ceiling recognize that effecting change in the culture of STEM is something women must do themselves in order to ultimately convince male colleagues that it is feasible to work in a professional environment based on mutual respect, collegiality, and a resounding esprit de corps.

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