Pioneering Women In Computer Science

by

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Although their contributions are not well documented, women have played an important role in the development of computer science. A survey of women pioneers demonstrates their influence in designing and programming the first electronic computers and languages, while laying the groundwork for women's expanding involvement in science.

Although the history of computer science is well-documented, one finds very few, if any, women mentioned in the standard texts on the history of this field. One might believe that women did not play an important role in the beginnings of computer science, but in reality they have made significant contributions in many areas, starting from the early days.

This article documents the involvement of pioneering women in the beginning days of computer science, from their work on the first machines to their development of the early programming languages. The pioneers are women who were involved in original work that resulted in ground-breaking technical development or helped to generate new ideas or methods in the realm of computer science.

Two Well-Known Pioneers

In any discussion of pioneers in computing, the names of two visionaries immediately come to mind: **Augusta Ada Byron Lovelace** and **Grace Murray Hopper.** Both exhibited an ability to see the future directions of computer science: Lovelace was the first conceptual programmer, while Hopper foresaw the importance of higher-level programming languages in the future of computing.

Augusta Ada Byron, Countess of Lovelace, was a mathematician who collaborated with Charles Babbage on the Difference and Analytical Engines, which are regarded as the theoretical foundation for the modern computer [8, 17].

Lovelace was born in 1815 to the poet Lord Byron and Annabella Milbanke, who were legally separated one year later. Raised and tutored by her mother, who was a proficient mathematician, Lovelace excelled in mathematics. Later, William Frend, a graduate of Cambridge, gave her further tutelage in mathematics. She was married in 1835 to the future first Earl of Lovelace, who supported her interest in mathematics. Beginning in 1840, Lovelace studied with Augustus DeMorgan; their topics included Leibniz's infinitesimal calculus and the convergence of infinite series.

Lovelace was 17 years old when she first met Babbage. When he showed her the Difference Engine, she immediately dubbed it a "thinking machine," [18] recognizing its value as a tool for science and mathematics.

Lovelace was best known for her 1843 translation from French to English of Menabrea's report on Babbage's Turin lecture; to which she added her own voluminous notes. Her paper discussed the Difference Engine, the first automatic calculating device, and the Analytical Engine, which contained the first set of principles for a general-purpose programmable computing machine. Lovelace's series of notes included a table describing the operations necessary for solving mathematical problems. She therefore became the first conceptual programmer for Babbage's Analytical Engine. In subsequent writings, she developed the "loop" and "subroutine" concepts-a century before electronic computing machines appeared.

Lovelace was a strong-willed, creative, intelligent, woman during the Victorian Era, when women in science were rare. Even so, her work was highly regarded by Babbage and DeMorgan, and she associated with intellectuals of her time, such as Faraday, Wheatstone, and Herschel. The Department of Defense's high-level programming language, Ada, is named in honor of her contributions and pioneering spirit.

Grace Murray Hopper was admired and respected not only for her technological achievements but also for her energy, enthusiasm, and willingness to serve as a mentor [l]. Hopper received a B.A. degree in mathematics and physics from Vassar College and a Ph.D. degree in mathematics from Yale. After teaching at Vassar, she joined the Navy and was assigned to a project with Commander Howard Aiken on the Mark I at Harvard University, where she designed and implemented a program that computed the coefficients of the arctangent series. In this way, Hopper was introduced to

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The first conceptual programmer, Augusta Ada Byron collaborated with Charles Babbage on the Difference and Analytical Engines. (Courtesy Charles Babbage Institute, University of Minnesota)

programming and became, in her words, "the third programmer on the world's first large-scale digital computer."

While Hopper was working on the Mark II in the summer of 1945 under the command of Aiken, an unlucky moth caused a relay to fail. Hopper and the other programmers taped the deceased moth in the logbook with a note, "First actual case of bug being found," which is currently on display at the Naval Museum in Dahlgren, Virg Aiken had the habit of coming into the room and asking, "Are you making any numbers?" Now, during a slow time, the programmers could reply that they were "debugging" the computer, thus introducing this term into computing language.

In 1949, Hopper joined the newly formed Eckert-Mauchly Corporation where Binac and UNIVAC I, the first commercial electronic computers, were being developed. While at Eckert-Mauchly, Hopper supervised the department that developed the first compiler, A-0, and its successor, A-2. Hopper was also responsible for developing the FLOW-MATIC programming language, the only implemented business data processing language at the time. The COBOL community, an industry-wide group, partially supervised by Hopper, used FLOW-MATIC as the model [14]. For this reason, Hopper is often referred to as the grandmother of COBOL.

One of the characteristics that made Hopper a pioneer was her technical vision. She foresaw many applications for computing, including artificial intelligence, saying;. "It is the current aim to replace, as far as possible, the human brain by an electronic digital computer." She is well known for her contributions to ideas about tools and techniques of compiling and programming that are now commonplace: subroutines, translation of formulas, relative addressing, linking loaders, code optimization, and symbolic manipulation.

Admiral Grace Murray Hopper, a pioneer in programming languages and computer science, is often thought of as the "grandmother" of COBOL. (Courtesy Annals of the History of Computing)

A dynamic presence for several decades, Hopper was one of the most requested speakers in computing. She was famous for carrying a "nanosecond"—a length of wire that represented the distance an electron travels in a nanosecond—and for encouraging programmers to use as few of them as possible. Her views on bureaucracy were also well known: "It's better to show that something can be done and apologize for not asking permission, than try to persuade the powers that be at the beginning." [10] Hopper was always a teacher and supporter of young people. She often said. "If you want something done, give it to a young person." [10] As a tribute to women in computing, an international conference named after Hopper was held in the spring of 1994.

The First Machines

Women were involved in all stages of the earliest computers, from funding the projects to designing and programming the machines. In fact, because of the war effort during World War II, the early programmers were almost all women. In those days, they were called either "calculators" or "computers." Women were often stereotyped as being good candidates for programming: "Programming requires lots of patience, persistence and a capacity detail and those are traits that many girls have." [16]

When early women programmers were asked how they were treated, most responded that they received the same treatment and respect as the men. They felt that it was not until later years that the field of computer science became less than ideal in its treatment of women. [5]. The cause of this transformation is perceived as the absorption of the male hierarchy business structure as the size of companies involved in hardware and software products grew larger.

These egalitarian beginnings may seem strange, and indeed, closer inspection suggests that there is more to the story. As pointed out by **Judy Clapp**, a programmer on the Whirlwind machine, "It all had to do with expectations. At that time, working women were expected to be nurses or schoolteachers. Thus, to be given the chance to work in a technical field was a great opportunity. However, upon closer inspection, almost all the leaders and managers were men." [2] With regard to the ENIAC, **Kathleen McNulty**, one of ENIAC's first programmers, states, "The girls were told that only men could get professional ratings. The time came later in World War II when no more men were available, and women were pushed into supervisory positions. Finally, in November 1946, many of the women received professional ratings." [6]

Even so, the first days were an exhilarating time. As Judy Clapp notes, "We felt like we were on the forefront, working day and night, inventing as we went." [2] **Mildred Koss**, one of UNIVAC's initial programmers observes, "There were no limitations to what you could accomplish. There was lots of vision and new ideals as to where the computer might be used. We looked at the computer as a universal problem-solving machine. It had some rules and an operating system, but it was up to you to program it to do whatever you wanted it to do." [10]

The world's first electronic general-purpose computer, designed by Presper Eckert and John Mauchly at the Moore School of Electrical Engineering of the University of Pennsylvania, was unveiled in 1946 as the Electronic Numerical Integrator and Computer (ENIAC). Six women, selected from a group of 100, were appointed as "computers": Kathleen McNulty, **Frances Bilas**, **Elizabeth Jean Jennings**, **Frances Elizabeth Snyder**, **Ruth Lichterman**, and **Marilyn Wescoff** [6]. Most had degrees in mathematics. Three other women mathematicians actively involved in programming ENIAC, and in recruiting and training the six appointees, were **Adele Goldstine**, **Mary Mauchly**, and **Mildred Kramer**; Adele Goldstine is the author of the ENIAC manual.

With ENIAC's 20 signed 10-decimal digit memory positions and 6,000 switches and cables, the women programmed ENIAC by what, is now called "machine coding" to perform ballistic computations during World War II. They used ENIAC's basic arithmetic and logical functions to calculate quantities such as rocket trajectories. Programming ENIAC was very different from what we are used to today. Instructions for transferring between arithmetic units and memory involved an established sequence that included all the units of the ENIAC, starting with the settings of the program switches.

After their work on ENIAC, Prosper Eckert and John Mauchly formed the Eckert-Mauchly Corporation, where work started on a machine called UNIVAC I. Many women were hired to program UNIVAC I, among them Grace Hopper, Adele Mildred Koss, **Frances E. Holberton**, **Jean Bartik**, **Frances Morello**, and **Lillian Jay**.

It was an exciting time. Grace Hopper, in a supervisory position, shared her vision for the computing machines and pushed higher-level languages at early stage. Problem-solving skills were important, and the computer was perceived as a tool. As Mildred Koss comments, "Logical thinking and experience was as important as theory in using the computer as a tool to solve problems with programming. Processing theories were being developed simultaneously." [10]

Holberton spent much of her early UNIVAC days working with John Mauchly on the code set for UNIVAC I, as well as developing programming strategies to accomplish sorting, such as putting records in sequence according to a specific key. In particular, Holberton developed the Sort-Merge Generator in 1951. After being fed file specifications, the Sort-Merge Generator produced a program to sort and merge those files. This was an important accomplishment, since it was the first step toward actually using a computer to write programs.

Koss spent much of her time with Grace Hopper in developing some early sorting algorithms and an editing generator, a precursor to the report generator [7]. Koss's Editing Generator, developed in 1952, read specifications describing the input file, records, and desired format of the output, and then produced a program to transform one format to the other.

In 1953, Koss moved on to Burroughs Corporation, in 1960 to Philco, and then in 1965 to Control Data Corporation (CDC). At CDC she worked with a team that was developing some of the early graphics algorithms. Her assignment was to develop a tape drum simulator for storing and retrieving graphics data as it was generated and manipulated. She has just retired in 1994 from a fruitful 25 years at Harvard University, designing applications and databases and leading an application development group.

Judy Clapp and Whirlwind

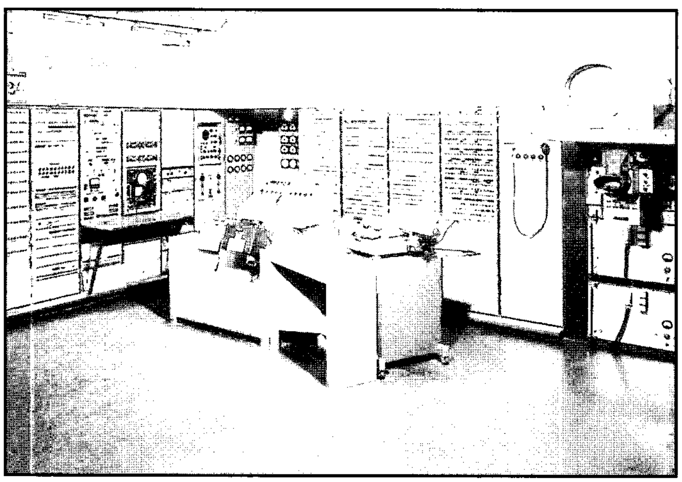
The first real-time control computer, and the first to use time-sharing, was the Whirlwind, developed at MIT. Several women were involved in the initial development work, including Judy Levenson (now Judy Clapp). Clapp had just received an M.S. degree in applied science from Harvard in the early fifties, when she started work on the Whirlwind, helping to program a prototype of one of the first non-numerical applications of computers: an air defense system that received inputs from radar, tracked flying aircraft, and directed the courses of other aircraft [2].

When programming of an operational version of the system was initiated, several hundred additional people were hired and taught to program in assembly language. About 20% of the programmers were women. Interestingly, some of the best programmers were music and English majors!

Clapp moved on, along with many on the Whirlwind team and the Whirlwind system, from MIT to Lincoln

Judy Clapp, one of the initial programmers of the Whirlwind system, is now pursuing software engineering technology and applications at MITRE Corp. (Courtesy Judy Clapp)

Laboratory and later to the MITRE Corporation. In addition to completing the system and using new machines developed by IBM specifically for Whirlwind, Clapp and the others developed the first set of software tools for large teams of people to coordinate writing, integrating, testing, and maintaining a large system. Clapp became a manager in software engineering technology and applications at Lincoln Labs and then at MITRE, where she continues to work.

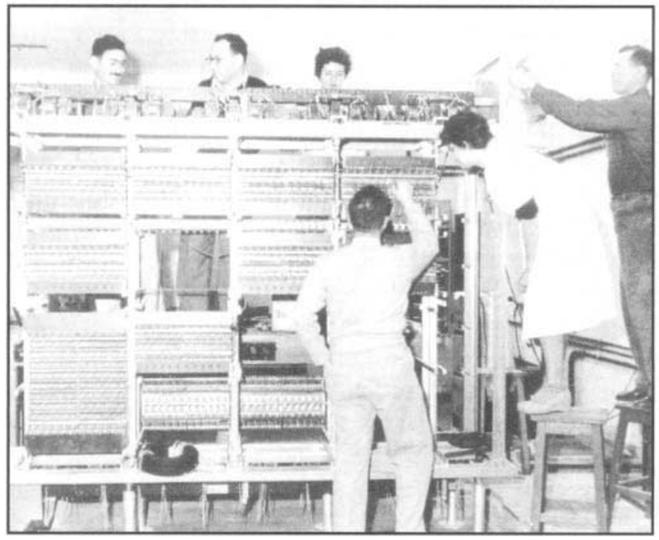


The Whirlwind I test control room in 1957. Whirlwind was the first real-time computer and the first to use timesharing. (Courtesy MITRE Corp.)

Thelma Estrin and WEIZAC

In many countries, the original deployment of computers resulted from the importing of computers that had been developed in other countries, primarily the United States. In the early 1950s, the Weizmann Institute of Science in Israel accelerated that country's participation in the information revolution by building a computer called the WEIZAC (for WEIZmann Automatic Computer), closely modeled on von Neumann's Institute for Advanced Study (IAS) computer. WEIZAC was built to solve problems in applied mathematics and classical physics for the Applied Mathematics Department [3].

Thelma Estrin, who received a Ph.D. degree in electrical engineering in 1951 from the University of Wisconsin, was one of the initial two engineers to work under Gerald Estrin in the design and development of the machine. Estrin's previous experience in working with von Neumann on the IAS project facilitated her design efforts [12]. In 1955, WEIZAC's central processing unit and primitive input-output were complete, and WEIZAC became the first large-scale electronic computer outside the United States and Western Europe.



Thelma Estrin (right, in white lab coat), working on the mechanical assembly of the WEIZAC chassis. (Courtesy Annals of the History of Computing)

Estrin's work prior to WEIZAC had been as a research engineer at Columbia University-Presbyterian Hospital, studying the electrical activity of the nervous system. Her work in the United States after WEIZAC turned toward applying the computer to bioengineering problems. In 1961 she received funding from the National Institutes of Health (NIH) to set up the first computer facility in a medical school—the Data Processing Laboratory (DPL)—located at UCLA's Brain Research Institute. DPL served as a computing laboratory in the area of nervous system research.

Estrin's interest included the recording and analysis of electric signals from the nervous system. She developed a computer-automated system that analyzed and encoded information in a microelectrode recording of a neuron, to obtain real-time analysis of their firing patterns. She also designed and developed one of the first analog-to-digital conversion (ADT) systems that could convert analog signals from electroencephalograms to digital signals. In the mid-1970s, Estrin used interactive graphics for modeling neuroscience data and for elementary uses in medical electronics.

In 1980, Estrin joined the UCLA Department of Computer Science as a Professor in Residence. From 1982 to 1984 she held a rotating position at the National Science Foundation as Director of the Electrical, Computer, and Systems Research Division. In July of 1991, she became professor emerita of UCLA, where she is still active in the computer science department.

Estrin has received many awards and served in many professional organizations. She is a former president of the IEEE Engineering in Medicine and Biology Society and a former Executive Vice-President of the IEEE. Estrin was the first woman member of the board of directors of the Aerospace Corporation and the first woman to be elected to the IEEE Board of Directors. She has received the Achievement Award of the Society for Women in Engineering, the Distinguished Service Citation and an honorary doctorate from the University of Wisconsin, and the Centennial Medal Award and the 1991 Haraden Pratt Award from the IEEE.

In addition to being active professionally, Estrin has always been involved in helping women in science, both through active efforts and as a role model. Estrin's advice for women getting master's degrees in biology and psychology is, "Don't dismiss the power of computers. You should strongly consider getting an additional master's in computer science. There are many scientific problem areas to enter and computing systems provide a fantastic tool for problem solving. [4]

COBOL

In the late 1950s, there was a need for a common business language (CBL) due to the time and cost of reprogramming, rigidity of programs, and lack of compatibility with other machines in the business world. In 1959, **Mary K. Hawes** from Burroughs Corporation suggested a meeting of users and manufacturers to prepare plans to develop specifications for a CBL for digital computers. A group of six people, including Grace Hopper, discussed the possibility of a formal meeting. The Department of Defense sponsored such a meeting in May 1959, at which it was decided that CBL should be developed and that three committees (short-range, intermediate-range, and long-range) were needed [14].

It was the Short-Range Committee that developed COmmon Business Oriented Language (COBOL), which was meant to be only an interim language. Three of the nine members on the initial Short-Range Committee were women: Mary K. Hawes from Burroughs Corporation, Frances E. Holberton from the David Taylor Model Basin, and **Jean E. Sammet** from Sylvania Electric Products. Four other women worked on the Short-Range Committee at one time or another: **Deborah Davidson** from Sylvania Electric Products, **Sue Knapp** from Minneapolis-Honeywell, **Nora Taylor** from David Taylor Model Basin, and **Gertrude Tierney** from IBM.

FLOW-MATIC, developed under the direction of Grace Hopper, and the specifications of Commercial Translator from IBM were the major technical influences on COBOL. The Short-Range Committee initially established several task groups, of which the two most important were on "procedural statements" and "data descriptions." Sammet was appointed chair of the former and Hawes of the latter. After work by the task groups and consideration of the full committee, it became clear that the full Short-Range Committee was too large to do effective language development work. A

Members of the COBOL Short Range Committee in 1959. Seated from left: Gertrude Tierney, IBM; William Logan, Burroughs; Frances Holberton, David Taylor Model Basin; Daniel Goldstein, UNIVAC; Joseph Wegstein, National Bureau of Standards; Howard Bromberg, RCA; Mary Hawes, Burroughs; Benjamin Cheydieur, RCA; and Jean Sammet, Sylvania. Standing: Alfred Asch, U.S. Air Force; unknown; William Selden, IBM; Charles Gaudette, Minneapolis-Honeywell; Norman Discount, RCA; and Vernon Reeves, Sylvania. (Photograph from Management and Business Automation, Mar. 1960, p. 24).

six-person team (including Jean E. Sammet and Gertrude Tierney) was formed to develop COBOL's specifications and then edit them into the form that was modified and then approved by the full Short-Range Committee. These specifications were submitted to the CODASYL Executive Committee in December 1959, about six months after the Short-Range Committee started its work. Further editing was then done by Betty Holberton prior to the issuance of the official COBOL specifications by the Government Printing Office in 1960.

Jean E. Sammet, who received a B.A. degree from Mount Holyoke College, an M.A. degree from the University of Illinois, and an honorary Sc.D. from Mount Holyoke, joined IBM in 1961. While at IBM, she was responsible for the development of FORMAC, the first widely used language for performing symbolic mathematics. In 1969, she published, *Programming Languages: History and Fundamentals* [13], which many consider to be the standard work on programming languages.

Sammet had the distinction of being the first woman president of the ACM (1974-76). She also served in many other positions in the ACM, including vice-president, chair of SIGPLAN, and editor-in-chief of *Computing Reviews* [15]. For her numerous contributions to the field of computer science, she was elected a member of the National Academy of Engineering (1978), received the ACM Distinguished Service Award (1985), and was in the initial group of ACM Fellows (1994). Sammet retired from IBM in 1988 and is currently a programming language consultant. She is working on a revision of her *Programming Languages* book.

Conclusion

Two common themes were cited repeatedly by the women interviewed for this article. First, there was the excitement in the early days of designing and programming electronic computers and languages. Many of the women felt the exhilaration of taking part in the beginning evolution of a scientific field and women's expanding involvement in science.

Second, a common concern was balancing of job and family responsibilities. The gender roles from the 1930s through the 1950s defined women as family caretakers and men a family providers. These perceptions caused many career women to work both on the job and at home, not leaving time for other activities. The women discussed in this article not only were pioneers in their technical areas, but were also on the frontier of changing women's roles and for the first time coming to grips with competing personal and professional issues.

The complex balancing of job and family is still a crucial issue for women scientists today, despite the gains that have been made. However, many of the women who started their careers from the 1930s through the 1950s are hopeful about the future for career women. As Joyce Currie Little, one of the first Convair Aircraft programmers put it: "In the old days, a lot of women chose jobs that allowed the to be compatible with family needs. Women today are choosing more between career and family. However, some good things are rubbing off on young men today, since as boys they are growing up with women who work and have careers."

Hopefully, women will find many role models among the pioneering women computer scientists described here, and readers will take advantage of the wealth of information available on women pioneers in computing and perhaps further document their contributions.

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Sister Mary Kenneth Keller

Sister Mary Kenneth Keller, from Cleveland Ohio, was one of the first women, and very likely the first woman to receive a Ph.D. in computer science in the United States. Keller entered the Sisters of Charity, a Catholic religious order, in 1932 and professed her vows in 1940. Later she studied at DePaul University, where she received a B.S. degree in mathematics and an M.S. degree in mathematics and physics. In 1965 she received a Ph.D. in computer science from the University of Wisconsin. Her dissertation work involved constructing algorithms that performed analytic differentiation on analytic expressions, written in CDC Fortran 63 [9].

Sister Mary Kenneth Keller was one of the first women to receive a Ph.D. degree in computer science in the United States. (Courtesy Mount Carmel Archives)

As a graduate student, Keller also studied at Dartmouth, Purdue, and the University of Michigan. At Dartmouth, the university broke the "men only" rule and allowed her to through the 1950s defined women as family caretakers and men a family providers. These perceptions caused many career women to work both on the job and at home, not leaving time for other activities. The women discussed in this article not only were pioneers in their technical areas, but were also on the frontier of changing women's roles and for the first time coming to grips with competing personal and professional issues.

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Sister Mary Kenneth Keller was one of the first women to receive a Ph.D. degree in computer science in the United States. (Courtesy Mount Carmel Archives)

As a graduate student, Keller also studied at Dartmouth, Purdue, and the University of Michigan. At Dartmouth, the university broke the "men only" rule and allowed her to work in the computer science center, where she participated in the development of BASIC.

After receiving her Ph.D. degree, Keller accepted an offer of a faculty position at Clarke College in Dubuque, Iowa. Keller founded the computer science department there and chaired it for 20 years. She also established a master's degree program for computer applications in education.

Keller felt that women should be involved in computer science and especially in the field of information specialist. In her words, "We're having an information explosion, among others, and it's certainly obvious that information is of no use unless it's available." Keller's vision extended beyond education and reached toward artificial intelligence. "For the first time we can now mechanically simulate the cognitive process. We can make studies in artificial intelligence. Beyond that, this mechanism (the computer) can be used to assist humans in learning. As we are going to have more mature students in greater numbers as time goes on, this type of teaching will probably be increasingly important." Sister Mary Keller died at the age of 71 but has left a legacy of computers and education at Clarke College.

The Grace Hopper Celebration

Anita Borg and Telle Whitney

The Grace Hopper Celebration of Women in Computing (GHC) was an experiment in a very different kind of technical conference. Until the event commenced (last June in Washington, DC), we had no idea whether it would be a success or exactly what kind of impact it would make. This article discusses the reasons for holding such a conference and the results of this very successful experiment.

It is widely believed that the health of every area of science and technology will be improved by increasing the diversity of participation at all levels to reflect the growing diversity of the working population. Numerous corporate committees and government agencies, such as the National Academy of Sciences and the National Academy of Engineering, have studied this situation extensively. Professional organizations within the ACM, IEEE, and Computer Research Association have also been addressing this issue for many years. For the reasons we are about to describe, we decided that a computing conference centered around women could play an important role in increasing diversity in the computing field along gender lines.

Why a Technical Conference?

Women constitute a minority of the participants in the computer field, especially at higher management and technical levels. Although there are, in absolute terms, a large number of women in computing, our relative numbers are small and we are widely geographically dispersed. Individual women are isolated, infrequently having the opportunity to work with or interact with other professional technical women.

Women exist in near isolation at industry conferences as well. A technical conference in computing is a very different experience for women than it is for men. Women always constitute a small proportion of the attendees (typically 10%), and often a smaller proportion of the invited speakers and program committee members. While the percentage of women at conferences is sometimes lower than our representation in the computing field as a whole, we would still be vastly outnumbered by men even if we were proportionally represented. Our numbers range from 0% to 30% depending on sub-discipline and seniority level. Working in such an environment, it is easy to fear that one does not really belong.

An opportunity to see, hear, and interact with a large number of women in a professional technical setting has been completely outside of the realm of possibility for women in computing until now. It has only been in the last few years that an electronic community of significant size—Systers—has existed to counteract some of the isolation and provide an opportunity to explore the possibility that there is a different way in which we might communicate (see Tracy Camp's sidebar). Many women have been encouraged and supported and ultimately remained in computing as a result of that virtual community. We believed the experience of a real in-person community would be even more effective.

Another gender issue in computing is the dearth of exposure of women (and of men) to female role models. For the same reasons that women do not meet other women in computing, it is difficult to see the significant achievements of women in the field as a body of work. In the community at large, individuals most frequently see senior role models at technical conferences. This is not the case for women. For example, if a woman were to have attended the biannual Symposium on Operating Systems Principles from 1983-1993, she would have heard 113 papers presented with 324 listed authors, 18 of whom were women. Assuming that women were represented as speakers in the same proportion as they appeared as authors, she would have seen six women give talks in a decade of conferences. In the same period she would have seen 107 talks given by men.

It is one thing to tell young women that there have been many great accomplishments by women and there are many role models for success. But it is quite another, and has much more impact, to point out either the women or their achievements en masse. So another reason for holding the GHC was to bring together in one place both younger women searching for their professional identities and more senior successful women to provide role models and proof that women continue to achieve great things in all areas of the computing field.

Why Would a Female-Based Conference Be Different?

The purpose of a conference is communication, whether that communication takes place during lectures, workshops, or social gatherings. Recent literature suggests that female communication style differs greatly from that of men, especially

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when there is a critical mass, i.e., enough women to counteract the dominant (male) cultural communication style.

Tannen describes the male purpose for communication as establishing the speaker's place in a hierarchy. At technical conferences, this is exhibited as competitiveness, posturing, and an abundance of ego. This is not necessarily a natural or comfortable mode of interaction for women even if some of us are experts in using it as a survival skill. The female purpose of communication is to make or break connectivity n a community or network. One might expect a conference whose speakers, organizers, and attendees are primarily women to reflect this female style. In large part, the CHC grew from our feeling that a technical conference in which the vast majority of participants were female would provide a less confrontational and more cooperative communication environment. On the other hand, it could be argued that because technology itself is gender-neutral, there really should be little difference between primarily male and primarily female technical conferences.

In our opinion, this landmark conference was a great success in every possible dimension. The computing community supported us financially and made support possible for many students to attend. That support also allowed for videotaping of the entire conference, and wide distribution of conference booklets. We were deluged by 30% more registrations than our maximum expected capacity (400) and in the end managed to squeeze in 450 attendees.

The speakers and attendees represented a larger accumulation of significant achievements by women in computing than has ever been assembled before. The affect was electrifying for audience and speakers alike. The mood was of enthusiasm, collaboration, cooperation, support, and sisterhood. But that was our initial hope; we are biased.

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Anecdotes to GHC

"It was the first time that women got together to talk about their respective fields of computing with other women who understand what they are doing and the challenges faced. The conference was particularly unique because of the diversity of the women attending and because of the broad spectrum of technical and non-technical areas covered. We were energized by the experience."

Wendy Rannenberg, Joanne Sterling, Meg Williams
Digital Equipment Corporation

"The most interesting thing I learned at the conference was about myself. I had never really noticed a lack of role models or mentors. Even though I have had serious problems lately in my work environment, I hadn't thought I needed a mentor. But when I got to the conference and I saw all those incredible female researchers I realized that I had been lonely and I had doubts. One speaker said it is not necessary for a successful woman to actively support women and minorities. It is only necessary for her to be where she is, to be visible, to be the proof for other women that (we) are capable and it is possible to reach their goals. I was missing the proof and I really needed to see all those people. I will never forget it."

Juniata Ingram-Lees
AT&T Bell Laboratories

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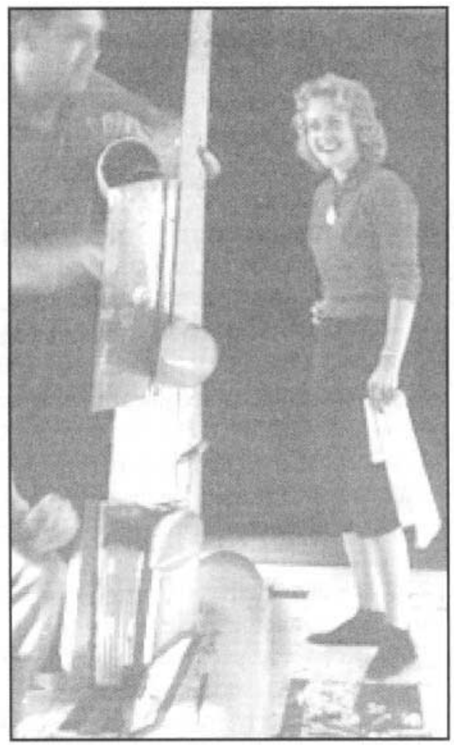
Programmers on Wheels

Joyce Currie Little was one of the original programmers at Convair Aircraft Corporation in the Wind Tunnel Division in the late 1950s. She wrote programs to analyze data taken from models (e.g., airplanes, automobiles, radio towers) that were tested in an 8-foot by 12-foot wind tunnel. She wrote her programs in an assembly language, SOAP, which was run on an IBM 650 with punched cards. To ensure accurate and reliable results, a room full of 37 women using Frieden calculators calculated all the checkpoints to confirm the computer output.



Joyce Currie Little in the windtunnel section with an aircraft model at Convair Aircraft Corp. (Courtesy Joyce Currie Little)

For analysis, the data had to be physically carried to the computer, which was in another building. At one point, Convair had a major project with American Airlines to prove that an airplane could take off in less than one mile [11]. Due to the expense of keeping the wind tunnel going, they needed the analysis in a very short time frame. To get the results in real time, Little and a colleague of hers, Maggie DeCaro, put on roller skates and, data in hand, furiously skated from the wind tunnel to the computer building—taking a shortcut through the hugh model design shop—bumped whoever was on the computer, loaded the current data, ran the data analysis program, and then furiously skated back to the wind tunnel with the results. The raised some eyebrows, but successfully completed the project on time!

Ever since she was a child, Little wanted to attend college. Through the encouragement of three people—her father, her high school mathematics teacher, and her high school basketball coach—Little went to college and majored in mathematics, with a minor in physical education. She received a B.S. degree in mathematics in 1957 from NE Louisiana State University, where a math teacher encouraged her to major in math and participate in independent study. Little received an M.S. degree in applied mathematics from San Diego State University in 1963. While she was in graduate school at San Diego, he physics professor, being interviewed on campus by Central Dynamics – Convair Aircraft Corporation, insisted she be interviewed, resulting in the offer to work in their Wind Tunnel Division, in San Diego, Calif.

After graduating, Little left Convair and moved to Maryland. In order to care for her stepson, she turned down a good job offer from Westinghouse on the Solomon project (a predecessor of the ILIAC IV computer) and took a position at Goucher College, where she managed a computer center and taught statistics. Continuing her education. Little enrolled, mostly part-time, in the Ph.D. program at the University of Maryland, College Park, and in 1984 received an interdisciplinary Ph.D. degree combining computer science, applied mathematics, management science, and educational administration.

While pursuing her Ph.D., Little later moved on to Baltimore Junior College, where she developed their first computer curriculum and became the head of the Computer and Information Systems Department. In 1981, Little left Baltimore for a position as a computer science professor at Towson State University, where she is currently the chair of the Computer Science Department. Little has been active in the ACM: she received the Distinguished Service Award in 1992 and was inducted in the first group of ACM Fellows in 1994.

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