Las mujeres del ENIAC

Women's First Roles in the 20th Century Computer World: The ENIAC

At the dawn of World War Two, it became evident to the Ballistic Research Laboratory (BRL) in Aberdeen, Maryland that it needed a new method for calculating ballistic tables for gunners in the war. These tables were extremely important to the gunners, who had the location of a target, the distance to it (the range), and the angle to the target from a cardinal direction. He needed, however, a conversion of the angle through the vertical plane of the gun. This was so that he knew how high to raise the weapon when firing; because of gravity and the projectory of the bullet, one cannot fire directly at a target. The gunner also had information pertaining to any head, tail, and cross winds in the area, the local air density, and the weights of his shells. Prior to the early 1930s, women calculated tables for this information and "every combination of gun, shell, and fuse" (Goldstine 135-6) -- women had this responsibility, since the Army considered it clerical work, which men "lacked the patience" for (Petzinger 1). It took roughly 20 hours for a person to calculate one such table manually. Around 1930, however, it quickly became apparent to the BRL that this was not efficient, and the organization began using a Bush differential analyzer to do the calculations. By using this machine, the time to calculate one table was cut to approximately 15 minutes. As time went by, however, even this improved time was inadequate for the vast number of tables which needed to be calculated; in 1935, the Army set up a contract with the University of Pennsylvania's Moore School of Electrical Engineering to allow the BRL full use of their faster Bush analyzer (Weik 2). Once this contract was in place, the BRL began instituting programs at the Moore School as part of an extensive project by the US Government to train people in various technical fields to assist in the war effort. Lieutenant Paul Gillon, for example, instituted classes for young women with science degrees, and contracted some of the School's instructors to train these women in ballistic computing. In 1942, a BRL officer by the name of Herman Goldstine took over operations at the Moore School. He terminated the Moore School's contracts with the instructors of the ballistic classes, and appointed three women as teaching staff instead: his wife Adele, Mildred Kramer, and Mary Mauchly. While an instructor, Adele Goldstine also made frequent trips to colleges throughout the Northeastern United States, in the hopes of recruiting more knowledgeable young women to be trained at the Moore School. Shortly thereafter, the Women's Army Corps (WAC) formed, and some of these women became available as "computers" to the BRL.

As mentioned earlier, the Bush differential analyzer, while able to perform calculations more quickly than a human, was still inefficient for the vast amounts of tables that the BRL required. A digital machine would not have the speed restrictions that the analog device had; however, no existing machine would run faster than the Bush analyzer. Therefore, the optimal course of action seemed to be to design a new machine that used a digital approach, but had considerable speed enhancements. In 1942, John Mauchly, a professor at the Moore school, circulated a brief memorandum summarizing his ideas on differential and harmonic analyzers; it caught the attention of a graduate student named Presper Eckert, and the two began communicating frequently. In April of 1943, a committee (including Mauchly, Eckert, Herman Goldstine, and Lieutenant Paul Gillon) met with the director of the BRL to discuss ideas about a new digital computing machine. "At this meeting," Goldstine relates, "Gillon named the proposed machine the Electronic Numerical Integrator and Computer and gave it the acronym ENIAC" (150).

Two years later, in April of 1945, the machine was complete. Adele Goldstine and a colleague produced an operating manual, a technical report, and a maintenance manual for the ENIAC. Later that year, Herman Goldstine put together a team of "six of the best computers to learn how to program the ENIAC." These "computers" included Kathleen (McNulty) Antonelli, Frances (Bilas) Spence, Jean (Jennings) Bartik, Elizabeth (Synder) Holberton, Ruth (Lichterman) Teitelbaum, and Marilyn (Wescoff) Meltzer (Goldstine 202, Petzinger 2). Although there is no mention in Goldstine's recollection of the history of the ENIAC as to the vast importance of these seven women (including his wife Adele), it is evident in his writing that these women were responsible for the majority of the programming and maintenance of the ENIAC:

> **Holberton [the man in charge of the six women programmers] and his group had been assigned the responsibility...of becoming the programming staff for the ENIAC when it was turned over by the Moore School to the government [in July 1945]. ... They were trained largely by my wife, with some help from me...[t]he only persons who really had a completely detailed knowledge of how to program the ENIAC were my wife and me. Indeed, Adele Goldstine wrote the only manual on the operation of the machine (Goldstine 229-30).**

At that point, "programming" the ENIAC meant "setting dozens of dials and plugging a ganglia of heavy black cables into the face of the machine, a different configuration for every program" (Petzinger 2). To ease this burden, Jean Bartik -- one of the original programmers of the ENIAC -- teamed up with Adele Goldstine in 1946 to lead a group that implemented the mathematician John von Neumann's "stored program" computer. The stored program machine relieved programmers of needing to reconfigure the cables for each equation that the machine solved.

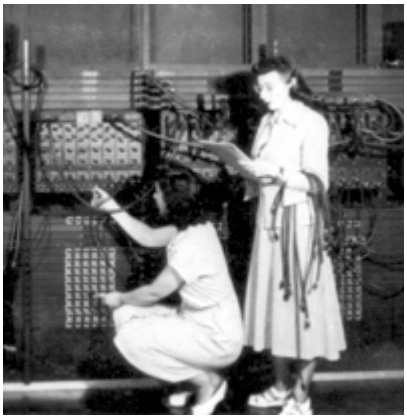
Unfortunately, the women faced many trials as programmers: "their government job rating was SP, as in 'subprofessional.' Initially, they were prohibited as security risks from entering the ENIAC room, forcing them to learn the machine from

wiring diagrams." (Petzinger 2-3). Apart from the difficulties and discrimination that these women faced at the time, many re-tellings of the ENIAC's history barely even mention their contributions. Karen Coyle laments this fact in her essay "How Hard Can It Be": "It takes difficult eyes to see where women have been and what they have done. The role of women like Ada Lovelace or Admiral Grace Hopper...will not appear on the pages of books that look to glorify male heroes." (45). Even Herman Goldstine's precise and detailed recollection of the ENIAC and the circumstances surrounding its existence merely categorically lists the names of the women programmers -- misspelling one of them -- and mentions which of the male engineers that each woman eventually married. Sadly, it therefore appears that Coyle's interpretation of the way that patriarchal histories remember influential women is correct.

Between World War II and the end of the century, there was very little activity from women within the field of computer science. This inactivity most likely stemmed from the contemporary societal pressures that told women to remain housewives. The notable exception during this time was Grace Murray Hopper. In 1949, Hopper joined the Eckert-Mauchly Computer Corporation as a Senior Mathematician, and in 1953 wrote the first compiler, for the COBOL language. In 1969, she won the first-ever Computer Science Man of the Year Award from the Data Processing Management Association, and in 1973 became the first person from the United States and the first woman of any nationality to become a Distinguished Fellow of the British Computer Society (The ADA Project, 1-2). Unfortunately, however, women like Grace Murray Hopper were a minority in the post-World War II era, and it would not be until the 1990s that women again became prevalent in the computer field.

The Women of ENIAC
A historical study of difficulties faced by women choosing a career in science.

Cynthia Soulliere



The ENIAC (Electronic Numerical Integrator and Computer) was developed during World War II to compute tactical trajectories that required substantial mathematical skills. Its designers, John Mauchly and J. Presper Eckert, successfully built and tested the first general-purpose electronic digital computer, once described as "the machine that changed the world". **Although the names of Mauchly and Eckert resound throughout the history of computing, the contribution of female programmers to the design of the ENIAC has largely been relegated to the field of trivia. These "Women of ENIAC" were vital to the ENIAC's success, working in a field that until this time could be described as 'men-only'.**

Many of the women who worked in the University of Pennsylvania's Moore School of Electrical Engineering, the site of the ENIAC project, chose to forego a traditionally female career in teaching, so that they could work in mathematics. This was a peculiarity of the time. It was generally expected that a college-educated woman would do one of two things, marry or teach (Fritz 1996). These women wanted to apply their knowledge and work in the field of mathematics. **The Moore School employed both civilian women, who had been educated in mathematics, and also some members of the Women's Auxiliary Corps (WACs) as "computers", responsible for making tables for firing and bombing trajectories (Winegard and Akera 1996). The women worked with desktop calculators, but much of the integration required to calculate these trajectories needed to be done by hand (Kay McNulty Mauchly Antonelli undated). Women were regarded as capable of doing this work more rapidly and accurately than men. Eighty women were employed with only three male employees at one point (Fritz 1996). This was little support since it was thought that women were more capable since the task was too repetitive for men.**

When the designers were looking for programmers, six women were chosen to design and build the trajectory program. The women, Kathleen McNulty, Frances Bilas, Betty Jean Jennings, Elizabeth Snyder, Ruth Lictermann and Marlyn Wescoff, were all highly skilled in mathematics and most held a college degree. They were not given the same professional rating as their male counterparts with identical education and experience (Moye 1996). Their rating was actually SP meaning "subprofessional". Since the ENIAC was being developed for military use, security didn't allow the women to work in the ENIAC room at first. They were forced to learn how to program utilizing exclusively engineering diagrams, since programming manuals had not been developed yet. When they were finally allowed in the ENIAC room, the majority of their time was cleaning up after the male engineers. It is important to note that programming was not like today. It was a difficult labour of changing connections, and inputting vast amounts of data with punchcards. These women understood all the intricacies of the design from their self-training and did much of the problem solving integral to the successful demonstration of the ENIAC in 1946.

One of the greatest difficulties the female programmers faced was gender bias. The directors of the ENIAC project were worried about sexual tension in the workplace. It was a very unusual practice for men and women at this time to work in the same laboratory. John Mauchly, one of the ENIAC's designers, described the engineering workplace as a gendered institution. The women on the project were not afforded the same respect as men. The army's history of ENIAC made a point to record each programmer's name alongside the engineers they married, misspelling one woman's name. Jean Bartik was almost fired after she got married because the director of the Moore School thought she would leave as soon as she became pregnant (Fritz 1996). The misconceptions of having a mixed-gender workplace only served as stumbling blocks for these women and others that followed.

One might contend these women were lucky to even hold a job in mathematics at this time. However, it is apparent that their contribution has been overlooked in the media and by the program directors. To run the ENIAC, required programmers to be constantly resetting dials, changing and plugging in different cables. Complex differential equations had to be broken down to their simplest steps, routed into a bank of electronics and performed in sequence with an accuracy within one five thousandth of a second. Despite its complexity, programming was considered clerical work and relegated to

the women. After the first successful test of the ENIAC in 1946, the male staff celebrated, while the "subprofessional" female programmers went home. In the eyes of historians the machine was the story, not the programmers behind it. When the University of Pennsylvania celebrated the 50th anniversary of the ENIAC, only a few of its female programmers were invited to the ceremony at first. In history's eyes, their contribution has become largely a trivial oddity of wartime.

The women of ENIAC were more than mere technicians; they were integral in the design and testing of the ENIAC. Only two of the original six remained in the field of computer science after marriage though. Betty Holberton played a significant role in the development of FORTRAN programming, integral in the control its standardization. Grace Hopper described her as the best computer programmer she had known in her career (Fritz 1996). Jean Bartik returned to the field of computer science after raising her children. However, it was difficult for women to have a career and raise children at the same time. They were looked down upon by society as well as by colleagues in their profession.

History's treatment of female contribution to the sciences leads to a lack of female role models. Their work has been historically overlooked for that of men. The real tragedy is history's resistance to revision once social attitudes have changed. The women of ENIAC chose a career using their mathematical skills rather than conforming to socially accepted careers like teaching. They faced discrimination on the job due to misconceptions about the value of their education, and about the gendered nature of the engineering workplace. Their significant contribution to "the machine that changed the world" should not be overlooked as a triviality of wartime; rather it should be viewed as a triumph for these female pioneers in the field of computer science.

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For further information on women of the ENIAC or women in computing check out these sites.

Frances Elizabeth Snyder Holberton - involved in development of FORTRAN
http://www.uri.edu/personal/csul7234/bettyholberton1.html
Kay Mauchly
http://kzoo.edu/~k00jm02/antonelli.html
Ada Lovelace - wrote first program to calculate Bernouli numbers
http://www.scottlan.edu/lriddle/women/love.htm
Grace Hopper - developer of first compiler; software language development
http://www.inventorsmuseum.com/GraceHopper.htm
Women In Computers
http://www.mills.edu/ACAD_INFO/MCS/SPERTUS/Gender/gender.html
Pictures Of Women In Computing
http://www.cs.yale.edu/homes/tap/photo_gallery.html
Women In Programming
http://www.okbu.edu/business/women_in_programming.htm

The text below is from the speech inducting the ENIAC Programmers into the WITI 1997 Hall of Fame **presented by Linda Sanford, General Manager of IBM's s/390 Division, and written by Kathryn A. Kleiman, Attorney with Fletcher, Heald & Hildreth in Rosslyn, VA. Kleiman has been documenting the work and lives of the ENIAC Programmers and is working on oral histories and a documentary about their lives. For more information about this project, please contact Kleiman at KathrynKl@aol.com.**

The first programmers started out as "Computers." This was the name given by the Army to a group of over 80 women working at the University of Pennsylvania during World War II calculating ballistics trajectories - complex differential equations - by hand. When the Army agreed to fund an experimental project - the first all-electronic digital computer, six "Computers" were selected in 1945 to be its first programmers. They were Kathleen McNulty Mauchly Antonelli, Jean Jennings Bartik, Frances Snyder Holberton, Marlyn Wescoff Meltzer, Frances Bilas Spence and Ruth Lichterman Teitelbaum.

The ENIAC, was the first all-electronic digital computer, a machine of approximately 18,000 vacuum tubes and forty black 8 foot panels. The ENIAC project was classified so until the Programmers received their security clearances, they were denied access to the machine they were supposed to tame into usefulness. As the first programmers, they had no programming manuals or courses, only the logical diagrams to help them figure out how to make the ENIAC work.

They had none of the programming tools of today. Instead, the Programmers had to physically program the ballistics program by using the 3000 switches and dozens of cables and digit trays to physically route the data and program pulses throughout the machine. Therefore, the description for the first programming job might have read: "Requires physical effort, mental creativity, innovative spirit, and a high degree of patience."

In 1947, the ENIAC was turned into a "stored program" computer - the world’s first. Thus, these six programmers were the only generation of programmers to program it at the machine level.

On February 14, 1946, the ENIAC Computer was unveiled to the public and press. It ran the ballistics trajectory programmed by the six Programmers and captured the world's imagination!

All six women contributed to the programming the ENIAC. Many of these pioneer programmers went on to develop innovative tools for future software engineers and to teach others early programming techniques.

Marlyn Meltzer and Ruth Teitelbaum were a special team of ENIAC Programmers. As "Computers" for the Army, they calculated ballistics trajectory equations painstakingly using the desktop calculators - an analog technology of the time. Chosen to be ENIAC Programmers, they taught themselves and others certain functions of the ENIAC and helped prepare the ballistics program. After the war, Ruth relocated with the ENIAC to Aberdeen, Maryland, where she taught the next generation of ENIAC Programmers how to use the unique new computing tool.

Frances Spence and Kathleen Antonelli were a second ENIAC team. Both mathematics majors in the class of 1942 of Chestnut Hill College in Philadelphia, they responded to the Army's call for mathematicians and were assigned to operate the Differential Analyzer, a huge analog machine of which there were only a few in the world. Fran and Kay led the teams of women who used this machine to calculate the ballistics equations.

They were selected to be ENIAC Programmers and worked hard to learn the ENIAC and develop the ballistics program. After the war, both Fran and Kay continued with the ENIAC to program equations on the ENIAC for some of the world's foremost mathematicians. Kay married Dr. John Mauchly who, together with J. Presper Eckert, invented the ENIAC and UNIVAC computers and Kay worked with John on program designs and techniques for many years!

The third ENIAC Programming team was comprised of Jean Bartik and Betty Holberton. As ENIAC Programmers, they took on the challenging task of learning the Master Programmer which directed the performance of all program sequences of the ENIAC. They led the entire group in programming the ballistics trajectory for the February 14, 1946 demonstration, but that was only the beginning!

After the War, Jean Bartik worked on the team that converted the ENIAC into a stored program machine - making it easier and faster to program larger and more sophisticated problems. Jean then programmed the BINAC, designed logic for UNIVAC I, designed an electrostatic memory backup system for UNIVAC I, and later, developed reports to help businesses understand a powerful new class of computers - the microcomputer. She worked tirelessly to make computers easier to use.

A complete list of the contributions of Betty Holberton during her forty year career in computing would keep us here for quite awhile, so I will only share with you the highlights. After programming the ENIAC, Betty joined the company founded by Eckert and Mauchly and worked on the first commercial computers. She wrote the C-10 instruction code for UNIVAC I, forever making programming easier and faster for programmers. She designed the control console for UNIVAC I and its computer keyboards and numeric keypad. In 1952 she designed the first sort merge generator for UNIVAC I. She served on the COBOL committee to design the first business language to operate across computer platforms, wrote standards for FORTRAN and served on national and international computer standards committees for decades.

Works Cited

Fritz, W.B., 1996. The Women of ENIAC. IEEE Annals of the History of Computing, vol. 18, no.3, 13-28.

Kay McNulty Mauchly Antonelli. (undated). [Online], 7 paragraphs. Available: http://www.cs.yale.edu/homes/tap/past-women-cs.html#Kay Mauchly [1999, February 7].

Moye, W. (1996, January). ENIAC: The Army Sponsored Revolution. [Online], 32 paragraphs. Available: http://ftp.arl.mil/~mike/comphist/96summary/ [1999, February 7].

Weingard, D. and A, Akera. (1996, January 30). A Short History of the Second American Revolution. *University of Pennsylvania Almanac*. [Online], vol.42, no. 18, 42 paragraphs. Available: http://www.upenn.edu/almanac/v42/n18/eniac.html [1999, February 7].


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