Perspective

Global Efforts for Local Empowerment of Women Engineers

Johanna Levelt Sengers
National Institute of Standards and Technology, Gaithersburg, MD 20899

Betty Shanahan
Society of Women Engineers, Chicago IL 60611

Steven P. Castillo
College of Engineering, New Mexico State University, Las Cruces, NM 88003

DOI 10.1002/aic.11469
Published online February 28, 2008 in Wiley InterScience (www.interscience.wiley.com).

Keywords: carthage declaration, good management practice, InterAcademy Council, science academies, Society of Women Engineers, technological workforce, World Federation of Engineering Organizations

Introduction

The lack of participation of women in the science, technology, engineering and mathematics (STEM) enterprise has become a hot topic in the scientific, engineering, and sociological literature, as well as in magazines and newspapers.[1–6] One reason is the period of transition that the STEM field has entered, marked by a sizeable influx of young women in the 1990s, in contrast with a near-absence of women in leadership roles. The persistent imbalance threatens to impede further progress. The other is concern about keeping the STEM workforce at full strength.

The STEM fields have indeed been the driving force for the innovations that have transformed the way information is created and accessed. They have enabled dramatic improvements in the quality of life, and are engines driving the world economy. Today, STEM practitioners are called upon to find solutions to the sustainability crises enveloping the world. When countries, such as the U.S., continue to have an insufficient supply of STEM practitioners, while routinely importing a sizeable fraction of their STEM graduate students and professionals, the enormous potential of attracting additional women into STEM remains unrealized, limiting future economic growth.

Discouragement of girls from mathematics and science classes in American high schools was the rule in much of the 20th century, fueled by, and reinforcing the popular belief that girls cannot do and are not interested in science. Systematic exclusion of women from engineering education was still practiced in some premier U.S. engineering departments by the late 1960s. In many countries where such discouragement and exclusion were less pronounced than in the U.S., there was, and often still is, a de facto end to participation in STEM research and practice after women finish their university studies or get married.[7] The resulting dearth of female role models at the levels of leadership gives rise to other perceptions, such as: women are not welcome in STEM, and: women cannot be technical contributors or leaders in industry, government, or academe.

In the next sections, we describe some of the forces challenging the status quo. As World War I ended, isolated women professionals began to form networks and organizations, and discovered that the marginalization they experienced was a common result of the organizational culture in STEM. Women's organizations have since worked persistently, providing guidance, support and grants to female students; stemming some of the exodus of talented female colleagues by providing advice and mentoring; and raising consciousness.

Another force is diversity of the work force. In the U.S., ending the exclusion of women from any field has been part of the legislature of civil rights in the 1960s, equal education access (Title IX) in the 1970s, and equal economic opportunities in the 1980s. These laws protect the rights of racial and ethnic minorities, women and people with disabilities. The motivation is not only that white non-Hispanic males will soon be a minority of the U.S. workforce—organizations will actually benefit from the increased creativity of a diverse team. Making use of the new opportunities offered by diver-

Correspondence concerning this article should be addressed to J. Levelt Sengers at johanna.sengers@nist.gov.

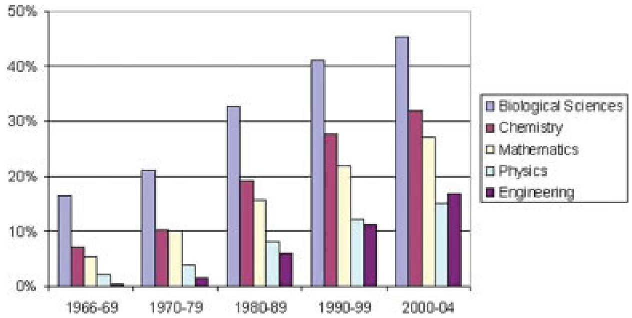

Figure 1. Percentages of women obtaining PhD's in STEM disciplines at U.S. universities in the last four decades.[42]

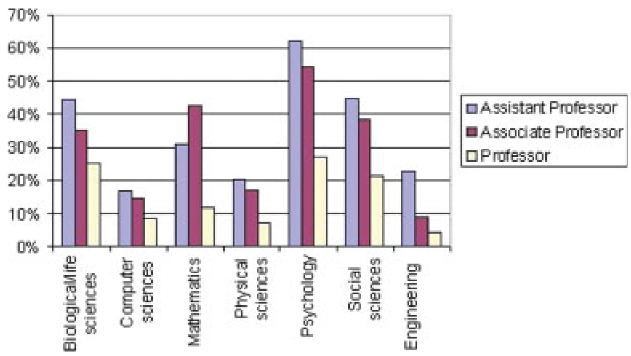

Figure 2. Percentages of women in academic positions in STEM in the U.S. in 2007.[43]

sity of the workforce has indeed become a government[8,9] and business priority.[10–13]

Another driving force is the desire and need to improve the life of the billions of human beings in developing countries. Here, the focus is on economic development, including issues such as education, population growth, agricultural practices, and health. Women experts in STEM disciplines, working with rural women—who bear the principal responsibility for health care, nutrition and agriculture in much of the developing world—are indeed crucial to achieving sustainable development of rural communities. Without access to education, communications, information, and technological innovation, women are marginalized and development is hampered.[14]

Recently, sociological and psychological studies have invalidated many of the commonly held beliefs about women's perceived lack of capability in STEM.[15,16] Once high school counselors and teachers began to encourage girls, well prepared young women started streaming into the "hard" sciences (physics, astronomy, chemistry, mathematics, the biological sciences and geology), as well as engineering and computer science. Presently, women in the U.S. earn 16% of the PhDs in physics and engineering, and are close to achieving parity in the biological sciences (Figure 1). The global picture is not all that different (Table 1). As a result, the STEM field in a time of transition. Entering undergraduate STEM classes are increasingly mixed-gender, although in the U.S. a worrisome leveling-off is seen in some STEM disciplines, but the composition of university faculty (Figure 2) and leadership, and of the decision-making levels in industry, still reflects the absence of women from STEM typical of the previous generation. How to make it through this transition period without undue loss of talent is a focus of this article.

Actions "from the bottom up", such as the efforts of women's professional networks, for instance, the International Colloquium "Empowering Women in Engineering and Technology"[17] will pass review first. The Colloquium was organized by the World Federation of Engineering Organizations (WFEO) in Tunisia, June 6–8, 2007, and the authors of this article all participated.

Actions "from the top down" by government, business leaders, and science academies are discussed next. The main focus is on a recent global study, co-chaired by one of the present authors (JLS): the 2006 InterAcademy Council Advisory Report "Women for Science".[14]

An overview then follows of the means available and the actions taken, or to be taken, to achieve full inclusion of women in STEM. A concluding section summarizes the principal points of the article.

Table 1. Doctorates in Engineering for Selected Countries, for 2002 or Most Recent Year[41]

Country	Total	% Women
Australia	457	22%
Canada	440	13%
Czech Republic	228	25%
France	957	27%
Germany	2,033	9%
Ghana	82	10%
Iran	76	5%
Israel	55	25%
Italy	738	36%
Japan	3,355	10%
Kenya	59	17%
Morocco	109	40%
Netherlands	444	18%
Russia	7,865	47%
South Korea	1,899	13%
Spain	475	25%
Sweden	927	25%
Switzerland	322	13%
Taiwan	656	6%
Turkey	344	30%
United Kingdom	2,020	18%
United States	5,242	17%

Actions from the bottom up

"Women's organizations have played a valuable role in raising the profiles of women scientists and engineers, and bringing to light the problems they face in environments dominated by men. At the more informal levels, small groups of women from professional societies and learned institutions have met to network, support each other, and influence the policies of their employers"[14] and their governments.

One example is the International Congress of Women Engineers and Scientists (ICWES), a triennial conference, which has been held since 1964. In 2001, the International Network for Women in Engineering and Science (INWES), was created and assumed the leadership for the continuity of ICWES. In addition INWES sponsors biannual regional leadership workshops for women in developing regions, and hosts a networking website. The 14th ICWES is scheduled in France in 2008, and will be hosted by Femmes-Ingénieurs (FI). FI was founded in France in 1982 by the pioneer women who pushed their way into French engineering schools in the 1920s.

The Third World Organization for Women in Science (TWOWS), founded in 1989, is the world's largest organization of women scientists, intent on improving the status of women in Sub-Saharan Africa, and in many other countries in early development. In the U.S., examples of women's organizations in STEM are the Society of Women Engineers (SWE),[18] an educational and scientific organization founded in 1950; the Center for Women in Information Technology (CWIT),[19] founded in 1998 to foster gender research in IT; and the Association of Women in Science (AWIS),[20] an advocacy group founded in 1971. In addition, women have formed committees within their disciplines' professional organizations. Some examples are the American Physical Society's Committee on the Status of Women in Physics, founded in 1972, the Women's Initiatives Committee (WIC) of the American Institute of Chemical Engineers, founded in 1997, and the IEEE Women in Engineering. These professional women's organizations aim to break the isolation women experience in male-dominated fields, to improve women's status and visibility, and to encourage girls to enter STEM fields.

In parallel, the disciplines of psychology, sociology, as well as "women's studies," have focused on finding reasons and remedies for the persistent, universal under-representation of women in the STEM fields. GASAT, the Gender and Science and Technology Association, exemplifies this approach.

Recent psychological and sociological experiments have yielded striking results, such as the universal undervaluing of women's achievements. For instance, the same proposal, CV, or manuscript, submitted for evaluation first under a female name, then under a male name, was ranked systematically lower by both male and female evaluators if submitted under a female name.[21] A Catalyst study[22] found that both male and female executives stereotype women as "caring": supporting, rewarding, and mentoring, and men as "taking charge": delegating and influencing upward, that is, effective leadership. It is easy to imagine what such unconscious biases will do to the advancement of women in STEM.

Other sociological results pertain to the early differences in socialization of boys and girls, practiced by both parents, and reinforced heavily by the global consumers' market, educator behaviors and the middle-school peer group.[23,24]

Gender-related perceptions of the STEM disciplines as boring male occupations not related to human well-being aggravate the already unflattering image of mathematicians, physicists, and engineers shared by the general public and by too many pre-college teachers and counselors.[25] This image turns both boys and girls away from STEM, and is becoming a great concern to college educators, as well as to business leaders and governments in the industrialized world.

The recent WFEO International Colloquium "Empowering Women in Engineering and Technology" in Tunisia provided a window onto the many forces, actions and changes occurring in engineering education, and in the technology workplace throughout the world. The colloquium was co-chaired by Kamel Ayadi, President of WFEO and Claudia Morrell, Director of CWIT. Sponsors included UNESCO, SWE, CWIT, FI, GASAT, and the U.S. State Department. Financial support came from Hewlett-Packard, and Cisco. CAWTAR: the Center for Arab Women for Training and Research led the excellent local arrangements.

Figure 3. World Federation of Engineering Organizations President, Kamel Ayadi, poses with members of the Association of Professional Women Engineers of Nigeria: Engineers Mrs. IjeomaTerese Ihenachor (left), and Mrs. Mayen Adetiba, FSNE (right).

Photo courtesy of the World Federation of Engineering Organizations.

Tunisia, a former French colony with six million inhabitants, has made great strides toward eradicating illiteracy and advancing women. Almost half of the Colloquium's 400 participants were from Tunisia. Among the participants from 60 other countries (cover picture), there was heavy representation from sub-Saharan Africa. Particularly noteworthy was the contingent from Nigeria (Figure 3), 45 mostly female engineers, the majority of them working for national or private engineering corporations, and members of the Association of Professional Women Engineers of Nigeria (APWEN), founded in 1982. The USA was represented by 31 mostly female participants, of which about 1/3 were in private business/industry, 1/3 associated with universities, while the remaining 1/3 represented a variety of government organizations and NGOs. No US discipline-focused engineering societies were represented, but the National Academy of Engineering delegated one staff member. There was a substantial, but not overwhelming presence of women experts and students involved in gender issues and gender studies.

The conference was structured on four tracks:

- Girls and women in engineering education;
- Women as entrepreneurs of small and medium enterprises;
- Women enabling technology in communities;
- Women in the engineering and technology workforce.

For each of the tracks, there was an introductory speaker, followed by numerous presentations and panels by participants from around the globe. Particularly heartening was the pride displayed by women from the Middle-East and Africa, who are making a success of their own businesses and providing jobs to women. Themes that were consistent across sessions, and formed the basis for the resulting "Carthage Declaration"[26] to WFEO are:

- Increasing the participation of women in the fields of engineering and technology will benefit all communities world-wide, contribute to their economies, and advance humanity.

- The participation of women in the engineering fields will be augmented by enforcing salary parity and provisions for raising a family, and by encouraging networking.
- The participation of women engineers and technologists in top managerial positions across the world will introduce a new outlook on leadership.
- The creation of an environment favorable to women requires at least 35% women participating at all levels of any organization, including top managerial positions.[1]

Action from the top down

In this section, we give a brief overview of motivations and actions by leading agencies in STEM worldwide, including governments, business, universities and science academies.

The United Nation's 1995 Fourth World Conference on Women, held in Beijing, focused on the rights of women to acquire education, economic power, and inclusion in leadership. The Beijing Declaration made specific reference to women in science and engineering.[27] The UN has since deployed numerous initiatives related to the education of girls and the careers of women in science and technology. UNESCO, in particular, has fostered international networks for women in STEM in the developing world.

Governments in many countries have become concerned about their STEM workforce, and about the loss of talent due to under-representation and dropout of women. In Europe, the UN equal-rights model led the way. Thus, the Treaty of Amsterdam, 1997, assigned to the European Union (EU) the promotion of equality of men and women as one of its basic tasks. The UK, which by 1993 had realized that women were an underused resource in STEM,[28] put the issue of women and science on the EU agenda in 1998. The European Commission, in 1999, established a group of national representatives responsible for women and science issues. This group met for the first time in Helsinki. The Helsinki Group members produce national reports on the situation of women scientists, and summarize and analyze these data.[29] The Helsinki Group assists the Commission in collecting sex-disaggregated statistics, and has a large influence on establishing EU policies encouraging and facilitating women's participation in STEM, as well as on EU funding programs.

The emphasis in Europe is, thus, on the principle of equality of men and women, measured by representation, for which targets are set in strategic planning, while funding programs are set up to eliminate gross under-representation of women.

In the U.S., as a consequence of the civil rights movement in the 1960s, the emphasis is on providing equal opportunities for all members of a society that is inherently diverse, and the focus is on eliminating existing barriers to under-represented minorities. The US took an early lead in improving diversity in STEM by passing the Equal Opportunities in Science and Engineering Act of 1980, followed by the founding of the Committee on Equal Opportunities in Science and Engineering, based at the National Science Foundation (NSF). NSF's several decades of attention to race and gender issues in the evaluation and funding of proposals, creating fellowships for under-represented groups, and encouraging change in the institutional culture, is paying off. One tangible result is the influx of women into the STEM disciplines.

In India, among the large masses of poorly educated villagers and slum-dwellers, women are the most disadvantaged. On the other hand, a highly educated fraction of the population propels modernization, and men and women enter college in roughly equal numbers, with near-parity in the sciences and over 20% women in engineering.[7] Traditional views, however, keep women from reaching their full potential. The government realizes that the education of women is key to elevating the masses of the poor, and that the dropout of highly educated women from the professions must be stemmed.[7,14]

Businesses are recognizing that diversity is not just a moral imperative, but also a business imperative.[11,13,30] "Employees from varied backgrounds can bring different perspectives, ideas and solutions, as well as devise new products and services, challenge accepted views and generate a dynamic synergy that may yield new niches for business opportunity."[31] A diverse organization gains flexibility in adapting to changing environments.[32] A study found that companies with the highest representation of women on their senior management teams had a 35% higher return on equity, and a 34% higher total return to shareholders than companies with the lowest women's representation.[33]

Universities in most countries, well through the middle of the 20th century, and particularly in science and engineering, maintained the tradition of an elite male preserve, where women have had a hard struggle to enter and survive, let alone to make a career. Leadership from the top is a recent phenomenon. The so-called MIT report of 1999[34] has been very influential in inducing change. The handful of senior women faculty, on request of the Dean of Science, carefully documented how they were disadvantaged in access to funding, laboratory space, and participation in decision-making committees. The MIT President took action to remedy the inequities. The MIT example rippled through the US university system, where many universities performed similar introspections and found that much improvement was needed, both at the student level, and in the way female faculty was recruited, supported and promoted.

Science and Engineering Academies, whose members, on average, are a full generation older than beginning university faculty, have been the slowest to realize that the virtual absence among their membership of women in the STEM disciplines might be perceived as a problem. Notwithstanding, or perhaps because of, their single-digit female membership percentages in STEM disciplines, the UK's Royal Society, the three Indian Science Academies, and the US National Academies of Science (NAS) and Engineering (NAE), have become leaders among the world's academies in efforts to make change. The U.S. academies, for instance, have published reports documenting the problems women encounter in the STEM disciplines,[15,35] and have set up both science and engineering websites targeting middle- and high-school girls.[36]

The world's 95 science academies are gathered under an umbrella organization, the InterAcademy Panel (IAP). In 1998, IAP formed the InterAcademy Council (IAC), with the mandate to study and report on issues of global concern. Its studies, so far, have been related to the role of science and engineering in developing nations, agriculture in Africa, and global energy.[37]

[1]The first author (JLS) expresses reservations about this statement. The origin of the 35% number may well be: Kantor, Rosabeth Moss. *Men and Women of the Corporation*. New York: Basic Books. 1977. Kantor's statements (referring to minorities that are visually distinct from the majority) are more nuanced: below 15%, the minority may dwindle; from 15–35%, maintaining the minority group requires vigilance and support; above 35%, the minority group is comfortable and requires no special support.

Table 2. Principles of Good Management Practice[44]

Goal

All members of the organization perform to the maximum of their potential, for the benefit of the organization.

Approach

- Top-level commitment to full inclusiveness of minorities within the organization.
- Establishing a necessary infrastructure.
- Widening the 'inner circle', where decisions are made, so that it becomes inclusive.
- Reviewing all policies and procedures for their impact on minorities.
- Transparency in communication, recruiting, hiring, promoting, salary reviews, and conferring of awards.
- Leadership training and mentoring of minorities, as well as of the majority.
- Supporting a healthy work-family balance for all employees.
- Setting indicators and establishing benchmarks in comparison with other organizations.
- Regular monitoring and review of progress by collected data disaggregated by sex, or other minority status.
- Sustained effort: changing institutional culture takes time.

Recently, they have produced an advisory report "Women for Science"[14] that gives a global overview of the status of women in STEM, and makes specific recommendations to Academies to help reduce women's under-representation. One of us (JLS) co-chaired the panel that wrote the report.

What needs doing?

In the introduction, the historical factors causing the absence of women from STEM disciplines were presented. The introduction stressed that, especially in the U.S., engineering fields find themselves in an interesting and challenging transition period: the entire top of the educational and industrial establishment is preponderantly male (Figure 2), while the influx from the bottom is becoming increasingly female (Figure 1 and Table 1). The institutional culture still being that of a male preserve, the precious female talent receives the covert or overt message to fit in or get out. Disenchantment with that culture may be causing the recent leveling-off of women undergraduates entering STEM. Forward-looking institutions and businesses, however, realize that the diversity of their staff is a valuable asset. They are gearing up to make the most of their human capital by sensitizing their hiring departments and managers to diversity issues brought about by the changing character of the workforce.[8,11–13,30,31]

Developing countries can afford even less to neglect the education of girls, nor to keep women ignorant of the benefits of science and technology. Since a billion or more rural women still bear the responsibility for health care, water management, agriculture, and nutrition in large parts of the developing world, engaging them in sustainable practices is essential to development. Educated women of their own culture (such as the biologist Wangari Maathai, founder of the Green Belt Movement in Kenya, and winner of the 2004 Nobel Peace Prize), are the link between modern science and technology, and the grass-roots communities that are yearning for health, education, and economic prosperity.

A prominent message of the IAC report is to increase the visibility of women scientists and engineers. Most STEM materials—textbooks, department newsletters, recruiting pamphlets, speakers' rosters at professional meetings—leave the impression that practitioners of STEM are exclusively male. Addressing this deficit is part of solving an even bigger problem facing the STEM disciplines in the industrialized world today: how to change their public image so that it can inspire and attract the young.

For changing the institutional culture, "equality" has not been a sufficient guidepost. Men and women are not equal in their biological roles regarding procreation. Furthermore, "equalizing" does not do justice to the individual creative talents that are essential to high-achievement in STEM. Gradually, however, the insight has ripened that minorities, as women in STEM mostly are, can flourish in a majority culture if they, just like their male colleagues, are given the opportunity to fully develop their individual talents for the benefit of the institution they serve. The IAC report calls this principle and its consequences "Good Management Practice,"[14] while it goes under the name of "Gender Equality Mainstreaming" in the European Union,[39] and "good practice" or "best practice" in university and business circles.[40]

Table2 summarizes the elements of good management practice. They require a firm commitment to inclusiveness at all levels by the organization's leadership, and persistent attention to gender issues in all operations. Encouraging a healthy work-family balance benefits all employees. Pay-offs will include a work environment conducive to success for all employees, and a decline in dropout of new hires.

In various forms, multinationals and business leaders[13,30] have adopted good management principles for including women and other minorities in STEM fields.

The U.S. National Science Foundation's "ADVANCE" initiative[40] deserves particular attention. Its objective is to develop approaches toward increasing the participation and advancement of women in academic STEM careers, thus contributing to development of a more diverse workforce. Colleges of Science and Schools of Engineering can apply for Institutional Transformation grants for initiatives in diversifying their faculties and supporting their women faculty members. At the 2007 WFEO Colloquium in Tunisia one of us (SPC) discussed the ADVANCE Program at the NMSU College of Engineering, of which he is the Dean.

In 2007, the IAC report has been adopted by the InterAcademy Panel as a top priority for the coming three years. This implies that IAP

- will urge the world's 95 science academies to begin implementing the report's recommendations;
- encourage academies to share experiences and success stories;
- organize workshops in various parts of the world to highlight the issues of women in STEM.

Efforts are underway to have Engineering Academies participate.

As to the results of the WFEO conference in Tunisia, the "Carthage Declaration"[26] made the following recommendations to WFEO:

- WFEO to encourage, display, promote and support women engineers and technologists as entrepreneurs, inventors and innovators.
- WFEO to lead in promoting equal opportunity of education to girls and women, and to offer them engineering as a career choice.
- The WFEO Standing Committee for Women in Engineering (WIE) to create a network of national WIE committees, and develop and maintain a website for sharing information.
- WFEO to establish an international center for women in engineering and technology.

WFEO president Kamel Ahady concluded the Colloquium in Tunisia, by proclaiming WFEO's intention to

- implement the recommendations of the Carthage declaration;
- establish a working group to review UNESCO's report on gender issues in STEM;
- form a standing committee on gender issues;
- invite a women speaker at a planned women's forum at the next WFEO World Engineers Convention;
- establish an international center for women in engineering.

Since the Colloquium, a working group has begun preparing the forum on women that will be organized in conjunction with the WFEO World Engineers Convention in Brazil in December 2008. Also, the WFEO General Assembly approved the creation of a Standing Committee on Women co-hosted by Nigeria and France at its November 2007 meeting.

Conclusions

We have reviewed the factors that have facilitated the influx of women into the STEM disciplines:

- Persistent pressures applied by women's professional organizations.
- International and national governmental actions in the framework of equal rights and access to opportunities for women.
- Women students and professionals proving that, once given the chance, they are capable of performing the work.

The presence of women is now quite noticeable at the entry levels in high school, college, and graduate school, but the STEM tenured faculty, and the industrial and business leadership are still male-dominated. In an optimistic view, this is a temporary aberration that will fade as more women enter the field. This view is not consistent with the facts that there is a recent leveling-off or even a decline at the STEM entry levels at U.S. universities.

Women remain reluctant to apply for faculty positions at research universities, and are slow to progress to tenure. The reluctance of qualified women to apply at prestigious STEM faculties and for top positions at companies is due to factors such as:

- These positions come with oppressive workloads and frequent travel. Women find them hard to reconcile with their personal and family priorities.
- The scarcity of women at the top keeps alive the perception that the institutional climate is not hospitable to women.

The first factor is a vicious circle. Active measures are needed to increase the percentage of women at the higher levels of the organization. The leadership needs to be aware of the unintended and intentional discrimination throughout the organization, and to firmly commit to creating a truly inclusive workplace.

The second factor can offer an opportunity to enlightened leaders. Those who recognize that talent and skills are precious commodities that must be nourished, and that optimum performance requires a healthy work-life balance, will benefit from fostering nontraditional corporate cultures. Introducing good management practices (Table 2) will facilitate reaching those objectives.

We began this article by highlighting the role of women's professional organizations in opening doors for women in STEM. We end with some observations regarding their present functioning, taking the 2007 WFEO Colloquium as an example.

The strong points of this colloquium were obvious. The colloquium gave women engineers, scattered across the globe, often trailblazers themselves, a chance to meet and interact; learn they are not alone; and that the difficulties they may be experiencing are part of an outdated institutional culture. The colloquium was encouraging, mentoring and training women. It offered opportunities for networking and for leadership development.Women's networking is indeed essential in breaking the isolation and marginalizing that have so long been women's fate in occupations where they are a minority. The ultimate goal, however, must be for women in STEM to be fully incorporated in the networks of the institutions and organizations they work for.

The missed opportunity was also obvious. The audience was 90% female, while the engineering profession is roughly 90% male. Few engineering societies and engineering academies were officially represented at this WFEO conference. Representatives of the leadership of technical universities or colleges of engineering were rare. Few leaders of NGOs or multinationals were there to hear about the working experiences of women engineers. Their absence sent a message that a major source of unused talent is of no big interest to the engineering profession.

In our opinion, to open the engineering field to women it is critical to establish a serious dialog between women's professional engineering societies and the male leadership in the field. Women's organizations have a wealth of information and experience to share, going back decades and crossing organizational and geographic boundaries. They have links to the findings of gender studies that expose the unconscious biased assumptions regarding gender roles that various cultures harbor. They are a strong and committed force that should be welcomed and harnessed in order to reach the goal of full acceptance of women in STEM. Women's organizations can also help the STEM professions with impressing on young women what creative and innovative engineers are doing to shape a better world.

Acknowledgments

One of us (JLS) acknowledges the hospitality of Universidad Complutense, Física Applicada I, Madrid, Spain.

Literature Cited

1. Summers LH, Remarks at NBER conference on diversifying the science and engineering workforce, www.

president.harvard.edu/speeches/2005. This document is no longer posted on this Harvard web page, but a subsequent clarification is.

2. Ripley A. Who says a woman can't be Einstein. *Time*. March 7, 2005:165(10).
3. Linn M. Why aren't there more women in science? Can evidence inform the debate? *Science*. 2007;317:199–200.
4. Martinez E.D, Botos J, Donohey KM., Geiman TM, Kolla SS, Olivera A, Qiu Y, Vani Rayasami G, Stavreva D, Cohen-Fix, O. Falling off the academic bandwagon. *EMBO Reports*. 2007;8(11):977–981.
5. *Catalyst*. 2005 Catalyst census of women board directors of the Fortune 500 shows 10-year trend of slow progress and persistent challenges. March 29, 2006.
6. Bhattacharjee Y. Postdoc survey finds gender split on family issues. *Science*. 2007;318:697.
7. Indian National Science Academy. *Science Career for Indian Women: An Examination of Indian Women's Access to and Retention in Scientific Careers*. New Delhi, India; 2004. www.insaindia.org.
8. National Science Foundation. *Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology*. A Report by the Commission on the Advancement of Women and Minorities in Science. Engineering and Technology Development. 2004. www.nsf.gov.
9. National Science Foundation. Women, Minorities, and People with Disabilities in Science and Technology. 2007.
10. Centre for Strategy & Evaluation Services, *Methods and Indicators to Measure the Cost-Effectiveness of Diversity Policies in Enterprises*. October 2003;52–63.
11. National Academy of Engineering, Committee on Diversity in the Engineering Workforce. *Diversity in Engineering: Managing the Workforce of the Future*. Washington, DC: National Academy Press. 2002. www.nap.edu.
12. Wulf, W. The Importance of Diversity in Engineering. In Ref. 11.
13. Padilla, J. The Business Case for Diversity. In Ref. 11.
14. InterAcademy Council. *Women for Science; An Advisory Report*. Amsterdam: Edita, 2006. ISBN 90-6984-492-3. www.interacademycouncil.net.
15. Committee on Maximizing the Potential of Women in Academic Science and Engineering, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering*. October 2006.
16. Hyde, JS, Linn MC. Gender similarities in mathematics and science. *Science*. 2006;314(5799):599–600.
17. www.wfeo.org/women.html.
18. www.swe.org.
19. www.umbc.edu/cwit.
20. www.awis.org.
21. Steinpreis R, Anders K, Ritzke D. The impact of gender on the review of curricula vitae of job applicants and tenure candidates: A national empirical study. *Sex Roles*. 2002;41(7/8):509–528. www.umich.edu.
22. *Catalyst*. Women "Take Care", Men "Take Charge": Stereotyping of US Business Leaders Exposed. 2004.
23. Jacobs JE, Davis-Kean P, Bleeker M, Eccles JS, Malanchunk O. I Can, But I Don't Want To: The Impact of Parents, Interests, and Activities on Gender Differences in Math. *Gender Differences in Mathematics: An Integrative Psychological Approach*, Gallagher JM, Kaufman JC, eds. 2005;246–263.
24. AAUW Educational Foundation Commission on Technology, Gender, and Teacher Education. *Tech-Savvy: Educating Girls in the New Computer Age*. 2000;23–26.
25. Douglas J, Iverson E, Kalyandurg C. *Engineering in the K-12 Classroom: An Analysis of Current Practices & Guidelines for the Future*. American Society for Engineering Education; 2004. www.engineeringk12.org.
26. http://www.wfeo.org/documents/download/Carthage%20Declaration%20on%20Women%20Empowering%20eng.pdf.
27. Beijing Declaration and Platform for Action. *Report of the Fourth World Conference on Women*. New York, NY; 1995. www.un.org.
28. Peters J, Lane N, Rees T, Samuels, G. *SET Fair: A Report on Women in Science, Engineering and Technology from Baroness Greenfield to the Secretary of Trade and Industry*, UK. 2002. www.setwomenresource.org.uk.
29. Rees T. *The Helsinki Group on Women and Science in Europe: National Policies on Women and Science in Europe*. Luxemburg Office of Official Publications of the European Communities; 2000.
30. Thomas DA. Diversity as Strategy. *Harvard Business Review*. September 2004.
31. Society for Human Resource Managers. *What is the "Business Case" for Diversity?* 2003. http://shrm-emeraldcoast.org/diversity_documents/article7_business_case.htm.
32. Lockwood, NR. *Workplace Diversity: Leveraging the Power of Difference for Competitive Advantage*. Society for Human Resource Management; 2005.
33. *Catalyst*. The bottom line: Connecting corporate performance and gender diversity. 2004.
34. MIT Committee on Women Faculty in the School of Science. *A Study on the Status of Women Faculty in Science at MIT*. MIT. March 1999.
35. Committee on Women in Science and Engineering, National Research Council. *To Recruit and Advance: Women Students and Faculty in Science and Engineering*. Washington DC: National Academy Press. 2006. www.nap.edu.
36. www.engineergirl.org, www.iwaswondering.org, www.engineeryourlife.org.
37. These reports can be found on www.interacademycouncil.net.
38. Osborn, M, Rees T, Bosch M, Hermann C, Hilden J, McLaren A, Palomba R, Peltonen L, Vela C, Weis D, Wold A, Wennerås, C., *Science Policies in the European Union: Promoting Excellence through Mainstreaming Gender Equality*. A report from the European Technology Assessment Network (ETAN) on Women and Science. Luxemburg Office of Official Publications of the European Communities. 2000. www.cordis.lu.

39. Fox C, McWinnie S. *Good Practice in University Chemistry Departments*. Royal Society of Chemistry and the Athena Project. 2004.
40. http://www.nsf.gov/funding/pgm_summ.jsp?pims_id5383, and http://www.nsf.gov/crssprgm/advance/itwebsites.jsp.
41. National Science Board. 2006. *Science and Engineering Indicators 2006*. Arlington, VA: National Science Foundation (volume 1, NSB 06-01; volume 2, NSB 06-01A).
42. National Science Foundation. *Science and Engineering Degrees: 1966-2004*. NSF 07-307. January 2007. Available from http://www.nsf.gov/statistics/nsf07307/.
43. National Science Foundation, Division of Science Resources Statistics. *Women, Minorities, and Persons with Disabilities in Science and Engineering*. NSF 07-315. February 2007. Available from http://www.nsf.gov/statistics/wmpd/.