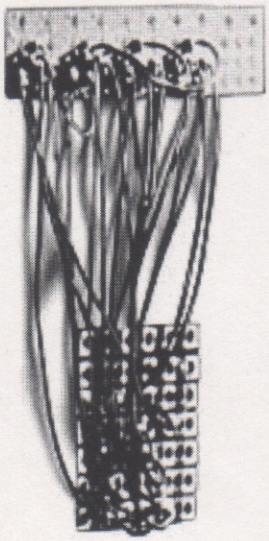
Lost and Found:
The First Computer Programers

by Lauren Walker

When Dr. John Mauchly and J. Presper Eckert, Jr. unveiled the Electronic Numerical Integrator and Calculator, or ENIAC, on February 14, 1946, they inaugurated the computer era and earned a place in the history books. But the six women who programmed the ENIAC almost wound up as a footnote. The women — Betty Jean (Jennings) Bartik, Betty (Snyder) Holberton, Marlyn (Wescoff) Meltzer, Ruth (Lichterman) Teitelbaum, Kay (McNulty Mauchly) Antonelli, and Frances (Bilas) Spence — had to invent programming virtually from scratch. There were no manuals, no programming language, no operating system, no notation with which to record the programming steps. There wasn't even a keyboard — problems were programmed using switches, cables, and plug boards. Yet their accomplishments were barely recognized, in their own time or later, until a young programmer named Kathryn Kleiman discovered their story while in college, and resolved to document these programming pioneers.



Not only did women program the first computers, they *were* the first computers. During WWII, women mathematicians were recruited to calculate the long differential equations needed to plot trajectories, at tenth-of-a-second intervals, for wartime artillery. "Computer" was the job title the Army gave them.

In June of 1945, the six programmers were chosen from among a group of about 100 human computers at the University of Pennsylvania to work on the top-secret ENIAC project. First, they were trained in IBM punch-card technology, because the ENIAC's input/output mechanism would employ it. Its printer was an IBM tabulator. Then, they were set to work figuring out how to communicate with ENIAC, though the computer itself wasn't even finished yet.

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"We had to learn to program it from block diagrams," says Jean Bartik. "The manuals were written a year later. There wasn't anything else to work from. There was no system of notation to keep track of what was going on with the computer, so we had to devise that. And every afternoon Betty Snyder and I would go in and ask John Mauchly any questions we might have. So you might say we learned programming from diagrams and John Mauchly."

The computer was mammoth, with 40 panels, 6000 switches, and 18,000 vacuum tubes. "The ENIAC had 20 accumulators, a multiplier, a divider, a square rooter, three function tables, and a master programmer," Bartik explains. "To produce the program to do the trajectory used almost all the units of the machine, and almost all the switches."

The process was complicated by the fact that ENIAC worked in parallel — it could do multiple functions at the same time, but to get the right calculations, the programmers had to make sure each necessary bit of information reached the right spot in the 100-foot long computer at the right moment. "Each time a unit finished an operation, it gave an output signal. If you were doing things in parallel, say addition at the same time you were doing multiplication, you would have to get things back in sync by using the program output signal from the unit that took the longest time. We tracked its internal clock, add time by add time, and that's how we did it."

ENIAC had a master programmer panel that could reuse bits of code and branch, "much the same way you do in modern computers," says Bartik, now 74. "Because most of the programs we did on it were so big in comparison to ENIAC's capacity, we had to be very careful. You had to work very hard to get the program on the ENIAC."

Not surprisingly, the ENIAC programmers also had to invent debugging. "One of the first things we did," Bartik relates, "was to have two of the programmers — Ruth Lichterman and Marlyn Wescoff — calculate a trajectory exactly the same way the ENIAC did it, so that we knew at every add time what should be in every accumulator. We could tell what numbers were in the accumulators because the front panel had holes in it allowing us to see what tubes were lit."

"Once we did those calculations, we used them to see if the machine was running correctly. We would run a test program before we ran our problem and then we would run it afterward. And if the one before and the one after were correct, then we assumed that the trajectory in the middle was correct."

"If the machine made a mistake and the test program showed a mistake, we could set break points and stop the machine at various points in the process to look at the accumulators. It was a hundred-kilocycle machine, and one add time was 20 cycles — the ENIAC could do 5000 additions per second. We could go add time to add time to determine which vacuum tube wasn't working."

The engineers were delighted that the programmers could debug the machine themselves. "The engineers loved us for that," Bartik says.

Nonetheless, the programmers were classed "subprofessional" by the Army. "I think they saw this work as routine, like typing, or, because of the plug boards, like being a telephone operator," says Bartik.

After the war, Bartik worked long enough to help the Army convert ENIAC to a stored-program, serial machine. "When it was turned into a stored-program machine it was turned into a serial machine, and they did some alterations so it could send two digits from the function tables to the master programmer, which converted them to specific instructions. Each of the three function tables could store 100 12-digit numbers or 600 instructions. We had an instruction set with commands like 'add to accumulator,' 'store from the accumulator,' 'multiply,' and 'divide,' which worked very much the way computers work today. Thereafter, the way people programmed the ENIAC was to sequence the instructions on the function table. We were the only generation of programmers that programmed it as a parallel machine. And nobody else ever set the switches or connected the digit and program trays."

Three of the programmers — Kay McNulty, Frances Bilas, and Ruth Lichterman — went on to train a new generation of programmers at Aberdeen Proving Ground. McNulty also went on to marry John Mauchly, who, with Pres Eckert, founded the Eckert-Mauchly Computer Corporation. Betty Snyder Holberton and Jean Bartik went to work at Eckert-Mauchly, where Bartik helped program BINAC, then went on to do logical design for UNIVAC, the first commercial computer. Holberton wrote C-10 instruction code for UNIVAC and later, at David Taylor Model Basin and the National Bureau of Standards, was instrumental in the development of computer languages COBOL and FORTRAN.

Except for occasional mention of those programmers who had married project engineers, however, these women never appeared in the history books. When Kathryn Kleiman, an undergraduate at Harvard in 1984, was researching the history of women in computing, the only two names most of the books mentioned were Grace Hopper and Ada Lovelace. But somewhere in the footnotes of a book on ENIAC, the first electronic computer, she found a list of the women's names. That got her started.

In pursuit of the story, she attended the celebration of the 40th anniversary of ENIAC in 1986. As the men were exchanging honors in the front of the room, Kleiman found a table of women sitting in the back, debating something. "I'm a programmer," says Kleiman, "and it sounded to me like they were talking about programming." The women were discussing the details of the settings they'd used to program the ENIAC forty years before. "So I

sat down, and turned on my tape recorder."

Their story, which became her senior thesis, has been with her ever since. Now an attorney specializing in Internet law in Alexandria, Virginia, Kleiman is seeking funding to produce a documentary on the women programmers of ENIAC, to make sure their legacy isn't lost. Kleiman was instrumental in getting recognition for the women at the 1996 50th-anniversary celebrations, and has served as a resource for a small flurry of articles, notably in the *Wall Street Journal* and *Ms.* magazine, on the ENIAC programmers.

"They weren't documented in the papers from the ENIAC project," Kleiman says. "There were virtually no materials with the programmers' names on them. I believe they might well have been lost to history if I hadn't started this project. And that would have been a terrible tragedy."

For more information on, or to contribute to, the documentary project, please contact Kathryn Kleiman at kleiman@internet-matters.com

Sources:

Private interviews with Jean (Jennings) Bartik and Kathryn Kleiman

Louis Bayard, "Computer Pioneers – Visible at Last," *Ms.* Magazine, May/June 1998

Thomas Petzinger, Jr., "History of Software Begins With Brainy Women's Work," *Wall Street Journal,* November 15, 1996

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