Chapter 6
Organizations That Help Women to Build STEM Careers

Abstract This chapter begins the second half of the book, which examines various case studies. The chapter is devoted to the descriptions and histories of four organizations that have worked to support increased numbers and better experiences for women in science and engineering careers. The chapter considers these organizations in the chronological order of their origins: the Society of Women Engineers (SWE 1950), the Association for Women in Science (AWIS 1971), the Women in Engineering ProActive Network (WEPAN 1990), and MentorNet (1997).

This chapter is devoted to the descriptions and histories of four organizations that have worked to support increased numbers and better experiences for women in science and engineering careers. We consider these organizations in chronological order of their origins. The Society of Women Engineers (SWE) was created in 1950, the Association for Women in Science (AWIS) in 1971, the Women in Engineering ProActive Network (WEPAN) in 1990, and MentorNet in 1997. All four of these organizations continue to be active today. Although this is a book focused on underrepresentation in computing, not on underrepresentation in the broader field of STEM, we include profiles of these four organizations for two reasons: before there were organizations devoted to underrepresentation in computing (most of which were formed in the late 1980s or the 1990s), the STEM organizations described below were the only ones that provided support to women in computing; and for the past 25 years, even though there have been specialty broadening-computing organizations, the organizations discussed here have continued to support women in computing. This is particularly true of MentorNet. These profiles are included to give a better overview of the organizations available to help women in computer; the profiles of the organizations specifically focused on computing, which appear in Chap. 8, are given in much greater detail.

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6.1 Society of Women Engineers (SWE)

The first organization that had any significant impact on broadening participation for women in the computing disciplines was the Society of Women Engineers (SWE), founded in 1950. Between 1946 and 1949, local groups of women engineers had been meeting on the east coast – in Boston, New York City, Philadelphia, and Washington, DC. The most active of these groups was created by women engineers at Drexel Institute of Technology in Philadelphia and City College and Cooper Union in New York City. Women had been encouraged to take on engineering jobs during the Second World War to replace men who had gone off to serve in the military. Once the war ended, women were discouraged from working or studying engineering so as to protect engineering positions for male veterans.[1]

SWE's objectives were stated in its Certificate of Incorporation as a nonprofit organization (February 13, 1952 as cited in Homsher 2011):

> To inform the public of the availability of qualified women for engineering professions; to foster a favorable attitude in industry toward women engineers; to contribute to their professional advancement; to encourage young women with suitable aptitudes and interest to enter the engineering profession; and to guide them in their educational programs.

There were internal struggles in SWE during the 1950s over how to carry out these objectives.[2] In the 1950s there were tensions between whether the goal should be to use activism to attain professional equity with male engineers or to increase public recognition for the accomplishments of women engineers as professionals. For example, there was debate over whether SWE should provide its own awards inasmuch as the traditional engineering societies such as the Institute of Radio Engineers and the American Institute of Electrical Engineers had done little to recognize and promote women as professional engineers. During its early years, SWE formed a Professional Guidance and Education Committee that encouraged and advised high school girls on engineering careers. In the mid-1950s, SWE formed Junior Engineer and Scientist Summers Institutes for high school girls to gain further experience with science and engineering, as well as receive college and career advice.[3]

These tensions continued throughout the 1960s and 1970s, mostly in connection with determining what SWE's role should be, if any, in supporting national legislation in favor of the rights of women: equal pay laws, community property laws, special women's legislation, Social Security, and above all the Equal Rights Amendment. Some women pushed hard for SWE to actively support these pieces of legislation, but

[1] For an interesting example of women replacing male engineers during World War 2, see the story of the Curtiss-Wright Engineering Cadets as told by Meiksins et al. (2011).

[2] For a more general discussion of women in engineering and science in the United States, see for example Bix (2004), Hacker (1981), Oldenziel (1999), Rossiter (1982), and Zuckerman et al. (1991). On the history of women in computing, see for example Abbate (2012), Edwards (1990), Ensmenger (2010), Fritz (1996), Grier (2005), Light (1999), and Misa (2011).

[3] On SWE's outreach to high school girls in the 1950s, see Bix (2004, 2013).

others were concerned that to do so would jeopardize the organization's nonprofit tax status or its professional credibility. The leadership was more conservative than the rank and file on these issues. In the 1970s, SWE had a period of activism: passing a resolution in favor of the Equal Rights Amendment, helping in 1973 to form the Federation of Organizations for Professional Women, and voting in 1977 to support the National Organization of Women's boycott by not holding the SWE National Convention in any state that had not ratified the Equal Rights Amendment. In the late 1970s, however, SWE's participation in the women's rights movement waned as some of the other organizations in the women's rights movement began to speak out in opposition to technology as something that undermined women's position in society.[4]

Membership in SWE stood at 61 in its initial year of 1950. Because of the Cold War and in particular the space race stimulated by the launch of the Russian artificial satellite Sputnik in 1957, there was a large increase in federal support for the study of science and engineering as a national defense measure.[5] A small amount of this support went to scholarships and fellowships for women engineers. By 1961, when SWE took offices in the newly opened United Engineering Center in Manhattan with all of the other major American professional engineering societies, membership stood in the 700s. Both the Civil Rights Act of 1964 and the Title IX legislation of 1972 increased university interest in educating women and minorities in the engineering disciplines. The first student chapters of SWE were formed in the late 1950s – at CCNY, Drexel, Georgia Tech, MIT, Purdue, and the Universities of Colorado and Missouri.[6] Rapid membership growth occurred in the 1960s and 1970s, especially among student members, and by 1982 total membership had reached 13,000. Membership today is more than 27,000.[7]

It is interesting to consider the place of race and ethnicity within SWE. A few African American women joined SWE in the early 1950s. The 1957 National Convention was held in Houston, and one woman, Yvonne Clark, was not permitted to stay in the conference hotel because of her race. As a result, SWE set a policy not to hold any of its national conventions in the South, which it only lifted after passage of the Civil Rights Act in 1964. In the 1970s, when new engineering societies such as the Society for Advancement of Chicanos and Native Americans in Science (SACNAS) and National Society of Black Engineers (NSBE) were formed, SWE members who were African American, Native American, or Latina felt torn between loyalty to these race-centered organizations and SWE.[8]

Today SWE offers a variety of programs: ones to interest girls and young women in engineering such as bringing a working engineer to meet middle schools girls,

[4] For more on SWE's political activism, see Kata (2011).

[5] For a discussion of SWE and the Cold War, see Puaca (2008, 2014).

[6] Bix (2004).

[7] On membership and the influences that have shaped it, see the SWE web pages and also Daniels et al. (2011).

[8] For a discussion of race and sex in SWE, see Watford (2011). For a more general discussion of race, ethnicity, and gender in science and engineering, see Leggon (2006, 2010) and Leggon and Eller (2011).

scholarships, professional awards, professional development programs offered in the form of webinars, conferences, and a career center with a large job board. A recent survey indicates that most women join SWE primarily to meet other women interested in engineering or to find support for their own career.[9]

It is difficult to identify how many of the members of SWE were particularly interested in IT-related disciplines or to gain any overview that has statistical reliability. But we do have accounts of a few individual women involved in SWE who have been interested in IT-related education, research, or work – and we tell several of their stories here.

Gwen Hays studied engineering at the University of Pittsburgh – the only female in an engineering department with 1500 students – and received a bachelor's degree in electrical engineering. She worked at the National Security Agency, where she became interested in software design, and at Westinghouse on computer-aided design and radar development, before retiring from Westinghouse and becoming a llama farmer. She tells how, when her local chapter of SWE wanted to join the Engineering Center of Baltimore, it was resisted for some time because the men did not want women members. She also discussed how she used SWE to learn "more about society and how to work with society [in a way] that you wouldn't [learn] through the engineering channel." (Hays 2010)

Suzanne Jenniches earned a bachelor's degree in biology and taught high school biology until she switched 4 years later to being a computer test engineer – the only female doing this job at Westinghouse. She moved up through the technical and management ranks to become the vice president and general manager of the government systems division of Northrop Grumman. She held leadership positions in a number of professional organizations, including the presidency of SWE. Although she found that she was able to develop the "rhino skin" that she needed to survive in the workplace and had a supportive husband at home, she valued SWE for being "a very nurturing and caring environment, with people who can relate and understand," a place where you can "be yourself," a place to practice leadership skills, and a place to network with technical women. She used her presidency of SWE to attract more executive-level technical women from industry into SWE because she believed they are the people most able to make a difference in the workplace environment.[10]

Thelma Estrin, who earned her bachelors, masters, and doctoral degrees in electrical engineering at the University of Wisconsin in the late 1940s and early 1950s, was a leading scholar in the application of electronics and computers to biology. She has also had two daughters who have had highly successful careers in the computing field – one as an entrepreneur, the other as a college professor. She looked enviously on the opportunity for young women in SWE today to have a "community," a place to get support; and she would have probably become active in the organization had she been younger, but as she was coming up through the ranks, she did it without the support of organizations or other women. As she said, "I was the first woman engineer I ever knew." (Estrin 1992, 2002, 2006)

[9] See Daniels et al. (2011).

[10] The direct quotations are taken from Jenniches (2003). But also see Jenniches (2010).

In 1979 Paula Hawthorn received a PhD in computer science from the University of California at Berkeley with work on database systems. She worked for Hewlett Packard, Lawrence Berkeley Laboratories, and several startup firms. Her experience early in her career was that there were a lot of women in her field because "you didn't have to have a certain set of prerequisites to be a computer scientist or a computer programmer. You had to have a good mind… There wasn't a sense that you had to have a degree in computer science. So there were lots of women, who came from lots of other occupations." (Hawthorn 2002) However, the major field advisor at Berkeley when she was a doctoral student in the early 1970s urged her to drop out because she was a woman with children without her husband present. As she remembered the advisor saying: "You cannot be a serious student if you have children…to be a graduate student at Berkeley, you have to give up everything. This has to be your whole life. There is no time for anything else…If we had known that you had children, we would not have accepted you."

Throughout her years as a doctoral student at Berkeley, the number of women in the graduate computer science courses kept dwindling. Part of the reason was that the department had what they believed to be objective criteria for the awarding of financial aid, such as having a large number of undergraduate mathematics and physics courses – and this (unnecessary) set of criteria prevented many women from receiving the financial aid they need for attending graduate school. So, as discussed in Chap. 10, Hawthorn, fellow doctoral student Barbara Simons, and Women's Center staff member Sheila Humphreys developed a re-entry program to take in as doctoral students a group of students with nonstandard degrees. Hawthorn also formed women's groups at Berkeley and at Lawrence Berkeley Lab – and revived one at Hewlett Packard which had been shut down by management for fears of its becoming too militant – where she could relax, be among other women, and compare notes on how to handle certain situations that came up.

Interestingly, neither Hawthorn nor Simons had any interest in SWE. Their attitude is represented by the following quotation:

> It is true that the women that are the most successful are those who absolutely do not believe that they are discriminated against. Barbara and I used to call them the "My Daddy Was An Engineer" women. That was why we never wanted to join SWE, the Society of Women Engineers: there were so many engineers in SWE whose daddies were engineers, who felt that there was absolutely no issue with them being a woman in engineering, and that anyone who talked about anyone being discriminated against was just making it up! (Hawthorn 2002)

6.2 Association for Women in Science (AWIS)

In 1967 the physiologist G. Virginia Upton from the Veteran's Administration began to organize receptions at each annual meeting of the Federation of American Societies of Experimental Biology, so as to build a community of women researchers. At the 1971 meeting in Chicago, 27 women continued Upton's tradition but

turned it into an organizational meeting to create the Association of [later, 'for'] Women in Science (AWIS). Elected as co-presidents were Judith Pool from the Stanford University Medical School, who handled fundraising, and Neena Schwartz from the University of Illinois College of Medicine, who handled program and volunteer development (Rossiter 2012).

The earliest activity of AWIS was to build a registry of women scientists to be considered for jobs, appointments, and awards; and to increase the number of women appointed to technical panels and study sections that evaluate NIH proposals – the largest funder in the biomedical sciences. When meetings of AWIS representatives with NIH officials did not result in significant changes, AWIS became the lead plaintiff in a suit against the NIH's parent organization, the Department of Health, Education and Welfare (*AWIS et al. v. Elliot Richardson*). The effect of their legal victory was an increase within a year's time in the percentage of women sitting on these technical panels and study sections from 2 to 20 %. The legal victory was also a powerful recruiting tool, enabling AWIS to rapidly attract a thousand members. The American Association for the Advancement for Science helped AWIS through its initial organizational growing pains.

During the 1970s, in addition to building the registry and establishing an office, AWIS formed an educational foundation to receive donations and offer fellowships and other grants. It began publishing a newsletter that focused on both current policy issues and career development. The organization established and expanded a local chapter system in the 1970s and 1980s, focused on both career development of women scientists and the encouragement of girls and women from the local community to enter science careers. In the 1990s, AWIS became actively involved in mentoring undergraduate and graduate students using an unusual community-mentoring model, which was developed with the support from the NSF and the Sloan Foundation, and which won a Presidential mentoring award. In the first 5 years, the program involved 6000 student protégés and 2500 mentors.[11] AWIS has also been involved in research on issues concerning the advancement of women in science, such as a study sponsored by the Sloan Foundation in the 1990s of the chilly academic climate for women scientists.[12]

AWIS's initial success in reforming the NIH peer review system led it to become actively involved in policy issues related to women and science. In the 1970s and 1980s AWIS used the legal system to ensure that affirmative action and equal opportunity employment laws were enforced to protect women scientists. The Association

[11] See Bird and Didion (1992), Didion (1995), and Fort (1995). For a more recent version of AWIS mentoring, see Fridkis-Hareli (2011), which describes the mentoring activities in AWIS's Massachusetts chapter. The AWIS process involves building mentoring circles of three to five peers and one to two mentors, all with similar interests and career goals, who meet in person monthly during the academic year.

[12] On the chilly academic climate study, see Didion et al. (1998). For a recent snapshot of AWIS's full range of activities, see its 2014 strategic plan at http://c.ymcdn.com/sites/awis.site-ym.com/resource/resmgr/Files/Strategic_Plan_FINAL_NOV1720.pdf. The plan includes 40 action areas organized under the headings: advocate for positive system transformation, help all women in STEM achieve success, and maximizing our impact by optimizing organizational capacity.

lobbied extensively for creation of the Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development Act (CAWMSET), which was signed into law by President Clinton in 1998. More recently, AWIS lobbied Congress to strengthen the use of Title IX legislation to apply to science and engineering departments in higher education. The Association also publishes an electronic newsletter that keeps members apprised of relevant policy issues.[13] In 2014, AWIS entered a partnership with SWE to carry out public policy work together.

AWIS reaches more than 20,000 professionals each month through its members and chapters. 79 % of AWIS members hold an advanced degree and 66 % are at the middle or senior levels of their careers. About half of its audience is academic – the rest spread across industry, government, and non-profits.[14] While women in the computing fields have no doubt benefited generally from AWIS research and policy efforts on behalf of STEM women, and very likely some individual female computer scientists have benefitted from AWIS's mentoring activities, the emphasis of AWIS is on science – and particularly on the biological sciences – so AWIS has had a limited impact on helping women in the computing disciplines. One area is which AWIS has perhaps had its greatest impact on the computing field is in biocomputing. A number of biocomputing researchers have been involved with AWIS, including Hua Fan-Minogue from the Stanford Medical School, Sayanti Roy from Notre Dame, Estefania Elorriaga from Oregon State, and Hoda Abdel-Aty-Zohdy from Oakland University.

6.3 Women in Engineering ProActive Network (WEPAN)

With persistently low numbers of women in engineering education programs, a number of colleges and universities have formed women-in-engineering programs to support their women students and faculty as well as to recruit additional women.[15] The first such program was created in 1969 at Purdue University.[16]

[13] For more information on the history of AWIS, see "History of AWIS", https://awis.site-ym.com/?page=history, accessed 16 May 2015.

[14] The information in this paragraph comes from the AWIS fact sheet (http://c.ymcdn.com/sites/awis.site-ym.com/resource/resmgr/Fact_Sheets/AWIS_General_Fact_Sheet.pdf).

[15] In addition to the sources cited in the body of this section, this account relied heavily on the WEPAN website (wepan.org), in particular the pages entitled "The First Ten Years: 1990–2000" and an article reprinted their entitled "Yes, WEPAN" (Home Douglas 2009). It also relied on oral history interviews with co-founders Suzanne Brainard (2015), Jane Daniels (2015), and Susan Metz (2015).

[16] Daniels (2015) indicates it was the interest in diversity of Arthur Hansen, who was the president of Purdue University from 1971 to 1982, that enabled Purdue to be a pioneer in broadening engineering to include more women and more African Americans. In this interview Daniels gives a significant amount of detail about the women in engineering program at Purdue that goes beyond the scope of this study.

Jane Daniels,[17] who directed the program from 1978 until 2000, had answered numerous inquiries from other universities wanting to establish similar programs and knew that there was a need for a central place to provide information and guidance to women in engineering programs.[18] With NSF support, Daniels first carried out a survey of deans of engineering and SWE advisors at various colleges and universities across the nation to identify interested parties. Then she organized a meeting in Washington in 1990, attended by 200 people interested in women in engineering. The group rejected proposals to continue to meet as a special interest group at SWE or ASEE meetings. Instead, it decided to create a new national organization, the Women in Engineering ProActive Network (originally the Women in Engineering Program Administrators Network) for people who were advocating programs for recruiting and retaining women and girls in college engineering programs. The organization of the conference and the creation of the Network were carried out by Daniels with the full involvement of Susan Metz[19] and Suzanne

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The program, she reports, "wasn't all altruistic." A downturn in student interest in majoring in engineering in the late 1960s was intentionally offset by drawing students from a wider pool that included women and African Americans. Funds associated with the federal Women's Education Equity Act of 1974 helped to strengthen Purdue's program for women in engineering, which provided funding for career outreach activities to high school girls and a course in the School of Technology, entitled Tools and Engines, in which female students could get hands-on experience with power tools and wiring circuits. However, most of the early funding of the program came from industry, especially from General Motors and IBM.

Daniels remembers that in the late 1970s the attitude was to "go find the women, bring them to Purdue, and fix them. Fix them so that they would do engineering just like our men always have, because, after all, Purdue has a wonderful reputation in engineering, so we don't want to change anything, we want to keep doing things the way we've always done it." Over time, effort was redirected to changing the system in various minor ways to make it a more inclusive community.

[17] Daniels (2015) sees lots of similarities between engineering and computer science: the similar, persistently low numbers of women in the two fields; "the environment is not, I don't see, as welcoming to women if they have more international students and faculty from countries that do not value women's educational rights and abilities"; and engineering and computer science are among the few STEM disciplines in which there is "meaningful employment and [the ability] to make important contributions to society" with only a bachelor's degree. (Daniels 2015)

[18] On women in engineering programs at colleges and universities, see Knight and Cunningham (2004).

[19] Stevens Institute of Technology, founded in 1870, was an all-male institution for 101 years. When the trustees voted to admit women in 1971, only a small number applied. Motivated by a concern about adequate enrollment and an optimism that women could be good engineers, Dr. Edward Friedman, Dean of the College at Stevens, suggested exploring external funding to develop pre-college programs to introduce women and their parents to engineering. Why would women consider going into a male-dominated field and why would their parents, teachers and guidance counselors endorse the idea of majoring in engineering if no one knew what engineers do all day? Metz was drawn into this initiative, received a grant from Exxon Company and subsequently, Stevens established the Office of Women's Programs, directed by Metz in 1980. National Science Foundation funding expanded the pre-college programming to include a series of four-week summer programs that attracted hundreds of high school women throughout the country to learn about careers in engineering and science. During that time, Metz began to do research on underrepresentation in STEM and the impact of pre-college programs. The American Society for Engineering Education (ASEE) Annual Conference typically offered a panel session on women in engineering,

Brainard,[20] who ran the women in engineering programs at Stevens Institute of Technology and the University of Washington, respectively.

These three organizers took turns in leading the organization over its first 10 years.[21] The target audience was people who worked with women engineering students at the undergraduate or graduate levels, e.g. directors of women in engineering programs, advisors, and interested faculty members.

By the year 2000, WEPAN had signed up more than 500 members and ran its programs out of regional centers based at the three universities of its founders. WEPAN established an annual conference, beginning in 1990, serving as an important community-building and networking opportunity for administrators and faculty who ran university-based women in engineering programs. This annual event has evolved and continues today under the title of WEPAN Change Leader Forum, catalyzing discussion and action on the impact of culture on engaging and retaining diverse communities of women in engineering – both in education and the workforce. (Private communication from Susan Metz, March 19, 2016) WEPAN also has partnered on a number of conferences, meetings, and workshops with other organizations including AAAS, the National Academy of Engineering, AWIS, SWE, the New York Academy of Sciences, NSF, the U.S. Department of Energy, and the National Association of Minority Program Administrators (NAMEPA).[22]

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and it was at this event where she met Daniels, year after year, until they teamed up with Brainard and founded WEPAN. More recently, Metz has served as Executive Director for Diversity and Inclusion and Senior Research Associate, reporting to the president of Stevens. (Private communication from Susan Metz, March 19, 2016)

[20] Brainard served as the executive director of the Center for Workforce Development at the University of Washington until her retirement and held affiliate faculty positions in both women's studies and human-centered design and engineering. She has served as chair of the NSF Committee on Equal Opportunity in Science and Engineering and served on several National Academy studies on diversity in engineering.

[21] For details about the running of the organization, see Brainard (2015), Daniels (2015), and Metz (2015). Metz notes that it was difficult identifying someone who would run for President of WEPAN who was not one of the founders because there was no staff to support any officer position.: "The very first President after the Founders all rotated through that position – and I held it for 5 years – was Jan Rinehart who was at Texas A&M at that time. Transitioning from a Founder-run organization to other elected officers is no easy task, especially for that first person. Although Jan was reluctant, Dr. Karan Watson, Jan's supervisor at Texas A&M was very supportive and provided some release time. Jan was an outstanding leader, paving the way for other non-Founders to run for office. Eventually, WEPAN hired a full-time executive director and CEO, Diane Matt, who is still in that position today. (Private communication from Susan Metz, March 19, 2016)

[22] Brainard singled out the strong relationship that WEPAN had with the National Academy of Engineering during the years in which Bill Wulf was NAE president. She also pointed to close ties with Shirley Malcom and Yolanda George at AAAS. WEPAN had strong relations with the National Association of Multicultural Engineering Program Advocates (NAMEPA), an organization of educators and representatives from the public and private sectors to enhance recruitment and retention on underrepresented minorities in engineering careers. (See http://www.namepa.org/index.php?option=com_content&view=article&catid=19%3Adefault&id=62%3Ahistory&Itemid=76 for NAMEPA's history.) WEPAN had good, if not extensive working relations with AWIS from the beginning. However, there were some rough patches in WEPAN's early relations with SWE. When the two organizations eventually came to an understanding and agreement that SWE

Of particular importance were WEPAN's regional training seminars for educators wanting to create or strengthen women-in-engineering programs on their campuses. Between 1992 and 2001, with support primarily from AT&T, the Sloan Foundation and the Fund for Improvement of Post-Secondary Education (FIPSE), representatives from more than 150 institutions attended these seminars.[23] Topics at the seminars included acquiring resources, conducting pre-college outreach programs, developing retention and mentoring programs, implementing student needs assessments, evaluating initiatives, and encouraging industrial participation. Materials prepared for these training sessions found their way into published books funded by FIPSE entitled *Increasing Access for Women in Engineering* by Susan Metz and *Curriculum for Training Mentors and Mentees* by Suzanne Brainard.[24] Working together with Carol Muller, WEPAN became the incubator for the electronic mentoring program, MentorNet, for the period 1996–2001. (See the discussion of MentorNet later in this chapter.)

It is probably not coincidental that the number of women in engineering programs in the United States increased from 26 in 1991, to 66 in 1995, to more than 100 by 2004. However, over the last 10 years, the number of women in engineering programs has noticeably declined through underfunding and merger with minority programs.[25] Daniels notes that in the early years, most of these centers were managed by individuals with backgrounds in education or the social sciences, but there has been a trend in recent years for these programs to be managed by young people with engineering backgrounds. Daniels sees this as a good thing because then the

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was primarily about professional development for women engineers and students and WEPAN was primarily about working with faculty and administrators to develop programs and initiatives to increase awareness about engineering, retain engineering students and understand and impact the culture of engineering, they became more collaborative and effective working together. (Brainard 2015; Daniels 2015; private communication from Susan Metz, March 19, 2016)

[23] These training sessions appear to have ended formally in 2001. The three founders extended this kind of work by entertaining a series of visitors at each of the home institutions and by making site visits to other college women in engineering programs.

[24] An effort was taken to move these materials online eventually because the Ford Motor Company was interested in having them available to its engineering staff members who were serving as mentors to college engineering students. Ford paid the full cost of this transfer of materials online.

[25] The Sloan Foundation funded a multi-institutional study of the impact of women's programs in the late 1990s, entitled Women's Experiences in College Engineering, which was not able to demonstrate benefit of such programs on recruitment and retention of women in engineering. (Private communication from Carol Muller, 24 February 2016)

Brainard (2015) tells the story of the evisceration of the center at the University of Washington in 2004, while Denice Denton was the dean of engineering. Denton was the first female dean of an engineering school at a major research university. On women's engineering centers generally, Brainard indicated it was much more difficult to convince university administrators to continue operation of a women in engineering center than a minorities in engineering center. One reason was that the women "typically had higher grades than the guys did; and they did very well or they dropped out because they didn't like the climate they were in," so there was not a large group of women engineers who were performing poorly academically to target as the need for the center. Another reason was that industry was generally more interested in increasing minority numbers than numbers of women in its engineering ranks. (Brainard 2015)

program director has first-hand experience of what it is like to be an engineer and perhaps can relate better to the students.[26] (Daniels 2015)

Beginning in 1993, each year the University of Washington surveyed its male and female undergraduate engineering students about perceived barriers to their education. Topics included the quality of teaching assistants, teaching, engineering labs, departmental assistance, and curriculum. Based upon this survey and with funding from the Engineering Information Foundation, WEPAN developed a national climate survey that it administered in 1998. More than 8000 undergraduate engineering students (57 % female) at 29 institutions responded to the survey. The survey results showed that female students reported less self-confidence in engineering and physics than male students; and that female students had less confidence in asking questions in class and lower comfort levels with lab equipment. This study received considerable attention from engineering schools. (Metz et al. 1999) The national survey was repeated in later years, when funding was available. It enabled individual schools to see how they measured up to national averages as well as to track their progress over time. The WEPAN staff used these surveys, from time to time, to assess the needs at a given institution and then suggest a course of programmatic changes the institution could implement.

Another important early activity was the creation of WEPAN's Knowledge Center. In the early days, program directors simply tried things out, to see if they would work. Program directors were hungry for research that would help them to shape and justify their programs. The Knowledge Center collected published research on relevant topics from the education and social science literatures. It also became a repository for data on women in engineering.

The Strategic Initiatives and Programs page on WEPAN's current website provides a snapshot of WEPAN's activities today, a time when none of the three founders are actively involved in the daily leadership of the organization. The annual conference has received added importance, in part because it is now the financial underpinning for the organization. WEPAN is currently supporting four strategic programs listed in Table 6.1, the last three of which are supported by the NSF. All four of them involve transforming engineering culture, although each does it in a slightly different way and sometimes with a slightly different audience.[27]

It is worth taking time out to discuss in more detail the last of these programs, the ENGAGEEngineering.org Project. It began with a 2.6 million dollar Extension Service grant in 2009 from NSF's Research on Gender in Science and Engineering Program directed by Jolene Jesse. The principal investigator was Susan Metz, Executive Director of Diversity and Inclusion at Stevens, with partners Diane Matt,

[26] "Not all see this as a good thing – however. These folks have less training in the social sciences and education to help them understand how to address institutional issues, and to appreciate the underlying causes and potential remedies for women's historical exclusion from engineering studies and professions. They are often not well-placed in terms of influence and status in university hierarchies." (Private communication from Carol Muller, 24 February 2016)

[27] Cultural change in an organization is notoriously slow and difficult to achieve. It may be too early to see many results of these cultural change programs.

Table 6.1 WEPAN's strategic initiatives (as of early 2015)

The *Advancing Culture in Engineering Initiative* engages educational and workplace leaders in changing the engineering environment in which women and underrepresented minorities learn and practice engineering. It is based on a four-step Gender Inclusive Organizations framework created at Simmons College:
Equip the Women by equalizing experience between men and women;
Create Equal Opportunity by eliminating structural and procedural barriers within organizations that impede women;
Value Difference by appreciating rather than eliminating the differences between men and women; and
Re-Vision Engineering Culture by addressing the assumptions, norms, and practices that lead to gender inequities within organizations.
Transforming Engineering Culture to Advance Inclusion and Diversity (TECAID) is a project working with five mechanical engineering departments to sustain interactive cultures in the various formal and informal aspects of engineering education – in the classrooms and labs, in faculty meetings, and in informal student interactions whether they are at work or play.
Engineering Inclusive Teach (EIT) is a faculty professional development project to implement best practices to help faculty members create inclusive engineering learning environments
Engaging Students in Engineering (ENGAGE) provides small grants to engineering faculty members to put into practice research-based classroom strategies to enhance student engagement and retention.

Source: WEPAN Strategic Initiatives and Programs (https://www.wepan.org/?page=528)

the Executive Director of WEPAN, and Patricia Campbell, the President of Campbell-Kibler Associates. Campbell is a long-time participant in work on gender and race in STEM.[28] The goal of the project was to increase retention of women in STEM through the dissemination of three research-based strategies.

The project identified three strategies "that have a rigorous body of research connecting each with retention of engineering students." (Metz 2015) The strategies include: increasing faculty-student interaction in and out of the classroom, using everyday examples that are "relevant to students to teach technical concepts", and assess and improve students' spatial skills ability among those who have weak skills.

> [T]he reason we chose these three strategies was that although using them improves the educational experience for everyone, they disproportionately impact women and underrepresented minorities. In addition, the strategies were not wholesale changes to the curricu-

[28] When discussing the NSF ADVANCE program, Metz (2015) observed how difficult it is to build a program, say, for the advancement of women faculty in engineering – although she could have been speaking of broadening participation programs more generally: "My women faculty don't want to hear that in front of their male colleagues. So you still tread a very thin line of supporting women in a way that they don't feel needy, that their male colleagues don't point fingers and say why aren't we getting these and we could use these too, or, yes, women are needy and they need the ADVANCE initiatives so that's good that you're doing that. Communicating what we're doing, how we're doing, being inclusive is really, really challenging without disenfranchising the women, making some women say 'I don't want any part of ADVANCE', like they did for women in engineering programs. Other students don't want to be part of anything that's just for women; so it's tricky."

> lum. We did not want to deal with the bureaucracy and challenges of getting things through curriculum committees. We wanted faculties to be able to take these plug-and-play resources and use them in their classroom. This worked very well with the faculty-student interaction and everyday examples strategies. Spatial visualization, identified as a critical cognitive skill connected to persistence in STEM, is not as straightforward. Although an individual faculty member can implement a spatial visualization assessment and training program, the ideal approach is for a school to assess all incoming engineering students through a 20-minute Purdue Spatial Visualization Test: Rotations (PSVT:R) and then provide the NSF-supported and -tested training program developed by Dr. Sheryl Sorby to those students who fall below 70% on the test. (Metz 2015)

ENGAGE initially used a train-the-trainer model by identifying a team of individuals in universities who, armed with the necessary information and resources, could implement the strategies on their campus – usually in three-person teams. The training occurred during a three-day workshop. The first year, the project included teams of faculty and administrators at ten high-profile, large schools because the organizers believed that success in these schools would give the program credibility and make it more desirable for other schools to participate. (Private communication from Susan Metz, 19 March 2016)

While the workshop went well – participants valued the information, planned to use it and rated the sessions highly – "the translation to other colleagues at the engineering schools was challenging." As Metz (2015, modified in a private communication, 19 March 2016) went on to explain:

> The faculty and administrators who attended the workshops were excited about the three strategies and many implemented one or more of the strategies at their schools personally. But the idea was [to] get your colleagues together, share this information, and have them use the strategies in their classrooms. That was not happening. We realized that faculty are really not comfortable in this train-the-trainer domain. They are used to being experts in their discipline. These retention strategies are not [within] their area of expertise so they have some vulnerability. They were not sharing information with their colleagues that they [were] totally comfortable with…[29]

As a result, the project organizers changed the dissemination strategy to directly involve individual faculty members.[30] Instead of giving mini-grants ($10,000 –

[29] Metz (2015) explains that although the trainers were uncomfortable communicating research results that they were not entirely familiar with to their faculty colleagues, that none of the faculty were particularly concerned with the research basis behind these practices: "We really thought that faculty were interested in the research behind these strategies, that we had to convince them that these were evidence-based strategies, there's reason to use them; but faculty didn't want to know the details. What they said was, "if you're telling me this is research-based and these are all the references – I believe you! Just explain what I should do. Again, we shifted our emphasis in faculty's professional development to the implementation of these strategies."

[30] It might seem that it would be easier to disseminate these research-based practices more widely through the train-the-trainer program, but in fact ENGAGE was able to disseminate these practices more widely after they adopted the strategy of involving individual faculty members. The original promise in the grant proposal was to reach 33 educational institutions. After the change in strategy, the project "started involving many more schools in the process. … [W]e started doing a lot of virtual events, webinars, discussions at ASEE Conferences, which was a terrific opportunity to share the research, share the experiences of schools who were doing it." (Metz 2015)

$12,000) to engineering schools, even smaller mini-grants ($2000–$2500) were given to individual faculty members to implement and document in their classrooms. Faculty at more than 70 institutions received mini-grants. These schools implemented one, two, or three of the ENGAGE strategies. (Private communication from Susan Metz, 19 March 2016)

> …if you are a faculty member and you are teaching hundreds of 1st and 2nd year engineering students – using the ENGAGE retention strategies can make a difference. We tabled the professional development workshops and instead began developing and conducting webinars – each focused on one ENGAGE strategy. Engineering faculty was the target group and we partnered with ASEE and ASME primarily to get the word out. That started gaining some traction. As a result of the webinars and enhanced electronic communications, website downloads of everyday examples, lesson plans, papers, presentations, and resources for each strategy hit 233, 359 downloads in 2015. (Metz 2015)

One of the reasons that the ENGAGE project is so interesting for the purpose of this book is that, in the fourth year of the project, the principals decided to collaborate with the National Center for Women & Information Technology (NCWIT). Thus we have an opportunity to see the ways in which broadening participation in STEM and computing are similar and different.

Prior to the joint project, the ENGAGE project had not done any work with computer science and only limited work with computer engineering. Most of ENGAGE's effort had been with mechanical engineering. The principals in the ENGAGE project were familiar with the people at NCWIT, particularly with NCWIT's senior scientist Joanne Cohoon, because both groups had received grants from the NSF program on Research on Gender in Science and Engineering and had come to know one another through the annual principal investigator meetings. NCWIT also had a well-developed Extension Service model for bringing research-based practices into academic departments (see Chap. 8).

> …that's when we got together and said, okay, ENGAGE is focused more on retention and engineering. NCWIT is focused more on computer science and recruitment. If we got together, melded our strategies, and focused on those departments that had the lowest representation of women, let's see if NSF would fund that. … We focused on four departments: Computer Science, Computer Engineering, Mechanical Engineering, and Electrical Engineering – two of the largest engineering disciplines [with] the lowest representation of women. And we used the NCWIT consulting process too – each "client school" is assigned an Extension Service Consultant, someone who has received extensive training by NCWIT. NCWIT does a great job in data collection. They have a tracking tool, so [schools are] required to document enrollment and retention numbers. (Metz 2015)

While the ENGAGE team has statistics about the number of downloads of course materials they developed for making the classroom more engaging to various types of underrepresented students (which number in the hundreds of thousands), they did not have the funding through the NSF Extension Services grant to track the retention of students. The philosophy of this grant program was to disseminate research-based practices, not to repeat the research that confirms the best practices.[31] Evaluation and

[31] Metz (2015) made an interesting comparison between progress at broadening participation in the academic and industry sectors: "I think we're all heading in the right direction. But it's a slog;

use data supports the claim that ENGAGE created and disseminated resources that faculty use, but it is not definitive what impact these resources had on retention of a diverse student body. "We have to assume that it has because of the implementation approach." (Private communication from Susan Metz, 19 March 2016)

While both the original ENGAGE grant (through no-cost extensions) and the ENGAGE-NCWIT grant are still ongoing, there is a sense that both programs have had some success, but neither has been revolutionary:

> Neither one of these grants has really penetrated engineering schools holistically. There have been some [signs of progress], … there are packets of faculty who embrace it, do it, and slowly it trickles out into their schools; but, boy, it's a slow process. The numbers … I don't know … That's the biggest frustration. The numbers are still challenging. (Metz 2015)

This slow process is problematic in that NSF typically expects to see results in a three-year time frame.[32] However, the ENGAGE program did not begin to show real progress until the fourth, fifth, sixth, and seventh years. Extension Services grants have the luxury of time – more than others. NSF also expects principal investigators to be able to sustain successful programs, typically without ongoing NSF funding after the initial grant runs out. When asked how ENGAGE plans to do this, Metz (2015, extensively revised in private communication of 19 March 2016) replied:

> This is what this last year is devoted to. Faculty who have used the strategies are committed to them. We need to keep pushing out the information to the community. ENGAGE launched a redesigned website that has a simplified, modernized interface that is mobile-adaptive, making the website more user-friendly and accessible for our visitors who are more frequently using mobile devices to access the website (21.3 % of website visits come from a mobile device, up from 2.6 % in 2011). Popular, heavily viewed and downloaded resources and content are highlighted on the website, and redundant, infrequently used information was eliminated. Information on the website is organized by ENGAGE strategy, and then in three simple sections: "Why it Works" – key, compelling highlights of the evidence behind the strategy; "Learn More" – additional detail on the research evidence; and "Take Action/Resources" – a complete list of information and links for easy downloads of all resources and tools related to implementing/using the strategy. This page effectively functions as a toolkit for each strategy, and WEPAN is committed to keeping this going.

When asked whether working in a computer science environment was different from working in an engineering environment, Metz (2015, extensively revised in a private communication of 19 March 2016) replied:

> I don't think so. I think it's very similar and all disciplines are concerned about recruitment and retention and broadening diversity. However the concept behind the NCWIT-ENGAGE

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academia is much slower than industry in embracing change, particularly in terms of the culture and climate in engineering. They don't have the profit incentives that industry has. McKinsey and Company (Women Matter) and many others have researched and documented the real value of diversity including impacting the bottom line. Women have so many career choices and culture matters. Why should they go into a culture where they have to struggle and continually prove themselves."

[32] This issue of expectations by NSF of short-term windows for progress and of operations becoming self-sustaining after one or two rounds of NSF funding is discussed at several places in Aspray (2016).

> Extension Services grant was for the engineering departments (mechanical, electrical and computer) to work with the computer science department collaboratively. Sometimes this worked well and sometimes it did not work at all. However it is unclear at this point how critical the collaboration was in terms of impact. Since computer science is often in a different school from the engineering departments and since universities tend to be very siloed, faculty don't know each other, the culture is different, and logistically it is just more challenging to work together. In many cases, engineering and computer science worked to address the goals of the grant independently. NCWIT is exploring the value of collaborating across schools.

Returning to a discussion of WEPAN's current Strategic Initiatives and Programs, the WEPAN webpage identifies three programs in the area of dissemination of research and knowledge. One is an online repository (mentioned above) called the Women in STEM Knowledge Center, created in 2008 by WEPAN and the American Society for Engineering Education, with more than 2000 resources about gender underrepresentation in STEM. A second one is professional development webinars on topics such as academic coaching, salary negotiation, and stereotype threat, which are viewed by almost 3000 people each year. The third one is its national change leader forum.

WEPAN is also entering into strategic collaborations to advance diversity in engineering. These include two collaborations with ASEE – on diversity in corporate settings and diversity of the ASEE membership; and with the University of Colorado BOLD Center on strategies for success of underrepresented engineering students.

WEPAN's mission specifically is to serve women in engineering, not women in computing. With the exception of the ENGAGE project, WEPAN has not focused on computing. But strategic partnerships have always been a key component of all WEPAN's initiatives and the combination of NCWIT and WEPAN constituencies could be very powerful. The centers at Washington, Purdue, and Stevens all have strong ties to the computing community. Computer science resides in the engineering school at Washington and at Stevens, so the women in computer science were important clients of Brainard's and Metz's programs. Both Washington and Purdue had Virtual Development Center projects associated with the Anita Borg Institute (see Chap. 8), and Brainard was actively involved in that work. Brainard's program has also been actively involved in the Grace Hopper Celebration (see Chap. 8) for many years, and has provided the official external evaluation of the NCWIT programs.

6.4 MentorNet

In 1987, 2 years after completing her doctoral degree at Stanford in education administration and policy analysis, Carol Muller returned to her undergraduate institution, Dartmouth College, as an assistant dean in the engineering school. She felt as though she had stepped back in a "time warp" and that Dartmouth's engineering school had not yet internalized the social changes of the 1950s, 1960s, and 1970s. Though her newly created job was not at all focused on women, or even on

students, she was curious to determine why there were so few women in engineering at Dartmouth. In 1989, she contacted Karen Wetterhahn, a Dartmouth professor of chemistry newly appointed to the role of Associate Dean of the Sciences at Dartmouth, and together they founded the Dartmouth Women in Science Project, launched in 1990 with support from the president's office and individual faculty members' research funds. Soon, that effort was joined with more major funding from the Sloan Foundation and the National Science Foundation, which enabled the two founders to hire a director and continue the expansion of the Women in Science Project (WISP).[33] WISP sponsored paid research internships for first-year female undergraduate students, working in labs with a faculty member; lectures by visiting women scientists to offer role models; a newsletter; and site visits to industrial research and engineering organizations.[34] (Muller 2014; also see Muller et al. 1996; Cunningham et al. 1996)

An e-mentoring program piloted as part of the Women in Science Project eventually led to the creation of MentorNet. Muller had arranged for WISP students to make a field trip to the IBM facility in Burlington, VT. This was a long enough trip that, even though a number of students had signed up, the students were too busy with their own studies and lab sessions to follow through on the six-hour outing. When it became apparent that just one student would attend, the visit had to be rescheduled. Muller, who was driving the students to these industrial site visits, could see these visits were having a great impact on the students' interest and confidence in science and engineering fields; and she "began to think about [whether] is there a way we could get some of that benefit by connecting students with working professionals more readily, especially in a field like engineering, and also in the sciences." (Muller 2014, slight corrections by interviewee 24 February 2016)

Because John Kemeny had made computing an integral part of the Dartmouth curriculum and everyday life while he was president in the 1970s, Dartmouth had become an early adopter of email. The scientific community generally was also sooner to adopt email than the population at large, and Muller had the idea of an e-mentoring network for women in science and engineering. Muller wrote a four-page proposal that led to IBM funding for a small pilot project at Dartmouth in 1993 (Muller 2014).

[33] The Sloan Foundation funding, awarded in 1992, was used in part to fund faculty development retreats to engage faculty in learning about improved and exemplary teaching and mentoring processes in the STEM fields. (Muller 2014)

[34] The Women in Science Project was initiated by both Muller and a new Associate Dean responsible for the sciences in the College of Arts and Sciences, the chemist Karen Wetterhahn. The Dartmouth president was receptive to the idea because he was looking for ways to recruit more women to Dartmouth after a journalistic article about the fraternity system had made it sound as though Dartmouth was a bad place for women to attend college. The faculty was receptive because a group of psychologists at Yale, Brown, and Harvard had recently prepared a study that reported, after taking into consideration every factor they could think of such as courses taken in high school, there was still a large unexplained gap in this rigorous, data-driven scientific study concerning women's low enrollment in science, mathematics, and engineering at these schools (Muller 2014).

A rigorous evaluation of the pilot project showed the promise of e-mentoring, and both the Sloan and Intel Foundations provided funds in 1996 to plan for a national e-mentoring program using email. Sloan Foundation program officer Ted Greenwood pointed out that there were already some experiments underway with what we would now call e-mentoring, and the foundation arranged for a meeting in 1996 at the Boston airport of all the stakeholders in Muller's project, plus some others who were developing other e-mentoring programs. Participants in this meeting included, for example, Dorothy Bennett, who was running a tele-mentoring for young women in computer science at the Bank Street School of Education in New York City; and Lee Sproull from Boston University, whose book with Sara Kiesler, *Connections: New Ways of Working in the Networked Organization* (Sproull and Kiesler 1991), was in consonance with Muller's idea.[35] (Muller 2014)

Significant funds were provided in 1997 by the Intel and AT&T Foundations to implement the new e-mentoring program, by this time known as MentorNet.[36] Muller had relocated to Silicon Valley for family reasons and opened MentorNet's offices in 1997 at San Jose State University, where the Dean of Engineering, Don Kirk, was interested and offered office space. Muller was on the board of directors of WEPAN, and for its first 3 years, MentorNet was operated as a program of WEPAN so as to avoid added costs and complications of setting up a new non-profit organization (Muller 2014).

The plan was "to create a very large scale infrastructure using technology, and automating as much as possible, but with a lot of intelligence behind it so that multiple college students from campuses anywhere could connect, find the appropriate professional to serve as their mentor for them, and take off on a mentoring relationship."[37] (Muller 2014) To avoid having to take special steps to protect minors as well as get parental permission, MentorNet focused on college instead of younger students. Some people wanted MentorNet to allow only women to mentor women, but Muller disagreed:

> Some people had strong feelings that only women should mentor women and that just didn't seem right to me, so I made the point that if we relied on all the women, they are only 10% of the workforce and furthermore, we weren't really going to change things if we never gave men the opportunity to learn anything from the students they mentored about what [are] the experiences or life of the women. (Muller 2014)

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[35] Another early e-mentoring program, which Muller was aware of, was one run out of Hewlett Packard by David Niels. His program branched into mentoring in Africa. It also mentored high school students. (Muller 2014)

[36] The term 'e-mentoring' was coined, at least in this context, in 1993 by Amy Mueller (no relation), a Dartmouth graduate who worked at AT&T and served on the advisory committee for the Dartmouth Women in Science Project. (Muller 2014)

[37] As a later MentorNet CEO, Mary Fernandez, explained the MentorNet process: "it was a very early version of eHarmony except for [being for] women in STEM fields. So you fill out a profile, you are algorithmically matched with another person and then our program is a guided mentoring program. So we guide and mentor and the protégé with discussion topics that are relevant to the mentees, level of their education and some of their personal experiences and that has evolved considerably over time." (Fernandez 2014)

From the beginning, MentorNet was not only about "fixing" the students who were receiving mentoring (known in MentorNet as 'proteges'), but also about teaching the mentors to understand what these women students were facing, in the hopes that they could fix the system in which these individuals studied and worked.[38] Muller called it a "two-way learning relationship." (Muller 2014)

> [I]t did seem to me that this was an opportunity that could enable us to have a much bigger impact than just being the band aid or "fix or equip the women", whatever you want to say, because of the interactions students would have with their mentors. We were careful in our evaluations to look at what the mentors were learning as well as what the students were learning. Another thing we were really trying to do… through our coaching curriculum and our training was to impart… more information about some of the causes and perpetuation of the imbalance by gender and/or other diversities in the field. So that even when mentors who signed up because they thought perhaps they could help 'clueless' people they might have their eyes opened about experiences to help them see that these individuals were not lacking. (Muller 2014)

At first, MentorNet was about providing e-mentoring experiences primarily for college women. Both prospective mentors and protégés completed online applications, indicating not only demographic characteristics, areas of study/work, and interests, but also expressing their preferences for the individual with whom each would be matched. This information fed a bi-directional matching algorithm that considered the needs and preferences of both mentors and protégés.

> The initial program connected undergraduate and graduate students with professionals working in industry or government, providing different coaching and training for mentors and for the protégés, depending upon the students' educational levels. Soon, we were hearing from those who wanted to find additional mentors for academic careers, beyond their advisors. We slowly began to realize they were expressing the value of having *external* mentors. With a grant from NSF's ADVANCE program, we rebuilt our systems once again to accommodate a mentoring option for students and for early career academics (both postdocs and pre-tenure faculty members), linking them with faculty members as their mentors. At about the same time this new capability was deployed, we had sufficient mentors, protégés, and experience to move our matching to an "on demand" year-round system, rather than linking the timing to an academic calendar.

[38] Mary Fernandez, a regular mentor for MentorNet and today the CEO, explained the impact that a mentoring relationship could have on the mentor: "I think what the mentor is faced with is often having to understand their own choices in their career, in their professional and personal lives, as a way of helping the mentee or the protégé understand those choices for themselves. So there is a high degree of introspection that the mentor goes through. I think successful mentors do this quite naturally. And it's fascinating and … the upshot of this is that what we find – and this has been reported over and over and over again – the mentor feels a great sense of personal fulfillment, they feel an increased connection to their profession, their profession brings more meaning to them… It's the way of you understanding why is it that that you are doing what you are doing, what joy does it bring you and what frustration does it bring you. So almost everyone who I have spoken to, especially what we call our master mentors, the mentors who have been with us for years and years and years, … they all report that they feel they have grown and sometimes grown more than the mentee or protégé, which is very interesting because we focus of course on the needs of the protégé." (Fernandez 2014)

> [T]hen five years into it…we rebranded the whole thing very deliberately as the e-mentoring network for diversity in engineering and science. And so we really deliberately changed MentorNet's identity, went through all the materials and really turned it around. We recognized we wanted to partner with, and could have stronger relationships with, the whole community of underserved people in engineering and science, all of whom could benefit from MentorNet. (Muller 2014)

One of the early challenges for MentorNet was to get the colleges these students attended to consider a cooperative arrangement in which all would help support the system financially:

> [W]e were trying to create a collaborative among many different colleges and universities with the primary champions of the idea in those colleges and universities often being people who didn't have a lot of influence. They tended to be [, for example,] the directors of women and engineering programs. And so that was challenging all by itself. They were used to thinking of the other colleges and universities as competitors, not collaborators. (Muller 2014)

Another issue was overcoming the disbelief that mentoring could be effective over email. As Muller remembers:

> [U]sing email by itself was new for a lot of people, using the web was new. But using electronic communications for mentoring, I gave numerous talks and wrote papers earnestly justifying in great detail the ways in which people actually could build relationships with others they had never met face to face. At the time [mid to late 1990s], many people just felt that building productive relationships via email alone was pretty unlikely. (Muller 2014)

Muller argued that there were differences between e-mentoring and face-to-face mentoring, and that each had its own strengths and weaknesses.[39] In these pre-Skype and Facebook days, the advantages of face-to-face mentoring included the ability to read facial expressions and body language that "people find quite rewarding and stimulating and humanizing," which could not be duplicated in a written exchange. However, e-mentoring had its own advantages.[40] Email is user-friendly and widely available. Being asynchronous, it is useful for communicating across time zones or between people who have different work and study schedules. When one takes time to compose an email message, one can be more thoughtful and deliberate. Moreover, the email communication provides a lasting record that the protégé can return to

[39] Muller (2014) points out that, today, there are opportunities to get some of the advantages of face-to-face mentoring while interacting remotely online through the use of videoconferencing, and that some recent mentoring programs blend online and in-person contact between the mentor and the protégé. Also see Muller (2002).

[40] Muller (2014) points to the scholarship on mentoring and its use in workplace settings by Kathy Kram, Belle Rose Ragins, Stacy Blake-Beard, and Lois Zachary as being particularly insightful. She also praised Rhodes (2002) work in evaluating youth mentoring programs. MentorNet also benefited considerably from the active scholarship on mentoring and writing undertaken by its first program manager, Peg Boyle Single, who led authorship of a number of papers and studies based on the MentorNet work.

read many times.[41] (Muller 2002) Muller also noted some more subtle advantages of using email:

> [T]he early opportunities for people to mentor across race and even across gender without having visual cues to remind them or even in some cases let them know that the person they are mentoring was quite different from them, contributed to building stronger relationships and better understanding across differences… [P]articularly where status differences are concerned, e-mentoring flattens hierarchy as any electronic communications does and enables discourse on a more level field for the mentor and the protégé. Email conversations often work better for people who are a little more shy or reserved and for those who need to take some time whether because English isn't their first language or for other reasons want more time to compose their thoughts… [T]he process of writing down, which of course is what you do in an email, your concerns, your questions enables you to take a step farther in solving your own problems and in identifying what it is that you are really trying to achieve. (Muller 2014)

MentorNet faced funding challenges. Muller knew that the initial foundation support would come to an end and was not likely to be renewed. Clearly, the business model had to rely upon support from corporations and others interested in building a diverse STEM workforce. But what was the best way of selling this program to industry? The organization had "terrible ups and downs in founding cycles, the worst of it [was]…in about 2001, when the Internet bubble had popped." (Muller 2014) But there were other funding challenges. When the stock market crashed after 9–11, or when there was a natural disaster somewhere in the world, it was hard for MentorNet to attract foundation funding. Corporations, similarly, were reluctant to invest in the workforce through MentorNet when the stock market was weak. In one particularly trying time, MentorNet had to lay off its entire R&D team.

MentorNet also faced technological challenges. The technology involved building an interface, an automated algorithmic process for matching mentors and protégés, as well as providing an online facility for training, coaching, and program communications "while we were working with first hundreds and then thousands of mentoring pairs and doing it in an economically feasible way." (Muller 2014) While the technology does not seem remarkable in our current world of social networking, MentorNet's software platforms were built mostly by a single employee (Stephanie Fox) linking email, homegrown databases and a proprietary complex, dynamic matching algorithm, a number of off-the-shelf Microsoft applications, and building what is now called a "customer relationship management" system, at a time well before the existence of most of the social networking sites that we know today.[42] Each iteration of matching and related evaluation helped the team to improve the processes for more and more successful mentoring relationships.

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[41] Muller has authored or co-authored more than 40 papers on e-mentoring. In addition to the one cited here in the text, we mention only two more recent ones that concern populations that are double minorities, in these cases women of color: Muller et al. (2012), Blake-Beard et al. (2011).

[42] "We did apply for a patent, but the actual write-up, done on a *pro bono* basis by a law student, … [W]hile the patent was still pending, both Stephanie and I left MentorNet, so the follow-up was left to David Porush, and I gather he wasn't able to follow through successfully." (Private communication from Carol Muller, 24 February 2016)

Muller learned a great deal about mentoring through her experiences at MentorNet. She noted that 'mentoring' is a word that encompasses many different possible activities. She pointed to Sheryl Sandberg's riff on Dr. Seuss in her chapter entitled "Are You My Mentor?" in her book *Lean In*. (Sandberg 2013) Muller also observed that it is important for there to be clear, shared understanding of the expectations in a mentoring relationship so that there is not dissatisfaction on the part of the mentor or the protégé. The staying power of mentors is known to be particularly important with at-risk youth who have sometimes been let down by adults in their lives in the past and who may be particularly disheartened by the failure of a mentoring relationship. Muller expressed a certain amount of agreement with Sheila Wellington (2001), the former president of the non-profit organization Catalyst, which advocates for better workplace environments for women, who argues that people can learn by themselves many of the things that they rely on mentors for. Muller also pointed out the value of what the late Margaret Ashida, an executive at IBM and STEMx who was an early leader in broadening participation in computing, had called 'penalty free mentoring', where a student could have a mentor who was someone other than their advisor, "where you could ask dumb questions and not [be] worried that somebody was going to think they were dumb; or you could confide that you are thinking of dropping out or starting a family or other things that students often rightly might have assumed their advisors would take in a negative way or maybe would reduce their chances for success in their academic environment." (Muller 2014)

In 2008, after 12 years of founding and leading the organization – a much longer period of time than she had ever anticipated staying – Muller decided to leave MentorNet to pursue new learning and other interests. The board selected David Porush as the next chief executive. He was founder of the program in electronic media at Rensselaer Polytechnic Institute; Executive Director of Learning Environments for all the campuses of the State University of New York, where he had been a leader in developing online degrees; and co-founder and chairman of the social networking organization SpongeFish.

Porush made wholesale changes in the organization. He received grants from the Sloan and Bechtel Foundations to do strategic planning and platform re-engineering for the aging technology used by MentorNet.[43] He laid off the remaining staff and outsourced technology development overseas. In 2008, just after Muller left, MentorNet received NSF funding for a grant proposal she had written to extend the organization's mentoring to the geosciences (Porush 2010). In 2011 MentorNet was opened to all students in science and engineering, not just those from colleges and universities that were formal partners of MentorNet.

[43] The original MentorNet technology had been cutting-edge when first developed by Stephanie Fox, and it was robust enough to handle the scale growth of MentorNet over its first decade; but the original technology did not reflect the rapid advances in networking technologies that occurred during MentorNet's first decade. (private communication from Carol Muller, 24 February 2016)

Additional major changes came in 2013, when MentorNet chose Mary Fernandez as CEO.[44] Fernandez was committed to mentoring because of her own personal experiences. She had benefited from a mentor throughout her doctoral student years in computer science at Princeton University, provided through a program funded by AT&T for women and minority STEM students. During a summer internship at AT&T Bell Labs and while still a Princeton graduate student, she had a very positive mentoring experience with her mentor, the famous Bell Labs computer scientist Brian Kernighan.

> And I had – as many graduate students do, … some bumps in the road along the way. I wasn't quite sure if I was going to make it through and I had difficulty with my topic area. The person I intended to study with left [Princeton] not long after I arrived. Just one thing after another. Through the crisis of confidence, and Brian really helped me overall with those bumps although he would tell you that he didn't do anything at all. But I was really affected by having this incredible resource available to me, this objective person… who is really [standing] in my corner. (Fernandez 2014)

Upon graduation, Fernandez joined AT&T Bell Labs (soon renamed as AT&T Labs), first as a research scientist and later as a research manager. AT&T was a sponsor of MentorNet, and it was natural that Fernandez would work through MentorNet to give back to the community. Over the years, she served as a mentor to 17 students through MentorNet.

Fernandez's primary contribution to the organization so far has been to modernize the technology on which MentorNet operates.[45] As she explained about the durable technology that had powered MentorNet during Muller's tenure:

> Carol in many ways, in fact … is quite the visionary because MentorNet predates open social networks, Facebook, LinkedIn; it predates pervasive mobile communication; it predates everything that we do today and … the interaction the digital natives are so accustomed to – the people who are maybe … 25 and younger. The way they interact in the world, their virtual and physical world that are really in some sense one. … [T]hey are very accustomed to this way of communicating and interacting, whereas [for] those of us who are digital immigrants, there's still to a certain degree some foreignness to it. (Fernandez 2014)

[44] In Fernandez (2013), the new CEO of MentorNet discusses her 15 years of experience as a mentor.

[45] Fernandez notes that the new technology created during her tenure at MentorNet could be used for other purposes than women and minorities in science and engineering in the United States. She has been contacted both by organizations that want to broaden STEM participation in countries outside the United States and by U.S. organizations interested in unrelated issues. While she believes that the MentorNet platform could work for these organizations, Fernandez is not pursuing these opportunities at this time – for scale reasons. However, she is also cautious in her response to these other organizations, cautioning them that they will not be successful simply by applying this platform, that "the hard part is figuring out programmatically how to serve the needs of that target community and that is where subject matter expertise around the needs of your target community are absolutely critical, right. So I think it's the case and there has been huge amount, there is huge body of research, social science research around effective mentoring." (Fernandez 2014)

But the original technology "was not robust enough to handle the scale and growth of MentorNet and did not reflect the rapid advances in social networking technologies." (private communication from Mary Fernandez, 27 March 2016)

In creating the architecture for the new MentorNet technology, Fernandez drew on her experience with Software As A Service at AT&T, borrowed from LinkedIn "the paradigm of being presented with people who might be of interest to you and engaging in a protocol for inviting them and for starting a relationship," and copied Facebook's ability for online communication in order to facilitate chat. While MentorNet has a custom interface, the goal was to make it familiar to young people who were experienced with the popular social networking sites.[46]

One of the advantages of the new technology is that it enables the MentorNet staff to continually add or change the questions that are being asked of mentors and protégés. This enables scalable, large data collection and the use of statistical analysis and machine learning techniques to aid in formal evaluation, e.g. to determine which attributes of a mentor-protégé relationship are good predictors of positive mentoring outcomes. These attributes can be more finely structured than in MentorNet's earlier years so as to do targeted mentoring (or targeted research on mentoring) in the same way that advertisers do targeted advertising or customized content.

> I like to say that gender is too blunt an instrument or too blunt an attribute for understanding any individual, just like race is in some sense too blunt a dimension … let's say you have a Latina woman who is first generation in her family to attend college. She lives in the Southwest with a lower socioeconomic status. She is attending a two-year community college with the hope of transferring to a four-year university. Because of the circumstances of her family she does not have a lot of exposure or very limited exposure to the career opportunities that might be available to her if she were to get a two-year degree or a four-year degree … That's a complex person. She has many different characteristics.
>
> Now I will take another Latina woman who lives on the Upper East Side of New York City. Her mother is an anesthesiologist and her dad works at Goldman Sachs. She is interested in getting a degree in computer science because it seems like a really hot topic. She went to a private school. … Now if you were to just focus on women in the same bucket because they happen to be women and they happen to be Latina, Hispanic women, you're not comparing apples and apples here, certainly not with respect to the likelihood that [this] person is going to succeed in [her] academic trajectory.
>
> So the vision for our program over time is that we have the ability to understand who that person is really from a multidimensional standpoint – from many different perspectives – and to ask them both based on the knowledge that we have about people with those various characteristics as well as engaging them in the question about what are your biggest challenges. (Fernandez 2014)

LinkedIn was MentonNet's primary sponsor of the new mentoring platform and program.[47] A short-term goal is to connect the data collected by MentorNet with the

[46] Fernandez also says that, on the organizational level, MentorNet is following the model set out by Michael Wu in *The Science of Social* (Wu 2012). In particular, MentorNet is following Wu where the "question is really a matter of how, in business, you would call your 'go to market strategy', how are we going to establish the strategic relationship that allow our acquisition gear to be very efficient [for example, to reach a particular Hispanic population]." (Fernandez 2014)

[47] NIHGMS (NIH General Medical Sciences) is MentonNet's largest overall sponsor.

data collected by LinkedIn to make the mentoring process more effective. There are commonly more protégés than mentors, and sometimes there is a pool of protégés who have not yet been matched. If one does data analysis on the unmatched pool of protégés, one can determine the attributes of the mentor types most in demand. One can then do direct mentor recruitment with some specificity on the LinkedIn platform. (Fernandez 2014)

In addition to changing the platform, there have been some important changes in the mentoring process – all based in social science research results from the past 15 years. One is that they encourage a new mentor and protégé to connect with one another by videoconference (e.g., Skype or Google Hangout) in the first week after they are matched together – even if they plan to carry out all further interaction through some asynchronous means of communication such as email. This is done because research has shown that "if you see a person's face and hear their voice early on … this [is] … like an imprinting… [Y]ou feel a stronger sense of connection and also you can often discover quickly that maybe you are [they are] … not necessarily going to be good match." (Fernandez 2014) Similarly, Fernandez has introduced formal training for mentors in how to mentor effectively based on recent social science literature on organizational development. Working with an outside consulting firm that worked for corporations, the obligatory training for mentors now teaches them about the method of Socratic questioning and the power of storytelling as a mentoring tool.[48] "So we guide the mentor and the mentee with discussion topics that are relevant to the mentees' level of education and personal experiences. The topics have evolved considerably over time." (Private communication from Mary Fernandez, 27 March 2016)

Fernandez has noted a sizable increase in interest for mentors in the computing disciplines. This is tracking in consonance with the Bureau of Labor projections that 70 % of new STEM jobs over the next decade will be IT jobs.

In 2014, MentorNet became a division of Great Minds in STEM (GMiS), a national non-profit operating out of Los Angeles founded in 1988 to provide STEM awareness programs in underserved communities. Under this arrangement, Fernandez continues on as the President of MentorNet and reports to the CEO of GMiS (N.A. 2014).

[48] Fernandez has observed that in a previous generation, people were generally homophilic: mentors wanted to mentor protégés like themselves – women mentoring women, Hispanics mentoring Hispanics, computer scientists mentoring computer scientists. "The younger generations are not self identifying as strongly with respect to their ethnic or cultural heritage. They are more fluid in their own identity which is fascinating. And I saw this at AT&T before I left in fact. Specifically, in our employee resource groups. Employee resource groups traditionally have been founded around racial identify, Hispanic, Latino, Asian, South Asian, Pacific Islander et cetera. And what a lot of corporations are finding is that their younger employees don't self identify in that way such that it's important with respect to their professional development. So that actually kind of changes the way that people cluster. And so it's interesting for us because our mentors are of one generation and our protégés are of a different one. So I think that will be a ongoing, definitely an ongoing exploration." (Fernandez 2014)

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