Chapter 8
Organizations That Help Women to Build Computing Careers

Abstract This chapter discusses organizations with the mission of increasing the numbers of, and support provided to, women in computing-related education and work. Four organizations are profiled in the chronological order in which they appeared. The Anita Borg Institute (ABI), created in 1987, is strongest in its work on behalf of professional women in computing. The Computing Research Association Committee on the Status of Women in Computing Research (CRA-W), created in 1991, focuses on women graduate students in computing disciplines as well as women computing researchers in both universities and industrial research labs. In 1993, the computing professional organization ACM established its Committee on Women in Computing. Its scope includes undergraduate education and IT workers generally, not just computing researchers. The National Center for Women & Information Technology (NCWIT), founded in 2004, is the largest of these four organizations and has the widest scope, with interest in female students, academics, industrial workers, and entrepreneurs.

This chapter discusses organizations with the mission of increasing the numbers of and support provided to women in computing-related education and work. We will cover four organizations in the chronological order in which they appeared. The Anita Borg Institute (ABI), named after the late computer scientist Anita Borg who started these activities in 1987, is strongest in its work on behalf of professional women in computing. The Computing Research Association Committee on the Status of Women in Computing Research (CRA-W), created in 1991, focuses on women graduate students in computing disciplines as well as women computing researchers in both universities and industrial research labs. In 1993, the computing professional organization ACM created its Committee on Women in Computing. Its scope is broader than that of CRA-W, with more attention to undergraduate education and to IT workers more generally, not just to computing researchers. The National Center for Women & Information Technology (NCWIT), founded in 2004, is the largest of these four organizations. It has the widest scope of the four organizations, with interest in women students, academics, industrial workers, and entrepreneurs. All of these organizations continue to this day, and there are various types of cooperation and collaboration between them, so that there are many parallels and even some overlap between these accounts.

W. Aspray, *Women and Underrepresented Minorities in Computing*,
History of Computing, DOI 10.1007/978-3-319-24811-0_8

8.1 Anita Borg Institute (ABI)

In 1981 Anita Borg (1949–2003) completed her doctoral dissertation at the Courant Institute at New York University and joined Auragen, a start-up company building fault-tolerant operating systems.[1] In 1987, while in Austin, TX attending the ACM Symposium on Operating Systems, the leading operating systems conference, she took the first step at creating what became Systers, an electronic mailing list for computer scientists.[2] As Anita explained these origins in an oral history conducted by historian Janet Abbate (Borg 2001):

> I always look at the list of attendees to see how many women are there. Of four hundred attendees, there were only about thirty women. I ran into a friend of mine in the bathroom. We began talking about why there were so few women. Each time someone came in, she joined the conversation. It's a little bathroom with only two stalls, and we wound up with about eight of the women from the conference crammed in there, talking about it! We said, "You know, we should meet somewhere else. Why don't we try to get all the women at the conference to come to dinner together?" …We got, I think, all but two of the women, and it was great. …everything from graduate students, to me in the middle, to these senior women. It was so extraordinary that I collected their email addresses (for those who had [one] – not everybody had email at that point, or some had email, but it was just inside their companies) and set up a mailing list and came up with this funny little name.

At first, Systers was only open to women conducting research in the area of operating systems. Anita's close friend and later the CEO of the Anita Borg Institute, Telle Whitney, was originally turned down when she applied to join Systers because her research was in a different area of computer science. However, at the encouragement of Barbara Simons, another Ph.D. in computer science who eventually served as president of the ACM, Systers was eventually opened up to all technical women in computing. In Borg's mind, the golden years for Systers were when it numbered a few hundred people because it was then the right size to serve as a community. "Before Systers existed, there was no community of women in computing. It didn't exist. We all existed as individuals: we had a few women that we knew, but there was no community. There was no notion of how many women were out there, doing what" (Borg 2001).

At the time that Systers was formed, the technology was not capable of carrying out the tasks that Borg wanted it to perform. For example, most mailing systems assumed that all users were reading their email on the same hardware (a reasonable assumption for mail systems inside a corporation, but not true for of those who wanted to join Systers). So, Anita took on the task of building a mail system (Mecca) that would serve her needs. She wanted to build a system that not only handled

[1] This section is written primarily from the oral histories conducted by Janet Abbate with Anita Borg (2001) and Telle Whitney (2002), the oral history conducted by this author with Telle Whitney (2014), and Abbate (2012).

[2] While Systers was the first electronic mailing list for women in computing, it is not the only one. Others include ResearcHers organized by Susan Landau in 2004, PhdjobhuntHers and JrProfessHers organized by Rachele Pottinger in 2006, and ProfessHers created by Rebecca Wright in 2008 (Soffa 2011).

communication but also enabled individuals to have an online profile, much like a social networking site does today.

Over time, Systers grew and grew. As of 2014, it had approximately 4000 subscribers. At first it was primarily made up of faculty members and students from the academic sector, but over time a number of women working in industry also joined. The sense of an intimate community was lost as the numbers increased – even with technological improvements that enabled the formation of subgroups with like interests – and some of the original women on the list chose to become inactive on Systers.[3] New features were added, e.g. the Systers' Pass It On program, which provided grants to established technical women in computer science so that they could help women who were just beginning their technical careers.

The Systers website gives a sense of the purpose of the mailing list:

> Systers continues to serve this purpose by providing women a private space to seek advice from their peers, and discuss the challenges they share as women technologists. Many Systers members credit the list for helping them make good career decisions, and steering them through difficult professional situations. (Systers http://anitaborg.org/get-involved/systers/, accessed 6 October 2014)

Anita Borg apparently had to defend making Systers available open to women. In an article entitled "Why Systers Excludes Men" she argued that:

> Systers is not analogous to a private all-male club. It is different because women in computer science are a small minority of the community. It is different because systers is not interested in secrecy or in keeping useful information from the rest of the community. Useful messages regularly are made public after checking with the contributors. *It is unlikely that an underempowered minority will keep inaccessible information from the large empowered majority that has every means of communication available to it*. (Borg 1993, emphasis in original)

Borg goes on to list the reasons for keeping Systers female-only: women need (1) a place to find each other, (2) female role models and mentors, (3) a place to discuss their issues, and (4) to discover their own voice (Borg 1993; numbering added; drawn from the topical sentences throughout the text)

While some of the Systers discussion concerned women-specific issues, often involving career or workplace advice, other topics – in the TechTalk section – were about purely technical topics. Abbate has argued (2012, pp. 167–168):

> The FAQ for the main systers list also notes, "We allow people to ask for help on purely technical topics…because many women feel uncomfortable asking certain types of questions on lists dominated by men." These comments reveal that what is usually regarded as "purely technical" discussion is actually gendered: the aggressive tone in which many online technical debates are conducted is felt as masculine and alienating by some women who would otherwise be interested in the technical content. Rather than concluding that it is impossible to be both feminine and technical or that women must accept and adopt the aggressive style as inherent in the nature of technical discourse, TechTalk challenges the masculine norm by offering a less confrontational mode as an equally valid alternative.

[3] There were, for example, ResearcHers for women in research careers and systers-entrepreneurs for women interested in entrepreneurship (Jeffries 2006).

Perhaps the best-known activity with which Anita Borg was involved is the Grace Hopper Celebration of Women in Computing, co-founded with Telle Whitney. The first of these conferences was organized in 1994 (Borg 1994). The conference had multiple origins. One strand involves the vision of Nico Habermann, the founding dean of the College of Computer Science at Carnegie Mellon University, who had agreed to join the National Science Foundation in 1991 as head (the official title is Assistant Director) of the computing directorate. He was keenly interested in enhancing opportunities for women in computer science, and at his initiative there had been a series of conversations during 1992 in Washington, DC about how to do so (Borg et al. 1994). Unexpectedly, Habermann died of a heart attack in August 1993.

One activity that came out of these discussions was the Windows of Opportunity Symposium for Female Students in Computing, held in May 1993. The symposium, sponsored by a grant from the National Science Foundation to Computing Research Association and hosted by Professor Dianne Martin at George Washington University, brought together 208 students from more than 100 universities to network and learn about careers and research and funding opportunities (Martin 1993). In his keynote address, Habermann challenged the computing community to increase the percentage of female graduate students in the computing disciplines to 45 % by the year 2000. Anita Borg was one of the keynote speakers at the symposium.

Among Anita Borg's many activities, she was actively involved in CRA-W (described below), which had been formed in 1991 and was both studying and acting on issues related to women in computing research. She was also actively involved as a volunteer in ACM. She used both of these connections when she looked for funding to hold the first Hopper conference.

In her interview with Abbate, Borg mentions Marlene McDaniel as a direct stimulus to create the Hopper conference. McDaniel was working for a company that organized large trade shows, and she approached Anita about founding a conference of women in computing as a way to make money. Anita tracked her thinking about a possible conference:

> The whole idea of making money off all these women didn't appeal to me, but the idea of a conference was pretty interesting. I thought, First of all, wouldn't it be fun to get them all together and meet them? It would make such an even better experience for the community to get together. Then the question was, what kind of a conference could we have where somebody's boss would pay for them to go – where you could use money that wasn't out of your own pocket to go to this conference? And we thought: a technical conference. Wouldn't that be extraordinary, for women to get together and hear what everybody else is doing? So there were all these possibilities. One was, what would a technical conference that was almost all female be like?
>
> Would it be the same? I don't think so! I think it would be wildly different.
>
> So we planned, as close as we could, a top-notch technical conference…. I didn't know exactly what we were going to get…Some of our principles were: This was not going to be a half-assed conference. I've been to lots of get-togethers about women, and it's always on the cheap. This was not going to be on the cheap. This was going to be at a good place. It was going to be as high-class as SOSP or any other really good computer science conference: at a nice hotel, really well done. We figured we could do that if we raised fifty or a hundred thousand dollars. We raised two hundred and fifty thousand dollars! We had room

> for four hundred people: we squeezed in four hundred fifty, and we had to turn away a hundred people. This was in Washington. It was extraordinary; it was absolutely extraordinary, and I am wildly, wildly proud of that, because a lot of people said it wouldn't happen. (Borg 2001)

As Valerie Barr, a professor of computer science who has attended every Hopper Conference, remembers the 1994 event:

> [It] really was an amazing event. And part of what I absolutely loved about it was because it was only about 450 people. Which was amazing for everyone who was there, because who knew that there would be that many? We were all in this one auditorium the whole time, and basically it was one wonderful technical talk after another by all of these leading women computer scientists when most of us had no idea that there were even enough leading women computer scientists to give that many research talks. So it was really a great event. There were these fabulous talks, and then birds-of-a-feather sessions. And really just an incredible experience for the people who attended.[4] (Barr 2014)

At first, the conference was held every 3 years. In the early 2000s it started to be held every other year. Since 2006 it has been held annually. Long before the 2014 conference, for example, all 8000 attendee spaces had been sold out.

The conference always includes high-quality technical tracks. But it also includes student, academic, industry, and career tracks as well as a career fair. Other organizations piggyback on the conference, such as CRA-W holding career mentoring workshops and the Computer Science Teacher's Association holding computing teacher's workshops.[5] Borg's institute itself has piggybacked a Senior Women's Summit on the conference.

---

[4] Others who attended concurred with Barr. For example, Leah Jamieson (2015) remembers: "It really took my breath away to walk into that room and be in a room with 450 women." Camp (2015) remembers: "I was just blown away. I was so inspired by the senior women that were in the room. I had never had a senior female professor. I don't think I had a single one up to that point, at least no one's coming to mind. Many of them instantly became major role models for me. I got to meet Anita Borg. I remember when I met her, I was so nervous meeting her and she was just, at the end of our conversation, she gave me a hug. I'm glad I grabbed that confidence to go up and introduce myself, because that was a wonderful conversation and I ended up helping her with the next Grace Hopper in 1997, I was the Scholarship Chair for student scholarship."

[5] Originally, Anita Borg was a member of CRA-W and CRA-W was a co-sponsor of the conference. As Jamieson (2015) explains CRA-W's attitudes about the conference: "We are not getting along well. We're all in this space, but I think there was a sense of this was clearly an important gathering, an important forum… I think on the CRA-W side, I think it was more a stretch about what the connection with research was. My recollection is that CRA-W was not thrilled about being relegated to a no-role or very minor role and did watch, over time, as actually some of the collaborations came. For example, CRA-W would start to host some of the mentoring workshops and locate them with Hopper, which I think was the *rapprochemont* thing that happens. … Here's something that CRA-W does and does well. Divorcing it from Hopper was actually probably missing an opportunity, but it felt like a phenomenon of being in a crowded space and a whole bunch of organizations trying to claim some of that space." In the end, CRA-W signed over all rights and revenues concerning the Hopper conference to Borg's organization. In fact, the author (at the time serving as the executive director of CRA) of this book negotiated and signed this agreement with Borg.

The conference struggled with growing pains. Borg's institute experienced serious financial problems in 2004 (although it has been financially stable since 2006), and ACM stepped in to secure the finances; and in later years ACM continued to provide substantial funding for students to attend the conference.[6] Computing Research Association was also an initial sponsor, but like Borg's institute it did not have the financial wherewithal to underwrite the conference, and it was better for the sake of efficiency to have fewer organizers (Weyuker 2014). The early conferences were run entirely by volunteers, but as the conference grew in attendance it was necessary and prudent to bring in professional conference staff.[7] While some applaud the increase in the numbers of women attending the conference, others believe that this growth has come at a cost. The sense of intimacy that was so special at the first few conferences is lost when there are thousands in attendance. The organizers have had to work hard to maintain their preferred attendance ratio of half students in the face of companies wanting to sign up hundreds of their female employees. Some of the original members have decried the growing importance of the career fair, arguing that "the conference is becoming less valuable to faculty members because it is expensive and does not count in their departments as a research conference, and question whether … for the companies, [sending large numbers of employees has] becomes an easy way to say 'See, we really are trying to do something about diversity'"; also an easy way to recruit new women so as to bolster their diversity numbers without commitment to changing internal practices or paying women equal wages to men. If faculty attendance is dwindling over time, as Barr suspects, this means there is less opportunity to get out the message about the values of an academic career (Barr 2014).

As much as she loves the Hopper Conference, Barr has nagging doubts about its role in solving the problems facing women in computing:

> I was saying this to one of my ACM-W people the other day, we were talking about Hopper and the fact that it was 8000 and I predicted that their goal for next year would be 10,000. And then I asked one of the ABI VPs what she thinks for next year and she said, "Oh I think we'll get 10,000." I know that they're planning five years out in terms of venues. I think what will happen is that, and okay, this is the cynic in me again, I think that something like Hopper will be very big for the next few years, and there will be this incredible hiring frenzy and the companies that are, at the moment, only 17 % women on their technical staff

[6] As White (2015) tells this story: "What I do remember is how we pulled together and cemented the current relationship we have with Hopper, which dealt with some dark days for Anita Borg's Institute. She was extremely ill, dying. The Institute was in a precarious position. We had discussions of this on the ACM executive committee, and we decided to do two things. One was to provide ABI some funding so that they could survive, and two, we wanted as part of that to have a relationship with the Hopper conference going forward.

"We wanted to see the Hopper conference grow because it would be the main funding stream for ABI to stay alive and do its good work. If anything ever happened to the Anita Borg Institute or the conference was not being supported by the right groups, ACM would have the right to step in and sponsor the Hopper conference going forward. That was all understood and agreed to, and it was at that time ACM became the presenter of the Hopper conference, which has continued."

[7] For a few years after 2004, ACM also provided conference management services for the Hopper Conference.

> will inch up toward 30%, maybe 35%. And then everybody will say, "Well, things are so much better." And something like Hopper will begin to shrink in size, because the hiring frenzy won't be necessary anymore. In five years we're going to look around and those of us who are sitting here now saying, "But we're still earning 86 cents on the dollar, and there isn't really meritocracy, etc, etc…" will be the ones who will still be going to Hopper in five years, in ten years, and saying, "We still have a problem. Just because the numbers are better doesn't mean the attitudes have changed." I would love to be proven wrong. But I certainly think that that's a plausible scenario. Sexism is really entrenched, as is racism. And I think it's going to take more than just a hiring frenzy to take care of it. (Barr 2014)

Since 1986 Anita Borg had been working in the California research labs of Digital Equipment Corporation. She felt that she had hit a glass ceiling in her career there, and in 1997 she used her contacts with John White and Mark Weiser, two of the principal members of Xerox PARC management, to convince them to allow her to relocate there and direct her own Institute for Women and Technology. The Institute subsumed responsibility for both Systers and the Hopper conference.

Already, Anita had been thinking about other projects associated with women and information technology. She had submitted an unsuccessful six-million-dollar proposal to NSF to support the Diversity Collection, a web-based database that collected information about every program in the United States intended to get women and minorities more actively involved in the STEM disciplines. She had received funding from the Kellogg Foundation to hold a meeting of women to read and discuss Pamela McCorduck and Nancy Ramsey's book, *The Futures of Women* (1997), which Anita claimed changed her life.

Borg was particularly interested in learning about how women use technology and how it impacts them, as well as to give women greater input in the design of technology. Beginning in 1999 with projects at MIT, Purdue, Santa Clara, and Texas A&M and eventually expanding to nine universities, this interest was carried out in the Institute through a program called Virtual Development Centers. The Institute worked with the universities and the local communities to put in place a model undergraduate course intended to engage both technical and non-technical students in the design of technologies that would serve the local community. Each university developed its own course. Some were associated with the introductory computer science or introductory engineering course, while others were upper-level courses for majors. Some of the schools had both male and female students involved, while other schools had women only.[8] Projects were carried out by student teams during

[8] For example, at Santa Clara University there were projects involving the use of RFID tags to keep track of children in day care, a self-cleaning house, and a project management and scheduling system for use by a family. (http://www.scu.edu/engineering/vdc/and linked pages). At Smith College, the VDC was an introductory engineering course, called Teach Our Youth (TOY) Tech, in which the Smith students used engineering principles to design fun, hands-on learning experiences for students at a public school in order to teach them about science and engineering. At the University of Arizona, the students helped a medical clinic to keep better track of patients. After consulting with the people at the clinic, the students recommended a helpful, but non-technical solution that involved rearranging the office so that workers had better access to the files they needed. At Purdue, an all-women class developed applications for a laptop they thought would be appealing to young girls. The University of Colorado at Boulder students developed websites for

the school year, and then the students were brought together in Palo Alto, CA at the end of the school year to present their results (Barr 2014; Jamieson 2015).

Anita was diagnosed with brain cancer and died in 2003 at age 54. She had two aspirations for her Institute that she was not able to realize. One was to broaden the scope from information technology to all technology; the other was to make the Institute international in its programmatic reach. Even today, nothing has been accomplished in broadening the Institute to all technology. Modest progress has been made on the international front, notably including the formation of the Grace Hopper Celebration in India in 2010.

In January 2002, Anita's friend Telle Whitney came in to help out her friend with the Institute on a temporary basis, first as an advisor to assist with fundraising, then as the interim president. Telle, who holds a PhD in computer science from Cal Tech and who had worked in several chip startup firms, had senior management experience as the vice president of the Canadian firm PMC-Sierra. She ended up staying on at the Institute as the CEO after Anita's death. This was surprising given that Telle saw herself more as a technologist than as a nonprofit executive focusing on women. Anita herself had never been interested in management, and the organization – renamed the Anita Borg Institute in 2003 – had to work hard to become economically viable. The VDC program, which Anita had held a strong personal interest in, was expensive to operate, hard to scale up, received diminishing interest from the academic partners, and was challenging to find sustaining funds for after the original HP Foundation grant ran out.[9] The VDC program was cancelled in 2005.[10]

Systers and the Hopper conference remain the hallmarks of the Institute. But ABI also has other programs. The TechLeaders program was intended to teach leadership skills to technical women and build up a community of technical women. Each TechLeaders workshop is intended to focus on a single leadership skill, as the titles of the initial workshops indicate: Leadership for Cultural Change, Skills and the Art of Leadership, Effective Technical Leadership Styles, Developing and Running Effective Organizations and Institutions, Developing and Turning Your Vision into Action, and Combining Theatre and Voice with Leadership (Goral and

local nonprofits. For a general discussion of VDC, see Barr (2014). Jamieson (2015) discusses both the VDC program generally and the highly successful EPICS program at Purdue. On EPICS, also see Jamieson (2001).

[9] In addition to the HP Foundation, the VDC program received funding from Sun and Microsoft.

[10] Some people, such as Valerie Barr, who was the chair of the advisory committee of the Institute while Borg was alive and for a short while afterward, thought the VDC idea was "brilliant" and were sorry that there were not funds to carry it forward, especially after these nine schools had given successful examples of VDC courses (Barr 2014). After Anita's death, there was discussion about ABI's strongest organizational capabilities, especially in the face of financial realities. Rick Rashid from Microsoft and Justin Rattner from Intel were on the ABI board and encouraged the organization to focus on high-tech careers rather than on technical education. Even the long-standing academic members (Fran Berman, Leah Jaimeson, and Bill Wulf) thought this work focus was appropriate so long as ABI did not become completely divorced from students and education (Jamieson 2015).

Harris 2006). ABI runs a Women of Vision awards banquet each year to honor women who are making significant contributions to technology. This is a main event on the Silicon Valley calendar. ABI also runs an annual Technical Executive Forum in which senior leaders – both male and female – come together to grapple with the organizational change and how to increase the participation of women in the tech field. The Forum prepares white papers, distilling social science research – mostly from outside researchers – into a form readily consumed by its corporate audience. ABI also holds Hackathons (Tech for Good), networking receptions, and a job service.

8.2 Computing Research Association Committee on the Status of Women in Computing Research (CRA-W)

In 1989 Ed Lazowska, a professor at the University of Washington, and Ken Sevcik, a professor at the University of Toronto, encouraged Maria Klawe, then a computer science professor and senior administrator at the University of British Columbia (and today the president of Harvey Mudd College), to run for a seat on the board of directors of Computing Research Association. CRA is a nonprofit organization that represents the research-oriented computer science and computer engineering departments and industrial research labs in the United States and Canada. It is important to the life of computing research in North America, and although it had been formed in 1972, there had not been a woman elected to the board during its first 17 years. To break this pattern, Klawe agreed to run and was elected in 1990.

At the time of Klawe's election, Peter Freeman from Georgia Tech was vice chairman of the board. He introduced Klawe to Nancy Leveson, a former colleague who was then a computer engineering professor at the University of Washington. She had strong views about what CRA should be doing to engage women in computing.[11] Over a lunch, the three of them made plans to form a committee for this purpose. As Klawe remembers:

> Nancy and I had some very strong ideas about how we were going to organize this committee. … [B]ecause this was the Computing Research Association, it had to be entirely composed of strong researchers. This was not going to be a service committee. [If t]his was going to … get the respect of CRA, it had to have strong researchers. Moreover, it was going to do things… so every person who was going to be on it had to have an active

[11] Leveson had already been interested in issues related to women in computing. In the late 1980s, she served on the advisory committee for the Experimental Integrated Activities Division within the computing directorate at NSF, chaired by Rick Adrion from the University of Massachusetts. Leveson and Ruzena Bajcsy, a professor from the University of Pennsylvania and later the head of the NSF computing directorate, requested the formation of a group to look into women in computing issues., and a subcommittee was formed at NSF. The first grant from NSF to what became CRA-W was written by Leveson and submitted through CRA; it was funded by the Experimental Integrated Activities Division.

> project. You couldn't be on it just to have it on your resume. You had to lead, or co-lead, an active project. We also decided we'd have co-chairs so that it would be a reasonable workload to chair it. We decided that we would allow men to be on it, because there were men who really cared about women. And Joe O'Rourke from Smith [College] was the first male on the CRA-W. We also said that we would be co-chairs for the first three years, and that we would rotate the chair positions so that a lot of people [had a chance to lead] … so that we got new ideas coming in. (Klawe 2005)

In 1991 the Computing Research Association on the Status of Women held its first meeting, with Maria Klawe and Nancy Leveson as its first chairs. In an article that reviewed the first 2 years of the committee, Klawe and Leveson (1993) stated that there were already numerous studies and reports about the problems faced by women, and CRA-W's intention was to be action- rather than study-oriented. At its first meeting, CRA-W established an operating procedure that it continues today: each member of the committee must direct a project that addresses a significant problem (with inactive members regularly replaced), and these projects are typically carried out by groups of individuals, including many people who are not members of the committee.[12]

CRA-W received NSF project support from its first year.[13] The first NSF grant paid for the creation of a database – a project led by Joan Feigenbaum of AT&T Bell Laboratories – of female researchers in computing, which by 1993 contained more than 600 names (Feigenbaum 1992). Another early project, begun in 1991 and led by Fran Berman of University of California at San Diego, was the creation of a regular column (called The Pipeline) in *Computing Research News*, addressing issues affecting women in computing research. Eventually, 47 articles were published in this column on such topics as family-friendly leave policies for academics, childcare at professional conferences, and mentoring best practices.[14] CRA-W's second NSF grant, awarded in 1993, supported the CRA Distributed Mentor Project. In this project, which continues today under the name Distributed Research Experiences for Undergraduates (DREU), female computer science undergraduates were matched with a female computer science faculty member and given support to spend a summer working on research with that faculty member. The purpose was to overcome the lack of female role models and encourage female students to pursue graduate education and a computing research career. This project was directed in the beginning by Joe O'Rourke from Smith College.

---

[12] The material about the early years of CRA-W is drawn primarily from Klawe and Leveson (1993). The CRA board meets twice a year, and CRA-W provides a 6-month update on its activities as a report to the board at each meeting. The board briefing books, containing these CRA-W reports, are available from CRA from 2000 to the present. These reports provide finer-grain materials similar to those covered in the text here.

[13] Jamieson (2015) discusses the critical importance of NSF to the CRA-W program, and the critical role that Caroline Wardle and later Jan Cuny played as NSF program officers in supporting CRA-W's efforts.

[14] Most issues of *Computing Research News* are available on the CRA website. The first 3 years are missing, as are issues 4.1 and 6.2. So it is possible to construct a relatively complete history of CRA-W through these articles.

Other early CRA-W activities included a report prepared by Mary Vernon of the University of Wisconsin on strategies and experiences of female computer science faculty members on work-life issues; a booklet compiled by Sandra Baylor of IBM on graduate fellowships available to women in computing; another booklet targeted at high school women, entitled *Women in Computer Science* (50,000 distributed by 1998), presenting 18 brief biographies meant to inspire young women to pursue a career in this field; and efforts by Maria Klawe to establish and find funding for awards for outstanding male and female undergraduates in computing (Lopez et al. 1996; Irwin and Berman 1996; Francioni 1998). Based on a successful Academic Career Workshop that had been organized by Cindy Brown of Northeastern University at the 1993 Federated Computing Research Conference, CRA-W planned an academic careers workshop for 1994 organized by Jan Cuny of the University of Oregon and Dianne Martin of George Washington University.

CRA-W has organized consistently high-quality programs over the years, as attested by its winning the Presidential Award for Excellence in Science, Math, and Engineering Mentoring in 2003 and the National Science Foundation's Public Service Award in 2005 (CRA 2005). There are several characteristics of CRA-W's work and its membership that have helped to enable its success. It is focused on increasing the numbers of women computing researchers and the situations of and opportunities for them. Computing researchers have traditionally occupied a small number of occupations – primarily as faculty members in research-intensive universities or as researchers or research managers in government or industrial computing research laboratories. The skills and knowledge required for these occupations are well understood, stable, and vary little even if one moves from, say, a faculty position to a position in an industrial research laboratory. Thus, computing researchers represent a small and homogenous sector of the information workforce. The (primarily) women who have been active in CRA-W are extremely accomplished, and they often come from prestigious universities, which helps to open doors to funding. The goals of CRA-W align well with both the research and workforce goals of NSF, and NSF has been a generous funder of CRA-W programs. CRA-W also has had the deep pockets of successful IT companies to draw upon.[15] This is not to say that the programs created by CRA-W are not well designed and well implemented, but being so closely aligned with the goals of NSF and major research-oriented computing companies has made it easier to attract not only financial resources but also high-quality volunteer talent and places for internship experiences and job opportunities.[16]

[15] In its first 20 years, in addition to support from its parent organization (CRA), CRA-W received support from companies including Microsoft, Google, Sun, IBM, Intel, GM Canada, and Lucent Technologies; government agencies including NSERC and the National Science Foundation; professional societies including ACM and USENIX; and private foundations including the Henry Luce Foundation (Soffa 2011).

[16] Many of the people associated with CRA-W have remarked both privately and on tape about how committed the members of CRA-W have been and how well they have worked together. Jamieson (2015) is typical: "CRA-W just works unbelievably well. I do think the key part of that was, as I said, that everybody had a project. You could not be there just to be there. You had to work. The

Because of the narrow set of occupations that CRA-W targets, its programs have primarily fallen in a narrow range of activities that involve engagement of college students in computing research and recruitment of these students to graduate school and computing research careers; retention of students in graduate school to complete the doctorate; and advising and supporting women in their research careers as faculty members at research universities or in professional positions in industrial computing research labs – primarily at the beginning stages, but increasingly also at the mid-career and senior stages of their careers. As the title of CRA-W's column in *Computing Research News* suggests, CRA-W strongly adheres to a pipeline model of formal education to get women into the computing research workforce.[17]

As computing spreads through society, the task of CRA-W is becoming more complicated and CRA-W's traditional approaches may be challenged. This is partly because students in an increasingly wide range of academic disciplines (e.g. various other science and engineering disciplines, economics, and even digital humanities) are studying computing, so CRA-W has to target more than just computer science and computer engineering undergraduates. It is also because doctorally trained researchers are increasingly being placed in jobs that were not part of the traditional CRA-W target community, e.g. in faculty positions in departments other than computer science or computer engineering, or in a wide array of industrial sectors – not just the IT sector – and increasingly in companies that do not have their own research laboratories.

While CRA-W adds programs on an ongoing basis to fill in the gaps to meet the goals described above, many of its programs have been successful and had long staying power. Across these many years, the program goals have been unwavering. So instead of discussing the programs as they appeared chronologically, we organize the discussion by programmatic goal.

Three CRA-W programs are targeted at undergraduates: DREU, CREU, and the Distinguished Lecture Series. The Distributed Mentor Program (DMP) began in 1994 and changed its name to Distributed Research Experiences for Undergraduates (DREU) in 2009. This is a recruitment program. A number of the undergraduate women who could succeed in a graduate computer science program and in a computing research career are enrolled at colleges where the amount of computing research is limited. DREU enables these undergraduate students to gain experience

---

other thing that we would talk about actually fairly explicitly was that you'd get in discussions about leadership style and women in leadership styles and men in leadership styles was that just played out in really interesting ways in CRA-W. We would kid about the fact that at a CRA-W board meeting everybody would be talking. Things got done. There was very little worrying about who was actually managing the conversation. It was just friendly and collegial and constructive and a lot of energy and a lot of respect among all the people who were there. For me, it was just a pretty incredible model – both leadership but also effective organization."

[17] There has been talk from time to time within CRA-W of working on alternative pathways into computing research careers, such as transitional ramp-up programs into doctoral study that help women who hold undergraduate degrees in some field other than computer science and engineering get the computing background necessary for doctoral study in computer science; however, there has never been a successful CRA-W program on non-traditional pathways.

with computing research. The program matches highly qualified undergraduate women to a faculty mentor at another university and pays the expenses for the student to spend a summer working on a research project with the faculty mentor at the mentor's home institution. This gives the students a chance for daily interaction not only with the mentor, but also with graduate students and other faculty. Between 1994 and 2011, 545 students and 123 faculty members were funded under this program (Soffa 2011).

In 2008, CRA-W added the Collaborative Research Experience for Undergraduates (CREU) program. Whereas, under DREU, individual students went off to another university for a summer research experience, under CREU a team of undergraduate students work together with a faculty member at their home institution in a structured environment on a research project throughout the school year (and possibly the following summer). This arrangement enables undergraduates to gain a research experience without having to relocate, but it does require certain features to be in place in order to succeed: enough interested students to form a research cohort, a research-active faculty member who is willing to serve as the mentor, and adequate research facilities on campus. Between 1998 and 2011, 480 students had participated in CREU (Soffa 2011; Danyluk 2013).

In 2000, CRA-W added the Distinguished Lecture Series as another tool to recruit undergraduates into graduate study and a computing research career. Under this program, prominent female computer scientists visit an undergraduate campus – often one in which computing research activity is limited. The distinguished lecturer not only presents a technical talk but also participates in a variety of recruitment activities such as panel discussions, luncheons, and small group meetings where the visitor communicates to the students the nature and excitement of graduate study and a computing research career. More than 50 of these distinguished lecture visits were made between 2000 and 2011. (http://cra-w.org/ArticleDetails/tabid/77/ArticleID/53/Distinguished-Lecture-Series.aspx)

Four other CRA-W programs are targeted at graduate students: Career Mentoring Workshops, Discipline Specific Workshops, Distinguished Lecture Series, and the Grad Cohort. The CRA-W website describes the purpose of the Career Mentoring Workshops:

> Women often find themselves a minority in their own departments or research unit, typically have few female colleagues and role models, and may be concerned about their potential for success. CRA-W-sponsored Career Mentoring Workshops (CMW) bring junior researchers and educators together with women already established in their fields. The established professionals provide practical information, advice, and support to their younger colleagues. Workshops are generally co-located with major professional meetings, providing many attendees with the opportunity to attend technical talks and make contacts in their research areas. (http://cra-w.org/ArticleDetails/tabid/77/ArticleID/50/Career-Mentoring-Workshop-CMW.aspx)

The workshops, which began in 1993, were targeted in a one-size-fits-all approach at all women in computing research. More recently, there have been three different tracks of workshops:

> The CMW-R track targets female junior faculty in research universities and senior PhD students interested in research faculty positions. The CMW-E track targets female junior faculty in teaching colleges and senior PhD students interested in undergraduate education. The CMW-L track serves female researchers in industry and government research labs, and senior graduate students interested in research lab positions. (http://cra-w.org/ArticleDetails/tabid/77/ArticleID/50/Career-Mentoring-Workshop-CMW.aspx)

The total number of people who have participated in these workshops is not available, but between 1993 and 2002, 352 students participated (Soffa 2011).

Since 2006, CRA-W has sponsored 36 discipline-specific workshops in various areas of computer science and engineering, such as data mining or machine learning.

> The goal of these discipline specific workshops is to increase participation of members of underrepresented groups within a specific research area by providing career mentoring advice and discipline specific overviews of past accomplishments and future research directions. Specifically, the workshop should focus on helping young researchers at the graduate or post-graduate level become interested in and knowledgeable about the research and research paradigms of a specific discipline. (http://www.cra-w.org/ArticleDetails/tabid/77/ArticleID/52/Discipline-Specific-Workshops-DSW.aspx)

The Graduate Cohort program, which began in 2004 and is held annually, is a retention program for women in their first year of graduate study. The students meet for 2 days in both formal and informal settings with some 20 senior women computing professionals, where they learn about graduate school survival skills and the rewards of a research career, build peer networks, and identify potential mentors. By 2011, 1844 students had participated in this program (Soffa 2011).

Two programs are targeted at academic faculty: the Advanced Career Mentoring Workshop and the Borg Early Career Award. The workshops, which began in 2004, are directed at mid-career women who are focused on a teaching track, whether they are at a primarily teaching institution or a research university. Topics include "collaborations, mentoring up and down, managing up and down, promotion to full professor, promotion to other positions such as Dean, effective leadership, leading new initiatives, [and] negotiating." (http://www.cra-w.org/ArticleDetails/tabid/77/ArticleID/231/Advanced-CMW-E-formerly-known-as-CAPP-E.aspx) Named in honor of Anita Borg, the early career award is given to women in academia, government, or industry early in their career (no more than 8 years past the PhD) who have made significant research contributions but who have also contributed to their profession, especially to the advancement of women. (http://www.cra-w.org/ArticleDetails/tabid/77/ArticleID/47/Borg-Early-Career-Award-BECA.aspx) It has been awarded annually since 2004.

Five CRA-W programs are targeted at researchers in government and industry labs: the Career Mentoring Workshop, an Advanced Career Mentoring Workshop, Travel Support, the Distinguished Lecture Series, and the Borg Early Career Award. We have discussed the Career Mentoring Workshop, Distinguished Lecture Series, and the Borg Early Career Award above. The Advanced Career Mentoring Workshop for laboratories is similar to the one described above for mid-career academics but is intended instead for mid-career government and industrial research lab researchers,

e.g. people who might hold the title of senior staff engineer or principal member of the technical staff. Topics might include advice on how to reach the top of the technical ladder within their lab, lead initiatives, or manage up and down. (http://cra-w.org/ArticleDetails/tabid/77/ArticleID/71/Default.aspx?IsPreview=true) Travel support provides funds to women in industrial and government labs to attend workshops and conferences – funds that might be in short supply in their organizations during tight financial times. The travel fund program made 34 awards between its founding in 2007 and 2011 (Soffa 2011).

Over the years, CRA-W has received significant support from NSF for its programs. Around 2010, NSF began asking CRA-W for additional hard scientific evidence of the effectiveness of the CRA-W projects NSF was supporting. As Camp (2015) explains: "Basically, what CRA-W needed to do was to show that our programs had an impact, [that] our participants had impact from our programs that non-participants who looked identical to our participants did not. That was the goal." Towards this goal, in 2010, the CRA-W/CDC Alliance received a grant to establish the data buddies project. 35 departments of computer science were randomly selected and signed up to collect data from students to use as a comparative baseline for measuring the success of various broadening participation interventions. Two years later, the Alliance received another grant to establish the CRA Center for Evaluating the Research Pipeline (CERP). The responses of students who had participated in CRA programs could be compared with those who had not with respect to career goals, confidence levels, and other issues – thus providing a means for evaluating the effectiveness of CRA programs (Stout 2013).

A second grant from the NSF BPC program was awarded to the CRA-W/CDC Alliance in 2012 to hire a professional social scientist specializing in the study of underrepresentation in STEM disciplines. The data buddies program has grown from 35 to 70 departments, and CERP is now helping to evaluate programs run by other organizations, not only those associated with CRA-W. CERP is able to prepare customized reports comparing the data reported by the client department's students to the data reported by students in similar departments. It also can provide evaluations of programs, and it has done so for various undergraduate, graduate student, and postdoc programs run by CRA-W, CDC, and DIMACS.[18]

A third grant, from NSF's Education and Human Resources Directorate, was awarded to CERP in 2014. This funding is being used to analyze CERP data in basic research on persistence among different undergraduate groups in their computing education and careers. It is too soon to be able to judge the success of this activity (Stout 2015).

[18] For more detail, see the CERP organization website at http://cra.org/cerp/. Also see CRA 2013a, b.

8.3 ACM's Women in Computing Committee (ACM-W)

In 1990, the computing professional organization Association for Computing Machinery (ACM) formed a committee to address issues of underrepresentation of women and minorities in the computing field.[19] The committee included Anita Borg, Sheila Humphreys (for many years the diversity director in computer science and electrical engineering at University of California at Berkeley, discussed in Chap. 10), and Elaine Weyuker (a professor of computer science at New York University), and was chaired by Shari Pfleeger (a well-known software engineer who had worked at RAND, MITRE, and other companies). ACM CEO John White (2015) remembers that the CRA effort on women came together more quickly than ACM's did, and there was "a bit of a struggle to get the initial vision for starting some activities [within ACM] off the ground." Weyuker, who was also a member of CRA-W in its early days, was appointed as the liaison between these two organizations. The ACM committee met a couple of times, made little progress, and was disbanded no later than 1992 (Weyuker 2014).

In 1993, ACM formed a new committee called the Committee on the Status of Women in Computing and later renamed as the ACM Committee on Women in Computing (ACM-W). There are no records of ACM-W's work in its first 3 years. Amy Pearl was the first chair. The size of the committee, the program, and the budget were all small at first (Gurer 2015). White (2015) remembers that ACM "struggled to get good people involved and to come up with powerful things to do" during these years.

In 1996 Anita Borg asked her friend Denise Gurer, a computer scientist at SRI International who had been helping out with the scholarship program for the Grace Hopper Conference, to take over as chair of ACM-W since Pearl wanted to move on to other things. Gurer invited Tracy Camp, a young computer science professor at the University of Alabama who she had met through the Grace Hopper Conference, to join the committee in 1996; and Camp served as Gurer's co-chair from 1997.

The first written records available for ACM-W, an annual report for FY1997 (July 1996–June 1997), coincides with Gurer's first year as chair. That report provides a mission statement for the organization:

> engage in activities and projects that aim to improve the working and learning environments for women in computing. This includes promoting activities that result in more equal representation of women in CS such as mentoring or role modeling, monitoring the status of women in industrial and academic computing through the gathering of statistics, providing historical information about women's accomplishments and roles in CS, and serving as a

[19] In her oral history Weyuker (2014) recalls that this committee was formed in the late 1970s or early 1980s; however she also says that it was at about the time when CRA-W was formed. Since CRA-W was formed in 1990, this author believes that Weyuker was off by a decade and the Pfleeger committee was formed around 1990. This was conformed by John White (2015), who pointed out that one issue they ACM faced in forming its women's committee was to determine who to appoint since they did not want too much overlap with CRA-W, which was forming at about the same time; and that there was a similar question about having overlap and inefficiencies between ACM and CRA's efforts on women.

> repository of information about programs, documents and policies of concern to women. (ACM-W 1997)

Gurer remembers the senior staff of ACM – in particular the two most senior staff members, John White and Patricia Ryan – as unfailingly supportive but also conservative.[20] They wanted the committee to demonstrate its ability to be effective and use funds wisely, so the budget ACM provided started from a small base but grew in incremental steps. Gurer saw her task as building up the number of projects that ACM-W was undertaking. She remembers three projects as being of particular importance during her tenure with ACM-W. One was writing proposals to NSF to fund scholarships for students to attend the Grace Hopper Conference. The second was to engage some historical activities – a panel at the Hopper conference of women who had made a difference in computer history, and a special issue of the SIGCSE Bulletin, *Inroads*, on women in computing (Camp 2002). The third was the pipeline data project described below, on which Gurer worked with Camp on collecting statistics.

Perhaps the project that was most closely associated with the work of ACM-W and that received the widest attention within the computing community was Tracy Camp's project on monitoring the status of women in computing. This involved the publication of a much-cited article, "The Incredible Shrinking Pipeline" (Camp 1997), which popularized the pipeline model of participation in computing.[21] Camp analyzed National Center for Education statistics and showed how there had been a substantial drop in the number of women receiving computer science degrees over time. Camp pointed out that, while she was not the first person to talk about this numbers problem, the fact that she had a snazzy title and presented her results in the widely read *Communications of the ACM* meant that the topic received a lot of attention in the wider computer science community.[22] For example, she heard the director of the National Science Foundation use her phrase "the incredible shrinking

[20] ACM CEO John White confirmed Gurer's comment as a "fair assessment". "I believe that the [early years] of unspectacular performance of ACM-W contributed to there being, well, we're not going to dump money in ACM-W's lap. We want to see them come together with some good ideas. Then we, the EC [Executive Committee], will look at funding them" (White 2015).

White was strongly interested in engaging more women in computing. As a faculty member in the early 1980s at the University of Connecticut, he remembered that there had been large numbers of women in advanced undergraduate computer science courses such as compiler theory and advanced topics in software engineering; and he was concerned when the number of women in computer science courses and majors fell off in the 1990s. As manager of the computer science lab at Xerox PARC, he brokered the conversation between the director, John Seely Brown, and Anita Borg to house her research institute on women and computing there. When White was vice president or president of ACM, Barbara Simons encouraged him to have ACM become active in women and computing issues, and this was one of the origins of ACM-W. White had convinced Borg to become a member of the ACM Council while he was president, so with Borg and Simons, there were strong voices in support of women at high levels within ACM from the early 1990s (White 2015).

[21] Gurer (2015) indicates that she worked with Camp on some of this data analysis.

[22] Camp came up with the name of her paper when she was talking with her husband, who mentioned the 1981 film comedy with Lily Tomlin, *The Incredible Shrinking Woman*.

pipeline." Recently, there have been more than 500 papers that cited Camp's paper (Camp 2015).

We can command a more complete picture of the early activities of ACM-W by considering the 1996–1997 annual report. Anita Borg used Systers as her initial ACM-W project, but this online discussion group had been created outside of ACM-W and had a life of its own; the ACM-W participation seemed to make little difference to the success of Systers. Kathy Kleiman was directing an ENIAC programmers oral history project, which was funded by the Kapor Family Foundation; and it also had a life of its own. Denise Gurer and Teri Perl ran a Pathways project, which provided Internet-based mentoring for young women, who were matched with women computer scientists. This project was co-sponsored by the Math-Science Network but it never took off in the way that MentorNet did (see the separate discussion of MentorNet in Chap. 6). Susanne Hupfer ran the Ada Project, which was intended to be a clearinghouse of information about women in computing, but it never became well established. Judi Clark ran a project to create a CD-ROM of role models for women in computing.

For the decade 1993–2003, the committee carried out a set of loosely connected activities. Typically each member of the committee had responsibility for her own project. There was no effort to marshall the committee to do something of greater scale.[23] Elaine Weyuker, a later chair of ACM-W, called these early efforts "nominal projects", and criticized them for receiving funding "year-after-year…with no accounting." (Weyuker 2014) There were no procedures in place to keep each member working toward the promised goal, and the level of effort by the members varied considerably (Camp 2015).

New projects were added over time: Tracy Camp organized a teacher enhancement program for high school teachers of computer science, which today she does not remember as making a significant difference (ACM-W 1998; Camp 2015). An Ambassador Project was initiated to recruit representatives from around the world to report to ACM-W on women in computing issues in their home country (ACM-W 1999) An Ada Lovelace documentary project was added (ACM-W 2000). ACM-W joined a Coalition for Women in Computing, together with CRA-W, IEEE Computer Society, Usenix, IWT, WEPAN, NSF, AAAI, and SIAM (ACM-W 2002). There seems to have been little tangible development out of this coalition.

The activities of ACM-W began to take on more significance when ACM President Maria Klawe recruited Elaine Weyuker, at that time a distinguished software engineer at AT&T Labs, to be co-chair of ACM-W.[24] She joined Ursula Martin,

[23] It was only later that ACM-W decided to build student chapters to take advantage of the membership structure of ACM. This effort has been only moderately successful. In reflecting on bringing ACM's organizational capabilities to issues concerning women in computing, John White (2015) remarked that of the strong organizations with a mission related to women in computing (he mentioned CRA-W, ABI, and NCWIT) only ACM is an organization an individual can join as a member and contribute to these efforts, and "I just never felt like we've [ACM] been able to leverage [that advantage] well enough."

[24] Klawe had strong support from incoming ACM President David Patterson for the Weyuker appointment. Patterson indicated as part of the planning for his term in office: "I want to find

a distinguished theoretical computer scientist who was then at the University of Cambridge Computing Laboratory, in leading this effort.[25] Within a year, Weyuker was the sole chair, a position she held until 2012, when she handed off the chair duties to Valerie Barr, a computer science professor at Union College.

One of the major new activities of ACM-W was to provide scholarships to women to attend a research conference. In 2012–2013 this program – organized by Weyuker and Barr – provided 33 scholarships to 136 applicants (Barr 2014). Weyuker, Barr, and Anita Borg were close friends from their early days together at the Courant Institute at New York University, where Barr was a beginning doctoral student, Borg an advanced doctoral student, and Weyuker an assistant professor.

> So [with] Valerie, I started a set of scholarships for women to attend a research conference. The idea was as a recruiting-retention tool that this is not aimed at the fourth-year PhD at MIT or Stanford, this was meant for the undergraduate student at Backwater College or any place in the world to tell them, you know, there is a world of research out there and there is something more than they can aspire to or for a terminal masters students to encourage them to stay on and get the PhD … [B]ecause I had been – I come from a working class background, my parents did not know about research. … And so, I wanted to give women who might not have the resources that [women at research universities] had some kind of glimpse that there was something … that was really wonderful that they could aspire to. (Weyuker 2014)

Weyuker actively raised funds for the scholarships from major US-based computer companies, including Microsoft, Google, and Sun, and convinced the Indian consulting firm Wipro to make a major donation. She also convinced many of the ACM technical societies (SIGs) to waive their high conference registration fees for these scholarship students. As the quotation above suggests, the program was targeted primarily at women students from smaller schools in the United States and third-world countries where there were fewer resources than at the major research universities (Weyuker 2014).

Barr thinks of the scholarship program in terms of the pipeline metaphor: "encourage undergrads to think about graduate school, masters students to think about [the] PhD, and help [retain] early PhD students [through to completion]." (Barr 2014) While there has been no formal evaluation of the impacts of this program, both Weyuker and Barr are big supporters.

A second major new activity of ACM-W was the Athena Award – established in 2006 by Weyuker and Susan Landau, a leading cybersecurity and privacy scholar. The award recognizes a woman for her technical contributions to computing, and

---

someone to lead ACM-W, who has probably been active in CRA-W and some of the more visible and more successful women's activities" (as remembered by White (2015)). White also remembers that it was hard to attract strong talent to serve not only as chair but as members of ACM-W because of the slow start that ACM-W had, in contrast to the strong starts by ABI and CRA-W; if a strong computer scientist had limited hours to contribute to volunteer work, she or he would want to make sure those hours were contributed to an organization that would get something important done.

[25] Part of Martin's responsibility at Cambridge was to direct the Women@CL project, which was sponsored by Microsoft and Intel to promote activities for women in computing.

the award winner presents a keynote lecture at one of the major ACM technical conferences. Weyuker explained the rationale for the Athena Award:

> I have been on the ACM Fellows selection committee and had chaired it for a year. And as we all know, … there were very few women being selected. And the problem was that they were not being nominated. And then, I started looking at ACM Awards, so I go to the ACM Award banquet and the award winners would all be men and if a woman won an award, it was always for service, not for technical [contributions]…. I was on many program committees, it was very common that I would be the only woman on the program committee, and when I would suggest another woman, nobody would ever say "oh, no, … she is not competent" or if I would … suggest a woman keynote speaker – it would never be, "oh, no, she is not competent," it [would] tend to be – "oh, geez, that is a good idea, I never thought of her." So basically, my feeling was that women were invisible. And it was not so much that people were biased against them, but that we were not even … on anybody's radar … so what tends to happen when you try to think of who should be the keynote speaker, you think of, who have I heard before who did a great job. Well, if you never heard them before, they do not come to mind. And so, my ideas for the ATHENA Award was that it would be for outstanding scholarship alone that is no commitment, no requirement that they have done great service or anything, purely for scholarship… (Weyuker 2014)

In order to get buy-in from the research arm of ACM (the SIGs) as well as to reinforce the memory of the leading women researchers, Weyuker and Landau organized the award so that the SIGs made the nominations and provide the venue for the award lecture.

> …rather than having [an] individual nominate a person, instead have the SIGs do it; and that's what is required. … [T]he candidate has to be nominated by their SIG Executive; and the reason is I felt that if they go through the exercise of picking who are the outstanding women in [their] field maybe they can remember them long enough when they came to nominating people for other awards or having them be program chair or be the keynote speaker… (Weyuker 2014)

A third new activity of ACM-W involved regional meetings, beginning in 2006. These meetings were intended to produce a similar effect to the Hopper Conference, but on a smaller, regional scale in a number of different locales around the country. They were intended for women who could not afford the time or cost of attending the Hopper Conference. Gloria Townsend, a computer science professor at Depauw University in Indiana, was the creator. She organized several successful regional conferences, and when these were successful the project was scaled up to 12 regions of the country for 3 years with a grant in 2010 that NSF awarded to ACM-W, ABI, and NCWIT. These conferences typically lasted no more than 24 h, and cost no more than $50 (including lodging and meals). Most people could drive to them, helping to keep costs low. Typical attendance was between 60 and 250 participants. The grant funds have now been expended, so the regional conferences program is once again an activity solely sponsored by ACM-W, using ACM internal funding.

To take greater advantage of ACM's individual membership structure, Barr has pushed to build up student chapters and professional chapters for ACM-W. So far these efforts have met with only limited success.

ACM has faced a common problem faced by many professional STEM organizations with affiliated women's groups. Although long-time ACM executive director

John White has given generously of his time and from his budget for diversity issues, and whereas recent ACM presidents including Alain Chesnais, Vint Cerf, and Alex Wolf have also been highly supportive of ACM-W activities, until recently there has been a residual attitude that the problem of underrepresentation of women is one for ACM-W rather than for the entire organization to fix.[26] Barr sees this attitude changing in good ways over the past 2 years:

> The first time I went to an ACM Council meeting I thought, "Oh my God, if I wasn't in the room for that conversation, that would've just been awful." Now I don't have to be in the room. I hear afterward. … And what I hear these days is that the executive committee has amazing conversations, and there's a level of bringing up issues that have to do with diversity that happen even though I'm not in the room. So that's a great thing, because that means that it's really becoming part of the way other people are thinking about what ACM does and how it does it. … It doesn't mean it's always a bed of roses, but it's definitely progress. [The attitude expressed by one of the ACM Presidents that] most of the work ACM does in this area is done by ACM-W, and I've already spoken with [him] and said, "No. That's not the view. We just, we can't have that view anymore. The problem with women in computing, the problem of minorities in computing is everybody's problem, and everybody has to work to fix it…. I'm fine if you want to say that ACM-W provides leadership. If you want to think of us as your conscience, I'm okay with that. But there is no way you can let the other 107,900 people off the hook. Everybody has to start to do this work. And every SIG, every SIG chair, everybody's got to be held accountable for the dearth of women and minorities and the changes that have to happen. And our job is just to keep reminding you of that." (Barr 2014; also see White (2015) who talks about the leadership Barr has offered in changing ACM culture on this issue.)

8.4 National Center for Women and Information Technology (NCWIT)

The National Center for Women & IT is a national nonprofit, founded in 2004 and headquartered in Boulder, Colorado, that aims to increase the meaningful participation of women and girls in computing. Over time, NCWIT has grown so that it is today the largest network of computing-related organizations in the world, involving more than 700 organizations. For example, its K-12 Alliance of member organizations can now reach 100% of the girls in the United States through their distribution channels. (Sanders 2014; update by Ruthe Farmer, private communication, 1 April 2016)

After 25 years at Bell Labs, where she had been a Bell Labs Fellow and manager of a large, international engineering laboratory, Lucy Sanders retired and eventually joined the ATLAS Institute at the University of Colorado, Boulder, as the executive in residence. ATLAS is an interdisciplinary research institute examining issues of information and communication technologies in society, at the time managed by Robert (Bobby) Schnabel, the university CIO and vice provost as well as a professor

[26] Barr (2014), Weyuker (2014), and Camp (2015) all mention the strong support they received from the ACM senior staff.

of computer science. Caroline Wardle, the NSF program officer who was responsible for the IT Workforce program in the computing directorate at NSF (see Aspray (2016) for details), was concerned that the funding NSF was putting into diversity was not leading to increased participation of women. Sanders and Schnabel convened a 1-day workshop in 2003, with support from Wardle's budget, of about 30 people from academia, industry, and government to rethink what should be done to broaden participation in computing. As Sanders remembers the findings of that workshop:

> …the recommendations, which basically were…we need a connective tissue. We needed to connect the organizations that cared. We needed to connect organizations to best practices in research. We needed to make sure there were best practices in research. … We needed to make sure we were operating on fact and not reinventing the wheel. (Sanders 2014)

Telle Whitney, the CEO of the Anita Borg Institute, joined forces with Sanders and Schnabel, and they submitted a proposal to NSF. Peter Freeman, the recently hired head of the computing directorate, as well as deputy director Deborah Crawford, were highly supportive; and a large NSF grant started NCWIT on its way. This notion of being the "connective tissue" has been one of the guiding principles of NCWIT throughout its entire history. Another basic principle was added later: "we can also unite [our member organizations] in common action and create platforms for action that they can all plug into and do nationally," (Sanders 2014)

The founders decided early on that they wanted to be more than a grant-funded project at a single university or at a few universities, so they created a nonprofit organization. Sanders identified three reasons for doing so. First, they recognized that to sustain the operation at the level needed to solve the problem, they would need to raise substantially more funding than NSF could offer; and corporations and individuals, they believed, would be less likely to make a donation to NCWIT through a university. Second, they wanted an organization that could control the intellectual property that was created in the process of their work instead of having that intellectual property distributed haphazardly across many universities. The point was not to monetize the intellectual property but instead to consolidate ownership so that action would be easier if someone attempted to misuse the intellectual property. Third, the organizational capabilities of universities make them good at taking in funds but not so good at disbursing them. However, NCWIT wanted to be able to give away funds to people carrying out projects spread across the country[27] (Sanders 2014).

While many of the NCWIT staff conduct their work out of offices on the University of Colorado campus, the organization has staff members scattered around the United States – many of them located at other universities. Sanders, who assumed the responsibility of CEO of NCWIT, was comfortable with a distributed staff because for years she had operated a 650-person engineering operation at Bell

[27] NCWIT has no paid employees, though it does have contractors. The NCWIT staff are instead employees of the universities in which they are located: Colorado, Texas, Virginia, Washington, etc.

Labs in which the engineers were scattered around the world.[28] With the right focus and leadership, Sanders believes, a distributed workforce can be effective. Moreover, this distribution has advantages such as diversity of thought that comes from being in different places, and the freedom to choose where to place subcontracts depending on different indirect cost rates.

The support from NSF has been very helpful to NCWIT in its corporate fundraising because NSF has high credibility with corporations. Sanders's first major donation – a million dollars – came from her former employer Avaya.[29] But soon other companies, including Microsoft and Pfizer early on, joined as major donors. Sanders successfully appealed not only to companies in the IT sector but also to companies that "have huge use of tech in the delivery of their business value to their customer base" (Sanders 2014).

NCWIT faced a number of questions about the scope of its mission, especially in its early days: why only women and not all people who are under-represented? Why IT (and what is the scope of IT, anyway)?[30] Why just IT and not all of STEM? Why only the United States and not some international scope? There were two principles behind these delimiting choices. One was the need to stay focused to be effective. This explains why IT and not all of STEM. For example, math is a required course

[28] Most of the operational work was led by Sanders, even from the beginning and increasingly as time went on. Whitney and especially Schnabel have continued to be active advisors. ABI had a subcontract on the original NSF grant to conduct research on technical women, but beyond that ABI (or Whitney) has had little involvement in NCWIT's operations. There is good cooperation between NCWIT and ABI, for example related to the Grace Hopper conference. Sanders (2014) describes Schnabel's contributions to NCWIT in this way: "Bobby has been and continues to be, and was then, a leader in the computing community around gender, the broader … computing faculty, computer science administrators and chairs, and deans. He plays that role today. He has always kind of been an ambassador for this. … Of course, he approved the first grant and helped write the first grant, and did some of the things you would think of a PI would do. After the first couple of years… even from the very beginning, all the hands-on stuff, I did. I was like the CEO of the whole thing. Bobby has been always out there, always thinking, always thinking about NCWIT and where we should be going and what we should be doing, and really reflecting on it."

[29] When asked how she settled on the amount to ask from Avaya, Sanders replied: "I wanted to get a million dollars out of the corporation, $250,000 over 4 years commitment. To me, it made sense because it was like … It's funny. I rationalized that it was 1.5-loaded tech-headcount a year. Corporate folks waste that much in a day, probably way more than that in a day … lots of different ways they waste it. So, "Okay. That makes sense. Let's go ask 1.5" (Sanders 2014).

[30] With respect to the scope of IT, Sanders (2014) stated: "We took the name because of the government definition of IT that in fact it includes and they count all of that stuff as part of IT. When they count patents, they count them there. … We look at the broader definition of information technology. We struggled for maybe a year or so when people would go, "What exactly is in our jurisdiction? Is it computing engineering? Is it computer science? Is it electrical engineering? Is it information systems? Is it business systems? Is it informatics?" Finally, we all agreed, we would just call it 'computing' … Once … we [the community] stopped deciding that that was something that needed to be solved, it actually turned out that the broader population who we really need to reach, they don't care about these distinctions. We will sometimes use a specific subcategory … when it makes a difference. For example, in K-12, it makes a difference to call it 'computer science' because the only toehold, we, the computing community, has in the K-12 public education is the AP Computer Science course."

in high school while computer science is not – so they are bound to have different parameters to take into consideration. Focus also explains why addressing only women and not a broader group:

> When you think about what we're doing, our mission, it's hard to do it for a blanket group. When you have a research focus, when you're creating practices, when you're really, really mindful about what the research says about culture; you have to stay focused. Otherwise, you're going to be saying things that are untrue and not very helpful. For example, things about women and the practices for women in technology cultures are different than practices for women in a broader business culture. They're different for African-American men in the culture. In fact, practices for African-American men would be different than practices for Black men from Jamaica. You can't just kind of guess. (Sanders 2014)

The other principle is simply not to take on work until the organization has the infrastructure in place to handle it properly. For example, NCWIT's Aspirations in Computing program (described below) has been successful in the United States and has grown from honoring a few girls to honoring thousands. Sanders deflected efforts to grow this into an international program for now because she does not feel she has the staff and infrastructure to handle a global program effectively.

NCWIT's original organizational structure was based on alliances and hubs. The alliances are groups of like-minded organizations (and in some cases, people). NCWIT's first alliance was its Academic Alliance, to which all of the colleges and universities participating in NCWIT are members. It considers all issues of computing in higher education.[31] Next to be formed was an alliance of social scientists studying women and computing (quickly renamed the Social Science Advisory Board). Later, new alliances were added in the K-12, entrepreneurial, workforce, and affinity group areas.

As Sanders (2014) explains, the hubs were intended to be organizations that were already producing useful results to NCWIT's mission – to give NCWIT a jump start:

> When you're starting out, organizations grow in different ways. Sometimes you start very small and you start you grow, and then all of a sudden you realize you're going national. We all know groups like that, where they start in a few locales. … From our first grant proposal … we had to start big or look big. I said this at the last summit…, "We invented this whole infrastructure, and it wasn't even real. There was no there, there," and the whole audience falls out laughing. But in fact, that was the case. We invented a national infrastructure [which we called] alliances …. We only had two. … The hubs were places where we had imagined they were pockets of existing excellence in the day, like George Tech and Irvine, and that they could help us on some part of the pipeline … when the research started, which is what they did.

The hubs lasted only a few years before being folded into the alliances. The Georgia Tech hub conducted some research on faculty, the Girl Scouts hub worked on K-12 issues, and the UC Irvine hub considered pair programming and other educational practices. These organizations that were once hubs continue to be influential within

[31] As of late 2014, the Academic Alliance included over 800 people associated with more than 300 colleges and universities of all types, ranging from majority research universities, to minority-serving institutions, to women's colleges, to community colleges (NCWIT 2014).

NCWIT by contributing significant numbers of people to the NCWIT advisory committee.[32]

When NCWIT was founded, neither the IT industry nor the academic computer scientists were paying much attention to social science research.[33] Nevertheless, from its earliest days, NCWIT strongly supported social science research through an advisory board and through a group of social scientists on the NCWIT staff, led by Lecia Barker and Joanne Cohoon – later adding Catherine Ashcraft and others.[34] The social scientists undertook basic research, identified best and promising practices, and carried out rigorous, scientific evaluations of practices and projects.[35] This work has led to a better understanding of such issues as unconscious bias, stereotype threat, collective intelligence, and changing mindsets – all of which have helped illuminate the causes of under-representation in computing. Sanders believes that corporations are beginning to take an interest in social science research in part because of the presentations they have heard at NCWIT meetings (Sanders 2014).

One snapshot of the place of social science in NCWIT is given in Table 8.1, which presents the authors, titles, and affiliations of the research talks given in a session sponsored by the NCWIT Social Science Advisory Board at the NCWIT Summit in Chicago in 2012.

NCWIT's K-12 Alliance was started in 2005 through the efforts of two major members, the Girl Scouts of America and ACM's Computer Science Teachers

[32] ACM was one of the original hubs, although it was not involved in the creation of NCWIT. However, ACM generally and ACM CEO John White personally, have taken an active interest in NCWIT. This is likely to continue in the future since Robert Schnabel, one of the founders of NCWIT, assumed the role of ACM CEO in Fall 2015. ACM was able to contribute to NCWIT in more recent years especially in the K-12 Alliance because of the Computer Science Teachers Association it created in 2005 and its Education Policy Committee, focused on K-12 computer science education policy, created in 2007.

[33] The major exceptions were Xerox PARC and Intel Research, which both employed social scientists to conduct research.

[34] There can be disadvantages to being a social scientist working for NCWIT. The work is of an applied nature, which does not always square well with the criteria by which academic departments evaluate individual scholars for promotion or honors. The NCWIT social scientists do not have as much freedom to select projects to work on, even though the director (Lucy Sanders) is liberal about this issue. On the other hand, NCWIT's Workforce Alliances provide considerable access to corporate America that is not necessarily open to traditional academic researchers, and NCWIT has a powerful set of mechanisms for disseminating results as well as a high reputation for quality, which means that reports from NCWIT get noticed and paid attention to (Ashcraft 2015).

[35] Ashcraft (2015) noted a change in NCWIT research activities over time: "early on I think it was a lot of synthesis and assessing where the state of the field was and translating that into resources, and then I think in the last 5 years or so there's been more of a shift in doing our own research, and that's been important." The NCWIT staff has carried out a number of research projects. For example, the staff did a project together with the firm 1790 Analytics to understand the rates of female patenting over time, which it updated in 2015 and followed with a joint project between NCWIT and the US Patent Trademark Office on a qualitative study of practices that foster or hinder increases in female patenting. Recently, the social science advisory board has become more active in weighing in on NCWIT resource documents and research projects.

Table 8.1 Presentations at the NCWIT Social Science Advisory Board Meeting, Chicago, 2012

Sharla Alegria (U. Massachusetts-Amherst)	Becoming an IT Worker: A Study of Access to Good Jobs in the Knowledge-based Economy
Catherine Ashcraft (NCWIT and U. of Colorado-Boulder)	COMPUGIRLS Intersectionality Study
Catherine Ashcraft and Wendy DuBow (NCWIT and U. of Colorado-Boulder)	Male Influencer Study
Lecia Barker (U. of Texas at Austin and NCWIT)	Faculty Adoption of Practices to Improve Gender Imbalances in Computing
Enobong Hannah Branch (U. of Massachusetts –Amherst)	The Performance vs. Persistence Paradox: Myths About Women in IT
Sapna Cheryan (U. of Washington)	Changing the Image of Computing to Increase Female Participation
Nilanjana (Buju) Dasgupta (U. of Massachusetts-Amherst)	Thriving Despite Negative Stereotypes: How Ingroup Experts and Peers Act as 'Social Vaccines' to Protect the Self
Wendy DuBow (NCWIT and U. of Colorado-Boulder)	Aspirations Program Research
Margaret Eisenhart (U. of Colorado-Boulder)	Female Recruits Explore Engineering (FREE Project) and FREE Pathways
Margaret Eisenhart (U. of Colorado-Boulder)	Urban High School Opportunity Structures, Figured Worlds of STEM, and Choice of Major and College Destination
Nathan Ensmenger (Indiana U.)	Why Guys? How Programming Acquired Its Masculine Identity
Mary Frank Fox (Georgia Tech)	Programs for Undergraduate Women in Science and Engineering: Issues, Problems, and Solutions
Sarah Kuhn (U. Massachusetts-Lowell)	Crocheting the Way to Math Equality: The Effects of Teaching Style on Math Performance
Elsa Macias (Independent Education Consultant)	Preventing Stereotype Threat in Standardized Testing
Rose Marra (U. Missouri)	Leaving Engineering: A Multi-Year Single Institution Study
Jamie McDonald (U. of Colorado-Boulder)	Diversity, Technology, and Occupational Branding: Examining Efforts to Reconstruct the Identity of Computing and IT Work
Irina Nikiforova (Georgia Tech)	Turing Award Scientists: Contribution and Recognition in Computer Science
Maria (Mia) Ong (TERC)	Beyond the Double Bind: Women of Color in Science, Technology, Engineering, and Mathematics
Linda J. Sax (UCLA)	Trends in the Determinants of Gender Segregation Across STEM Majors
Allison Scott (Level Playing Field Institute)	An Examination of Perceived Barriers to Higher Education in STEM Among High-Achieving High School Students from Underrepresented Backgrounds
Gerhard Sonnert (Harvard U.)	Persistence Research in Science and Engineering
Roli Varma (U. of New Mexico)	Gender and Computing: A Case Study of Women in India
Sneha Veeragoudar Harrell (TERC)	The STEM Agency Initiative for STEM Learning Among Marginalized Youth: From Fractal Village to Global Village

Source: NCWIT (2014)

Association (CSTA).[36] The K-12 Alliance has as members formal education organizations, informal education organizations, organizations that serve educators, and organizations that serve children directly. These organizational members together reach practically every girl in the United States.

Some of the K-12 Alliance members are organizations focused generally on girls, not specifically on girls and computing (e.g. Girl Scouts, Boys and Girls Club, Campfire, YWCA). The K-12 Alliance brings to these organizations content-area expertise in computing, e.g. on how to run a successful computing program for girls.

Some of the K-12 Alliance members are organizations that serve influencers (e.g. the Computer Science Teachers Association, the International Society for Technology Education, Guidance Counselors Association, Physics Teachers Association, National Girls Collaborative Project). The K-12 Alliance offers research-based practices and resources for these organizations to do their jobs better in getting girls engaged in computing.

Another group of K-12 Alliance members are organizations that teach coding to students or teachers (Code-org, Bootstrap, Black Girls Code, Girls Who Code). These organizations are interested in being in the K-12 Alliance because it gives them a way to connect with other organizations having a similar mission. It also gives NCWIT a way to ensure that these organizations are teaching coding in an inclusive way.

The number of organizations that might want to become members of the K-12 Alliance is potentially so large – numbering in the tens of thousands[37] – that NCWIT has had to build a new membership model for the K-12 Alliance. To be a full member, an organization has to be national in scope or reach a specific niche of students that NCWIT is interested in. An affiliate membership is open to a much larger set of (often local) organizations. These Affiliates are not invited to the annual NCWIT Summit and they do not help to shape the K-12 Alliance programs, but they do receive information from the K-12 Alliance regularly, participate in its programs, and are eligible to apply to the grant program offered by NCWIT to teach other girls. At the moment, there are approximately 60 full members of the K-12 Alliance and 200 affiliate members (Farmer 2015).

When Catherine Ashcraft arrived as a research scientist at NCWIT in 2006, the Workforce Alliance was just getting started. Ashcraft (2015) notes that the companies that became members of the Workforce Alliance had a tendency to want to focus on outreach, in particular on K-12 activities; and much of the work prior to Ashcraft's arrival had been focused on getting these companies to think about how to reform the situation within their own organization rather than focus on outreach. When the corporate members finally did buy in to the message that this was to be a reform activity, individual member companies wanted to benchmark their own progress against other companies. The only available information was national

[36] There is an extended discussion of CSTA in Aspray (2016).

[37] This estimate of how many relevant organizations there are is based on the fact that the National Girls Collaborative Project is working with 18,000 organizations.

Bureau of Labor statistics, and that proved to be not particularly helpful for benchmarking. The alliance spent several years trying to get its members to collect and pool data. This was a largely unsuccessful effort because either the companies did not collect the correct data, or the uniform titles to be used in collecting this group data did not fit the company's occupational titles, or the management was unwilling to release the data. After several years, the Alliance abandoned the hope of providing useful data to its corporate members.

At the same time that the Workforce Alliance was trying to collect data, it was also working with the NCWIT staff to produce best practice sheets to use in the companies. Unfortunately, most of the companies were unwilling to write sheets about their own practices or did not have time to do so, so most (but not all) of the best practice sheets were prepared by the NCWIT staff on the basis of "publicly available stories of companies that had [adopted best practices]" (Ashcraft 2015). It was not until perhaps near the end of NCWIT's first decade that the companies began to seriously discuss best practices for retention and advancement of women within their companies. Before that, the focus had largely been on recruitment. The attitude was:

> [B]ecause if it's recruitment, it's not really a "you" issue, right? … it's just that if they were there, if they'd apply, I'd hire them, right? It's just that they're not applying and so sure, help me find them. I'd be happy, but it's not really anything that I'm doing that's causing this problem. (Ashcraft 2015)

In the past several years, companies had an increased interested in improving their internal operations for the purpose of broadened participation.

> People are starting to pay attention to the fact that we [NCWIT] even have an industry change model. I've been talking about the industry change model here and there for quite some time, but you hear other people mention it now… There's a model we have, it shows the different areas internally that you need to focus on, and so we have been working with companies, sitting down with them and having them actually identify areas of the model that they feel are key areas where they need to focus and then working on practices within that area.
>
> I think they're all kind of at the beginning stages of that, but running productive team meetings is one … on the … everyday level that I think is strongly felt by most of the companies, and one that we actually try to encourage them to focus on because … it is a huge factor in someone's everyday work life; and so making sure that multiple voices are heard and people aren't getting interrupted or people aren't taking credit for [other] people's ideas. They also … are looking at ways to more actively develop employees and start examining the criteria by which they choose employees to go into talent development programs and then paying attention to who you give what opportunities to. (Ashcraft 2015)

Over the first decade of NCWIT, the Workforce Alliance grew from about 10 companies to more than 50. In the early days, the Alliance meetings involved about a dozen people sitting around a conference table at the annual meeting. Today, most companies send three or more representatives, and a typical annual meeting has more than 200 attendees – a mix of human resources, diversity, and technical managers – seldom senior executives. These Workforce Alliance members come from a number of different industries. One of the interesting dynamics involves the members from the financial or healthcare industries:

> They are in with Google and Apple and these other companies that everybody thinks of as tech companies, and so part of their concerns or efforts around recruitment and stuff like that, or image and branding and helping younger people out there – potential candidates – know that we actually are a technology company or that we have a significant technology workforce. That's a huge part of their efforts… (Ashcraft 2015)

Ashcraft (2015) believes that, while the Workforce Alliance was slower to develop and show results than, say, the Academic Alliance, the Workforce Alliance has begun in the last couple of years to take its work more seriously and make increased progress. For example, she believes that NCWIT has raised awareness among its corporate members about unconscious bias and about the roles and values of male allies; and that the companies have started to make more use of NCWIT resources such as the manager-in-a-box toolkit, best practice sheets, and the list identifying the top 10 things to do in order to retain technical women.

> I think with Corporate America, it's always hard to tell what's lip service and what's face-saving and real change. I think a lot of people in the room are pretty committed and interested and feel like NCWIT's very helpful in the resources and our guidance, but I think that we feel like there's a shift in the last year or two. The corporate alliance I think has always been lagging behind the other alliances, … Sometimes … they seem to be lagging behind, and then other times they are doing stuff but they don't always want to tell us or it's hard to keep track of what they're doing [more so] than in the Academic Alliance. We know what the Academic Alliance is doing, more upfront, and they have data that they share and show and all of that. None of those conditions are really true in the Workforce Alliance… (Ashcraft 2015)

Part of the reason for recent change in the Workforce Alliance attitudes is a new concern about diversity in Silicon Valley after data about diversity numbers at the major firms had been publicly released in the press.[38]

> [S]ince all the firestorm in Silicon Valley with the releasing of the public data, it's definitely been a huge uptick in just the number of companies we go meet with and visit. I would say that the tenor of the conversations feel more real. Sometimes there's actually senior people in the room, so that's always a good sign, and they're actually talking about nitty-gritty details with us, about the questions they have or things they want to start. (Ashcraft 2015)

NCWIT also has an Entrepreneurial Alliance. It has become much more active in the past couple of years. Approximately 150 start-up companies have joined the Entrepreneurial Alliance, though they vary considerably in their involvement in NCWIT. In some ways it has been harder to work with the members of the Entrepreneurial Alliance than with the more established companies in the Workforce Alliance:

---

[38] On the recent interest among high-tech companies in Silicon Valley in diversity, see, for example, Brown (2015), Manjoo (2014), Kang and Frankel (2015), and Guynn et al. (2014). For a more positive view of what Silicon Valley companies are doing to promote diversity, see Silicon Valley Workplace Diversity (http://www.siliconvalley.com/workplace-diversity), which has links to a number of positive stories. For statistics on five companies (Cisco, Dell, eBay, Ingram Micro, and Intel) see CNN Money's interactive website entitled "How Diverse is Silicon Valley", http://money.cnn.com/interactive/technology/tech-diversity-data/ (accessed 21 January 2016). For additional statistics, see Jones and Trop (2015).

> Often they, even more so I think than the big companies, are worried about hiring because they're usually growing and trying to just establish [themselves], and so I think that was one thing that was hard initially is, you know, "We just don't have time for this," like everything's a state of panic and urgency even more than normal and so I think they want it fast. They don't have time to read a lot and then not in the study way, but you would, everything's kind of amped up so they have time to read even less. (Ashcraft 2015)

However, in other ways the Entrepreneurial Alliance is easier to work with. They are more willing to share data and are less concerned about their past practices being judged negatively. Their attitude is: "We're new. We're growing. Of course you can't expect us to have done everything right so far" (Ashcraft 2015).

One of NCWIT's earliest hires was Paula Stern, the former chair of the U.S. International Trade Commission, to serve NCWIT's interests in Washington. Although there was pressure from the science policy community to provide a consolidated voice in lobbying the Bush Administration in favor of STEM research and education, NCWIT decided to break ranks and talk about computer science education with federal legislators – particularly K-12 education. None of the computing professional societies was particularly pushing computer science education at the time in Washington. Computing Research Association was advocating for computer science research, but it stayed clear of undergraduate education and to some degree clear of graduate education so as to avoid overlap with ACM. Only in 2005 did ACM take a major step into K-12 computer science education through the formation of the Computer Science Teachers Association (CSTA).

NCWIT connected with Jared Polis, who had a keen interest in computer science education. He had made his fortune in online companies BlueMountain.com and ProFlowers, and his foundation was refurbishing and donating computers to local schools and nonprofits. When he was elected to Congress in 2008 as Boulder's representative, he helped to champion computer science education among his fellow Democrats. NCWIT and ACM's CSTA have worked together as champions of the move to reform K-12 computer science education, change the College Board Advanced Placement exam to make it more about computer science concepts, hire and train 10,000 new computer science teachers for the public schools, and improve articulation agreements between high schools and colleges.[39]

As other strong players have emerged, such as Code.org in 2013, NCWIT has been able to scale back its efforts in the K-12 area. Nevertheless, the NCWIT K-12 Alliance remains committed to these efforts.

More recently, Sanders has been talking to the Office of Science and Technology Policy and various federal agencies about the corporate data they collect. She figures the only way to keep companies accountable and focused on diversity issues is to make sure there are strong metrics by which companies are measured against their competitors. Companies are unlikely to voluntarily provide this data, so the best chance for having a data-driven metric for corporate diversity performance is to have the federal government mandate the reporting of the right kinds of data (Sanders 2014).

[39] For a detailed account of K-12 computing education policy, see Aspray (2016).

Sanders has announced on many occasions since the very founding days of NCWIT that her goal is to make enough change that NCWIT can put itself out of business in 20 years. She believes this was an important decision for the organization because it informed many of the other choices NCWIT had to make. It did not have to build an organizational structure, physical plant, and endowment that would last for 50 or 100 years. It could be more agile and move into new programmatic areas as opportunities presented themselves without worrying about long-term commitments it was making for the organization. Perhaps even more importantly, it could readily cede work to others (such as to Code.org in getting girls interested in computing) when those others were successfully covering an area that NCWIT had been working in.

What constitutes enough change to declare a victory? Sanders does not believe it needs to be 50% female participation. However, it does need to involve a high enough percentage of women participating – perhaps a third – that a tipping point is reached in the culture of computing environments, so that bias is mitigated and that it possible for women and girls to have meaningful participation. Anyway, aspiring to a particular number is wrong-headed, she believes. She argues that if one pushed in ways that increased the numbers of women but left the current climate intact, the numbers would eventually tumble again and there would be a renewed need for an organization like NCWIT (Sanders 2014).

Sanders has had moments of doubt,[40] but at the moment she is bullish in particular because of the promise she sees in the Aspirations in Computing program, which she regards as able over time to build a pipeline of 10,000–15,000 women attaining computing degrees. This change would double the number of women in computing.[41] Aspirations, which started out in 2007 as a program to honor the technical accomplishments of a few high school girls in Colorado, has grown into a national award program that spans from middle school through college and into the workforce[42] (Farmer 2013). Companies have formed into 65 clusters. Each cluster raises

[40] "It could be easy to get kind of dejected about [what we are doing] because you can't just fix [those big social issues such as the socioeconomic status of minorities or societal attitudes towards women] and it's also easy to feel like, 'Why are you asking me those questions? You know I can't control what society thinks.' I don't have that big a budget, you know?" (Sanders 2014).

[41] The Aspirations program has been built up by Ruthe Farmer, the chief strategy and growth officer at NCWIT. Farmer's first experience with NCWIT came in 2005 as program manager for technology and engineering at the Girl Scouts of the USA, where she was a principal in NCWIT's K-12 hub. After completing an MBA at the University of Oxford, she joined the NCWIT staff.

[42] Farmer (2015) explains how the program has grown. Bank of America supported expanding the program to 10 regions in which they were trying to build a pool of technical talent to hire. She wrote a successful program to the Motorola Foundation to scale the program further. One of the interesting challenges was to collect and review applications: "One key piece of that was that we had to own the data. Because if the girls information, the relationships with the girls are local and national, we have a virtual relationship with the girls through our Facebook community, but the person who's going to see that kid in person is going to be Indiana University or Bank of America in Florida, whomever is hosting the program. That's who's going to have that personal relationship and connection but we need to own all the data of who all these kids are. We spent the money to build an online system that would allow girls to apply, allow their parents to sign a release elec-

funds, organizes an award competition, and recognizes local high school girls not only for their achievements but also for their aspirations. Farmer (2015) contrasts the Aspirations program to the traditional talent search:

> But unlike virtually every other competition in the world, getting the Aspirations award is not the end of something, it's the beginning. And really the award is just our talent search. That's how we find them. It's what we do with them that is the important thing. Like with the science fair, you work for a year, six months, a year on your science fair project. You compete and they winnow it down and there are 10 winners. The science fair throws away all those people that didn't win. Our approach is an abundance approach. Let's find every girl that is exhibiting the potential to be in computing and recognize her and propel her forward. Not: let's find the four that are the best. Because we don't even know if they're the best. We have a system of winners and runners-up in order to increase capacity, and we don't want to discourage girls. I found girls don't apply for things they're not qualified for. It's pretty rare for us to get an application for a girl where we're just like, "What are you thinking?" 95 % of the time, you're like, God I wish I could award all of them. Because girls just don't apply for things that they don't think they have a shot at.

NCWIT provides an infrastructure for girls to apply and technology portals for judging. It also provides toolkits to the clusters to carry out their local programs. Currently, about 1400 girls are recognized as finalists or semi-finalists for their technical abilities, and the numbers are growing rapidly every year. Winners are announced in the schools and in the local press.[43]

---

tronically. This was early in the world of electronic releases and the legality of all that, so we had to go all through the process to make the legal. Allow technology volunteers to read their applications and score and judge them and then allowed our local people to administer their program, send emails connect to the girls – all without anybody having a spreadsheet of girls' personal data because that kind of a breach is dangerous. We built that system and then that enabled to really scale this award because this year, we had well over 5600 applications in the system. Every one of those applications is read by four professionals and scored, and their scores are average. We have pretty high fidelity, confidence in the fidelity of our scoring system. That allows us to rank them and then this year, we're going to award 2500 girls in person, going to an event and having their whole community sit there and honor them for being technical."

[43] Farmer (2015) tells several inspirational stories about girls who have entered computing because of the Aspirations program. One is Grace Gee from Port Lavaca, TX, who graduated from Harvard *magna cum laude*, held the prestigious Thiel fellowship, and co-founded a data science startup company called HoneyInsured that enables rapid enrollment in healthcare.gov. Another example is the story of "this girl Safia Abdalla from Chicago, who is a Somali immigrant, absolutely beautiful; she wore like a full headscarf and she's beaming. She's one of those young women that kind of radiates light. Her teacher in Chicago, she went to the University of Chicago Laboratory School. It's a really good school, smart kid. Freshman year, she's like 'I'm really into computer science.' Her dad was like, 'You're going to be a doctor.' She won our award 3 years straight and she won the national award. It was the second year that her teacher told me … We had a [national] Summit in Chicago and she got the award on stage at the Summit – all these people, huge audience, two female NASA programmers on the stage with her; and her dad took her out and bought her a MacBook Pro. It was like okay and so now, she is the founder of the Society for Data Science and she's graduating from Northwestern in Computer Science. This kid was I mean she was from an immigrant family and an immigrant family understands that doctors get respect regardless of your race. It doesn't matter where you came from. If you're a doctor, that's respected. They just didn't understand what Computer Science could mean for her. Now she's incredibly successful and it's really fun to watch."

Farmer (2015) explains why the Aspirations program is of particular value in getting girls involved in computing:

> The award is important. It's important for kids to have someone tell them they're good at something and validate that. I think what's happening to girls in the school system is that … not only are they not being affirmed in being technical, they're being negatively encouraged. They're getting questions like "are you sure you want to do this? are you sure you belong here? is this something you really want to do?" It's like girls are wading upstream through the river and boys were just kind of going with the flow like all my friends are all taking this class, I guess I'll take this class. There's not a social cost for a boy to sign up to take computer science. Girls, they get the push, I call it push-pull peer pressure so you're pushed out by this male classroom, mostly boys, boy-oriented activities and boy-oriented challenges. You look at some of the curriculum and it's all around like first-person shooter game development and then you look at the posters and the whole environment and often times the teachers are male as well. That's the push, plus the media messages about who belongs, and then the pull is your girlfriends who don't get what you're doing and they're like what are you doing over there when we're over here. We're all doing this and you're doing that. That experience goes well into college.

Farmer (2015) also points out that, by using social networking technologies, the high school Aspiration winners are building virtual communities. These virtual communities offer a means to overcome the isolation that an individual girl might have if there is not a critical mass of girls at a particular high school. The same is true in college. Farmer tells the story of five Aspirations winners who found each other and bonded in a largely male crowd of 700 MIT freshman by the green bag that is awarded to each Aspirations winner. In fact, Farmer asserts, 30 % of the women studying computer science in college today have been Aspiration winners. As the students move in to the workforce, the Aspirations program is becoming a kind of social network to recruit women into technology companies. Apple, for example, enables this social networking by having a special application address only for Aspirations winners. Because these networks are working 24/7 and available virtually, Farmer believes that these may offer the same benefits as more than once-a-year gatherings such as the Hopper conference.

Farmer (2015) also notes that these Aspirations students are cooperative rather than competitive, and that this characteristic is somewhat different from an earlier generation of women in computing:

> They are not competitive with each other. I think this is really important. One of the things that's so neat about this group of young women is that they don't see any difference between real friendship and online friendship. That's one thing that's interesting because they've grown up as sort of a Facebook generation, so they don't differentiate those relationships. If I was applying for a scholarship and there's one scholarship available, would it be smart to share that opportunity with thousands of other girls that might apply for that scholarship? Probably not. But they do it. They share opportunities with each other. Not only do they share, here's a scholarship you could apply for, but then they like get together on a Google Hangout and help each other with their essays. They're very supportive and encouraging. When somebody gets some [award], they were like, "Go you," and when they fail at something, they were like, "Oh that was tough for me too." It's a very warm community. I think there's a group of women a little bit older than me that we often talk about this concept of 'pulling up the ladder'. There's this group of women that came up in the '80s and sort of like scratched and clawed their way through the business world wearing giant shoulder pads

> and dressing like a man and acting like a man. Because of their small numbers, they've enjoyed some level of power in their low numbers. It's like I'm the only woman here and so there's sort of this pulling up of the ladder of like 'well, I had to scratch and claw my way here and so do you'.

One of the interesting offerings associated with Aspirations is a grant program that provides $3000 to a girl to partner with another organization, such as the Girls Scouts or the Boys and Girls Club, to teach computing to girls in their local community. NCWIT has not tried to standardize or brand these courses. Instead, it encourages the individual girl from Aspirations to design and teach the program in a way that seems appropriate for that particular environment. Almost 300 girls have taught these courses between 2012 and 2015.

Recently, NCWIT has entered into Project SEED, which is a partnership with the U.S. Departments of Housing and Urban Development, Education, and Energy to offer teaching in broadband-enabled STEM centers associated with the remodeling efforts for five public housing communities. Girls from the Aspirations program provide the computing content in these STEM centers.

The Aspirations grant program to teach computing to other girls is extremely cost-effective. It costs about $100 to educate an individual girl compared to a national average of between $700 and $2000 per student in other informal computing education courses. So far, the program has provided 150,000 h of computing education. Farmer (2015) also points out that the experience is good for the girl from the Aspirations program who is teaching the course:

> One of the reasons girls can feel less confident going into computer programs in college is lack of prior experience and exposure. Here's an experience. You've taught this. You have it on your resume. It gives you that boost of like I'm valid, I've done this. It creates a relationship between you and some adult stakeholder who's working with you, whether it's the Boys and Girls Club staff person or a faculty member. You're building that relationship that's going to be someone who's going to do a letter of recommendation or connect you socially to other people who are going to help you. (Farmer 2015)

After the girls go away to college, they remain on a Facebook account with all the other winners – now a community of 4000 young women – and provide peer mentoring to one another. This online contact can mitigate social isolation if they are one of a few young women in their classes or majors, and it gives them a place to discuss social and technical problems they are facing. Members of NCWIT's academic alliance are offering these young women scholarships, and members of NCWIT's workforce alliance are offering them internships and jobs through this network. So far, 63 % of the young women have persisted with computing when they made the transition from high school to college, and 82 % are studying or working in some STEM discipline. Half of the students currently participating are non-white. Data is being collected from the program, with student's permission, to carry out a longitudinal analysis. Aspirations is planning to beef up its college program as well as move into middle schools, where they hope to attract 10,000 girls (Sanders 2014).

Another of NCWIT's innovative programs is its Extension Service program, funded by NSF and modeled after the long-standing agricultural extension program

of the federal government. NCWIT's Extension Service aims to make systematic change in undergraduate programs so that they will increase the recruitment and retention of women students. The Extension Service staff, a group of social scientists familiar with the relevant research literature and with assessment methods, provides customized consultation to participating departments. "Consultants support academic departments in identifying opportunities, resources, and peers who are experienced in recruiting and retaining women. They guide departments in developing assessment plans to track progress, suggest resources, and provide ongoing consultation to help clients accomplish their goals" (NCWIT 2014). The Extension Services program is also partnering with ENGAGE: Engaging Students in Engineering (an NSF-sponsored extension service program closely aligned with WEPAN) to provide customized consultation to NCWIT Academic Alliance members in engineering as well as computer science departments, where women's participation is low.

NCWIT's Pacesetter Program, started in 2010, involves partnerships between companies and universities to increase the number of "Net New Women" in computing careers, by motivating technical women who were considering non-computing careers to make a computing career choice instead, or by retaining technical women in computing who were contemplating a departure from the field.[44] NCWIT claims a yield of over 2000 New Net Women in 2014 alone.

Pacesetters matches a top-down approach by executives who "can influence people, policy, and resources within the organization" with a bottom-up approach by change leaders who can build "out an extended team, including people in a variety of key roles across the organization" (Ross et al. 2012). Important to the program has been the requirement that organizations measure progress in numbers of women added in their organization to the computing community by a specific short-term date. Each organization chooses its own methods that are sensitive to its work environment, although the organizations are encouraged to draw upon practices that social science research has shown to be promising. For example, among the university Pacesetter members, the University of Texas at Austin offers a program that reaches out to freshman women who have not yet declared a major; while Virginia Tech sends teams of computer science faculty, staff, and students out to connect with women students in the dormitories and has created a way that students can design their own majors that match computer science with another discipline. On the corporate side, Intel has instituted a workshop in which senior technical women provide career development training to mid-career technical women; while Google has started a program with college women that, for example, gives the students mock interview practice. NCWIT convenes an annual Pacesetters meeting so that

[44] According to Ashcraft (2015), one of the reasons for focusing on Net New Women is that the companies do not necessarily want to release before and after data but are more willing to release data about the net change in the number of women over a given period of time. There has also been some opportunity to broaden the metric from Net New Women to metrics that concern number of hires, reductions in attrition, number of women promoted, etc. The companies participating in Pacesetters are also encouraged to have measures that indicate the effectiveness of particular interventions they are trying.

the various organizations can share ideas. NCWIT leadership makes regular site visits to each of the Pacesetter organizations to meet with the leadership and hold them accountable. Ashcraft (2015) argues that one of the greatest benefits of the Pacesetter program has been a deeper level of cooperation between the academic and corporate members of NCWIT.

The most visible part of the program is an advertising campaign called Sit With Me, which NCWIT developed in partnership with the brand marketing firm BBMG. People are invited to sit on a red chair in solidarity with computing through a campaign carried out on web pages, Facebook, Twitter, and at professional meetings, with the theme "Sometimes you have to sit to take a stand" (Ross et al. 2012).

NCWIT sponsors many other programs in addition to those described above. They include programs that: provide resources about computing to high school counselors; engage more community colleges in NCWIT activities; help colleges and universities create and support student women-in-computing organizations; collect and share lecture notes, homework assignments, and projects to enhance broad student engagement (called the Engage CSEdu program); provide a seed fund of up to $10,000 so that individual departments can develop and implement new programs to enhance recruitment and retention of women; conduct research on the organizational culture of technology start-ups, the reasons underlying the low participation of women, and possible interventions; produce audio interviews with women entrepreneurs in IT careers (called the NCWIT Heroes program); and create a partnership between NCWIT and Oxford Economics to study how cultural issues affect women on global tech teams.

8.5 Conclusions

The main purpose of this chapter has been to present four case studies of organizations promoting the participation of advancement of women in computing. We will not provide detailed comparison of these four organizations here. We will simply close with a quotation from Valerie Barr, which reflects on these four organizations and points to their complementary strengths:

> ABI has mastered doing the big event: The Hopper Conference, the Women of Vision awards. They have a level of connections to the corporate side that is pretty phenomenal! NCWIT really brings in the research side and is sort of institutional membership, and the alliance structure, which I think has value in [creating] this collection of best practices and making those available. … CRA is again institutional membership, and CRA-W is really pushing the research track, really encouraging faculty and grad students and undergrads in the research direction. ACM and ACM-W, we are the only one that is about individual membership, and I think that's important. I think that … because of the nature of our Celebration events, our scholarships, and our student chapters, reach out to individual students in a way that the other groups don't necessarily. (Barr 2014)

References

Abbate, Janet. 2012. *Recoding gender: Women's changing participation in computing*. Cambridge, MA: MIT Press.

ACM Committee on Women in Computing. 1997. Annual report, July 96–June 97.

ACM Committee on Women in Computing. 1998. Annual report, July 97–June 98.

ACM Committee on Women in Computing. 1999. Annual report, July 98–June 99.

ACM Committee on Women in Computing. 2000. Annual report, July 99–June 00.

ACM Committee on Women in Computing. 2002. Annual report, July 01–June 02.

Ashcraft, Catherine. 2015. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, December 7.

Aspray, William. 2016. *Paticipation in computing*. London: Springer.

Barr, Valerie. 2014. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, October 13.

Borg, Anita. 1993. Why systers excludes men. *Computing Research News,* September 3, 5, 13.

Borg, Anita. 1994. Hopper celebration an 'Unqualified success'. *Computing Research News*, September.

Borg, Anita. 2001. Oral history interview by Janet Abbate. *IEEE History Center Oral History Collection,* January 5. . http://www.ieeeghn.org/wiki/index.php/Oral-History:Anita_Borg. Accessed 4 Apr 2016.

Borg, Anita, Annie Warrn, and Mary Jo Doherty. 1994. Conference celebrates women in computing. *Computing Research News*, January 3–5.

Brown, Patricia Leigh. 2015. Silicon Valley, seeking diversity, focuses on blacks. *New York Times*, September 3. http://www.nytimes.com/2015/09/04/technology/silicon-valley-seeking-diversity-focuses-on-blacks.html?_r=0. Accessed 21 Jan 2016.

Camp, Tracy. 1997. The incredible shrinking pipeline. *Communications of the ACM* 40(10): 103–110.

Camp, Tracy. 2002. Women and computing. Special Issue. *Inroads*, *SIGCSE Bulletin* 34 (2).

Camp, Tracy. 2015. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, January 9.

Computing Research Association. 2005. CRA-W receives national science board award. *Computing Research News*, September. http://cra.org/crn/2005/09/cra-w-receives-national-science-board-award/. Accessed 4 Aug 2015.

Computing Research Association. 2013a. Center for evaluating the research pipeline (CERP): Director's welcome. *Computing Research News*, April. http://cra.org/crn/2013/04/center_for_evaluating_the_research_pipeline_cerp_directors_welcome/. Accessed 4 Apr 2016.

Computing Research Association. 2013b. Center for evaluating the research pipeline. *Computing Research News*, May. http://cra.org/crn/2013/05/center_for_evaluating_the_research_pipeline/. Accessed 4 Apr 2016.

Danyluk, Andrea. 2013. Collaborative research experiences for undergraduates: The CREU program still going strong at 15. *Computing Research News,* September. http://cra.org/crn/2013/09/collaborative_research_experience_for_undergraduates_the_creu_program_/. Accessed 23 Nov 2015.

Farmer, Ruthe. 2013. Expanding the pipeline – Growing the tech talent pool: NCWIT aspirations in computing program scales up. *Computing Research News*, March. http://cra.org/crn/2013/03/expanding_the_pipeline/. Accessed 5 Jan 2016.

Farmer, Ruthe. 2015. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, December 7.

Feigenbaum, Joan. 1992. CRA committee is creating database of women scientists. *Computing Research News,* March. http://archive.cra.org/CRN/issues/9202.pdf. Accessed 4 Dec 2014.

Francioni, Joan. 1998. Committee on the status of women in computing research. *Computing Research News*, November 2, 9.

Goral, Cindy, and Dianthe Harris. 2006. From the inside, out. *Computing Research News*, January. http://cra.org/crn/2006/01/from_the_inside_out/. Accessed 23 Nov 2015.

Gurer, Denise. 2015. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, January 9.

Guynn, Jessica, Paul Overberg, Marco della Cava, and Jon Swartz. 2014. Few minorities in non-tech jobs in Silicon Valley, USA Today finds. *USA Today*, December 30. http://www.usatoday.com/story/tech/2014/12/29/usa-today-analysis-finds-minorities-underrepresented-in-non-tech-tech-jobs/20868353/. Accessed 21 Jan 2016.

Irwin, Mary Jane, and Francine Berman. 1996. CRA-W advancing the status of women in CS&E. *Computing Research News*, September 3–4, 12.

Jamieson, Leah H. 2001. Women, engineering, and community. *Computing Research News*, May. http://archive.cra.org/CRN/issues/0103.pdf. Accessed 23 Nov 2015.

Jamieson, Leah. 2015. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, February 9.

Jeffries, Robin. 2006. Systers: The electronic community for women in computing. *Computing Research News,* September. http://cra.org/crn/2006/09/systers-the-electronic-community-for--women-in-computing/. Accessed 4 Aug 2015.

Jones, Stacy, and Jaclyn Trop. 2015. See how the big tech companies compare on employee diversity. *Fortune*, July 30, http://fortune.com/2015/07/30/tech-companies-diveristy/. Accessed 21 Jan 2016.

Kang, Cecelia, and Todd C. Frankel. 2015. Silicon Valley struggles to hack its diversity problem. *Washington Post*, July 16. https://www.washingtonpost.com/business/economy/silicon-valley-struggles-to-hack-its-diversity-problem/2015/07/16/0b0144be-2053-11e5-84d5-eb-37ee8eaa61_story.html. Accessed 21 Jan 2016.

Klawe, Maria. 2005. Oral history interview by William Aspray. *Computer Educators Oral History Project, Lisbon, Portugal*, June 27. http://www.cs.southwestern.edu/OHProject/KlaweM/klawe-200506-20100620.pdf. Accessed 11 Dec 2014.

Klawe, Maria, and Nancy Leveson. 1993. CRAW advances status of women in CS&E. *Computing Research News*, November 3–4.

Lopez, Dian Rae, Stephanie Sides, and Ann Redelfs. 1996. New booklet reaches out to young women. *Computing Research News*, January 3.

Manjoo, Farhad. 2014. The business case for diversity in the tech industry. *New York Times*, September 26. http://bits.blogs.nytimes.com/2014/09/26/the-business-case-for-diversity-in-the-tech-industry/. Accessed 21 Jan 2016.

Martin, C. Dianne. 1993. CRA presents windows of opportunity symposium. *Computing Research News,* September 4.

McCorduck, Pamela, and Nancy Ramsey. 1997. *The futures of women: Scenarios for the 21st century*. New York: Grand Central Publishing.

National Center for Women & Information Technology. 2014. *Organization website*. www.ncwit.org. Accessed 20 Dec 2014.

Ross, Jill, Elizabeth Litzler, J. McGrath Cohoon, and Lucy Sanders. 2012. Improving gender composition in computing. *Communications of the ACM* 55(4): 29–31. https://www.ncwit.org/sites/default/files/file_type/improving_gender_composition_in_computing_april_2012_communications_of_the_acm_copy.pdf. Accessed 21 Sept 2015.

Sanders, Lucy. 2014. *Oral history by William Aspray*. Charles Babbage Institute Oral History Collection, December 29.

Soffa, Mary Lou. 2011. CRA-W 20th anniversary celebration. *Computing Research Association Committee on Status of Women in Computing Research*. PowerPoint Presentation. Obtained from the author.

Stout, Jane. 2013. Providing a new way to evaluate diversity initiatives in computing research. *Computing Research Association*, August. http://cra.org/crn/2013/08/cerp_article_august-2013/. Accessed 23 Nov 2015.

Stout, Jane. 2015. Disseminating CERP research findings to promote diversity in computing and other STEM fields. *Computing Research News*, February. http://cra.org/crn/2015/02/disseminating_cerp_research_findings_to_promote_diversity_in_computing/. Accessed 23 Nov 2015.

Weyuker, Elaine. 2014. *Oral history interview by William Aspray*. Charles Babbage Institute Oral History Collection, October 8.

White, John. 2015. Oral history interview by William Aspray, *Charles Babbage Institute Oral History Collection*, June 26.

Whitney, Telle. 2002. Oral history by Janet Abbate. *IEEE History Center, Palo Alto, CA* **.** July 16. http://www.ieeeghn.org/wiki/index.php/Oral-History:Telle_Whitney. Accessed 5 Apr 2016.

Whitney, Telle. 2014. *Oral history by William Aspray*. Charles Babbage Institute Oral History Collection, September 17.