Programming Women:

Gender at the Birth of the Computing Age

Allie Feras
ID#: 1914546
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Honors Capstone
Advisor: Kimberly Sim
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In the spring of 1946, the public got its first glimpse of the Electronic Numerical Integrator and Computer (ENIAC) at a press demonstration of a ballistics trajectory problem created by Frances Elizabeth Snyder Holberton and Betty Jean Bartik, who had labored all night in preparation. However, when stories of the first electronic computer, which was faster than any existing analog computer, made their way into the morning papers neither woman received any credit. Instead, reporters focused on the ENIAC's male inventors, John Mauchly and J. Presper Eckert, who had built the machine to keep up with the demand World War II had created for faster and faster computation of firing tables to be used on the front. The omission of these women was the beginning of a long history in which women's contributions to computing were marginalized. Holberton, a graduate of the University of Pennsylvania who had previously worked as a statistician for *The Farm Journal*, and Bartik, a graduate of Northwest Missouri State Teachers College in math and English, were among a group of women who were the first to program an electronic computer.[1] These women, all of whom had at least some mathematics experience, were drawn into the war effort to work compute firing tables by hand and were later assigned to the ENIAC where they shaped this newly created technological field. Although the ENIAC, housed at the Moore School of Engineering at the University of Pennsylvania, had been classified, when the war ended the "electronic brain" captured the public's imagination and the computer age began.

Although today the stereotypical image of a programmer is well-educated, well-paid, and male, the first programmers were taken from the ranks of marginalized "human computers." Before the invention of the electronic computer, these human computers

[1] "Deposition of Francis Elizabeth Snyder Holberton," Box 14, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], Record Group 8.10, University of Pennsylvania Archive.
"Deposition of Jean J. Bartik," Box 12, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], University of Pennsylvania Archive.

performed the rote calculations necessary to scientific research. It was "the job of the dispossessed, the opportunity granted to those who lacked the financial or societal standing to pursue a scientific career."[2] While women had worked in computing for years, along with racial and ethnic minorities and the economically disadvantaged, WWII brought more young female math majors into the profession as it was considered an ideal temporary job for women, who managers assumed would return to the home once married.[3] The new electronic computers eliminated the need for human computers, mechanizing what had once been an employment opportunity for those who were given little chance at advancing.

Programming was originally considered a clerical job and therefore suitable for women, but over time it became stereotyped as a masculine profession, in accordance with its scientific, technological nature. Programming the earliest computers was often a repetitive task. However, with the advent of stored-program computers and the invention of the compiler, which enabled the computer to write its own code, programmers were freed up to focus on the more cerebral logical design aspects of the process. As the more repetitive programming duties became automated in the 1950s, the more intellectually challenging tasks were passed on to men. Though these technological changes were likely not the only factors in the masculinization and professionalization of programming—the return of men to the workforce at the end of WWII and the changing corporate environment of the computing industry also influenced this shift—they helped to speed up the industry's alignment with entrenched modes of thinking about gender and

[2] David Alan Grier, *When Computers Were Human* (Princeton, N.J.: Princeton University Press, 2005), 278.
[3] L. J. Comrie, "Careers for Girls," *The Mathematical Gazette* 28, no. 280 (1944).

work. While the new field had originally provided a space in which women had opportunities to contribute creatively, over time automation segmented and limited this space. The experiences of the women working on the ENIAC, at the Eckert-Mauchly Computing Corporation (EMCC) formed after the war, and in the UNIVAC division of Remington Rand, which purchased EMCC, provide a microcosm in which to examine the perceptions of gender and work in the programming field. As the group led by Eckert and Mauchly created more automated computers and came under greater corporate control, opportunities for women decreased. While women at first acted as the conduit between men and machines, as technology advanced their tasks were reassigned to electronic computers. To understand how these machines appropriated women's identities, it is important to examine women's contributions to the field and the perceptions the men in charge of the computing industry had of programming and gender. These issues can help to explain how female participation in the computer industry changed over time to reflect larger social standards of what is appropriate work for women.

Programmers were not always called by this name, and the verb "to program" was not originally associated with computers. It did not come into common usage until the inventors of the ENIAC were teaching other scientists and engineers about the theory of electronic computation. The word was "at the heart of the process that transformed the digital electronic computer from a laboratory experiment to an important scientific and business tool."[4] The ENIAC did not have the capability to store its program instructions, so programmers had to physically wire together sections of the computer to create a path for the data, called a "set-up." Later computers could store their instructions, and in

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[4] David Alan Grier, "The Eniac, the Verb "To Program" And the Emergence of Digital Computers," *IEEE Annals of the History of Computing* 18, no. 1 (1996).51.

discussing this prospect at the Moore School Lectures in the summer of 1946, the team that had built the ENIAC began to refer to instructions as a “program” and the act as “programming.”[5] However, none of the original women who programmed the ENIAC were invited to these lectures,[6] excluding them from expanding their knowledge in a field they had created and contributing their experiences to its formalization.[7] When these women were hired to work with the ENIAC, they were not given instructions on how to program the machine. Instead, the engineering team gave them block diagrams of the computer and they had to figure out how to make it obey instructions. In this way, though they did not coin the term, Elizabeth Snyder Holberton, Betty Jean Bartik, Kathleen McNulty Mauchly Antonelli, Marlyn Wescoff Meltzer, Ruth Lichterman Teitelbaum and Frances Bilas Spence invented programming.

Not only do the actions of men in the history of computing obscure women’s contributions, but the machines themselves also obscure female experiences. Throughout the history of technology, machines of many types have been semantically equated with women because they were both seen as useful for rote tasks. "In the imagination of factory owners, women and children could perform their labor in the same steady, predictable manner as machines that went through their repetitive mechanical operations.”[8] Human terms, such as “memory,” “computer,” and “brain,” were also used

[5] Ibid.
[6] Grier, *When Computers Were Human*.
[7] Grier, *When Computers Were Human*.
[8] Ruth Oldenziel, *Making Technology Masculine: Men, Women and Modern Machines in America, 1870 - 1945* (Amsterdam: Amsterdam University Press, 1999).

to describe machines,[9] making it easier to imagine them as a replacement for human labor.

It is also important to consider how changes in the physical act of programming could have affected its genderization. The structure of the ENIAC required programmers to plug in various cables to give the machine instructions. While this demanded considerable mental labor in planning ahead, it made the most visible component of programming a repetitive, light physical task. However, in 1944, before the ENIAC was even fully functional, Eckert and Mauchly already had plans to create a stored-program computer, which would eliminate the need for all those wires.[10] These changes would not bode well for women, as the reduction of light physical work would lead to fewer opportunities.

The managers who recruited programmers for work with early computers viewed the job in gendered terms. In the earliest computing outfits, they considered programming a dull, rote activity suitable for women. As the nature of the job changed they began to perceive it as more difficult mental labor, which effected their personnel decisions At the time, women were often seen as temporary labor because it was assumed they would get married and leave the workforce, and they were not given jobs with opportunities for advancement.[11] It is difficult to determine how exactly such concerns affected managers, but the job descriptions and classified ads produced by EMCC and Remington Rand frame programming in masculine terms that do not fit within ideas about women's work.

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[9] Scott McCartney, *Eniac, the Triumphs and Tragedies of the World's First Computer* (New York: Walker, 1999).
[10] Ibid.
[11] Ruth Milkman, *Gender at Work: The Dynamics of Job Segregation by Sex During World War Ii* (Urbana: University of Illinois Press, 1987).

To understand how these factors affected the transformation of the programming profession, it is essential to understand the context in which these women came to be the first programmers. Although ideas about gender and work were more solidified in other fields, computing was too new to be so structured and the Moore School had to work with the available labor pool, allowing women a chance to contribute to the creation of programming.

General Computing Scholarship

Despite female programmers' considerable contributions to the field, most computing historians ignore their participation in early computer development. These historians view the story of the first electronic computers through a male lens. Scott McCartney's history of the ENIAC reads more like a biography of Eckert and Mauchly; most often, when he mentions the female programmers, it is to use them to comment on the men's personalities and temperaments. For example, he quotes Bartik explaining that she feared Mauchly's temper but does not discuss how Bartik's work influenced the project. Sometimes, they are referred to as "one of the women 'computers'"; in this context, he ignores their individual identities However, McCartney does mention that the female programmers figured out how to program ENIAC without manuals, and in a few short paragraphs writes that they were influential on the development of the computer. "Even though the women had significant responsibility for the success of the project, they continued to be treated as clerks, although they were in fact programmers."[12] Still, although he states in this small section that the women were a significant part of the project, he does not show it in the rest of his work.

[12] McCartney, *Eniac, the Triumphs and Tragedies of the World's First Computer.*, 97.

Similarly, in *From ENIAC to UNIVAC: An Appraisal of Eckert-Mauchly Computers*, Nancy Stern traces the development of ENIAC and UNIVAC and the trials that followed from the perspectives of the men who invented them. She barely references the women involved; most of her discussion of them takes place in a footnote detailing their various marital relationships. She also only refers to them as “programmers” in the index; in the text, they provide “programming assistance.”[13] While this may seem like a matter of semantics, it downplays women’s active participation by framing their identities as wives who program instead of programmers.

Kurt Beyer, however, reexamines women’s contributions to computing in his biography of Grace Hopper. He argues that the progress of women in the working world has not been linear; the percentage of women receiving Ph.Ds in mathematics in the 1920s and 1930s was unmatched until the 1980s. This period was advantageous to women’s progress in the field and created many competent women who would go on to become some of the first programmers. Beyer writes that while women had many opportunities in the earliest days of computing, once corporate entities like Remington Rand became involved they imposed a more male-dominated culture on the nascent industry. Although Beyer’s book is specifically about Hopper and what motivated her, it shows the influence of gender on the profession.[14]

The neglect of women’s contributions to the computing industry through the 1940s and 1950s has created a glaring hole in the scholarship. Many scholars have assigned agency only to the men involved. This examination of how women interacted

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[13] Nancy B. Stern, *From Eniac to Univac : An Appraisal of the Eckert-Mauchly Computers*, Digital Press History of Computing Series (Bedford, Mass.: Digital Press, 1981).
[14] Beyer, "Grace Hopper and the Early History of Computer Programming".

with the electronic computers—specifically the ENIAC and the UNIVAC—aims to fill that void by showing how technological changes can affect the gendered perceptions of a profession.

Scholarship on Women and Work

Broader studies of women and technology and women and work provide insight into the experiences of these programmers and the perception of the their new profession. By examining how society genders work and applying these views to the careers of women in early computing, changes in the field's genderization can be better understood. When placed in the greater context of mid-20th century trends in female employment, their experiences provide an example of how gender norms were negotiated in a new field. Many scholars have investigated the transition of women in and then out of the workforce in the period surrounding WWII, but of these studies focus on either the loss of factory jobs to men after the war, or the solidification of stereotypes about "pink collar" job such as nurse, teacher, or librarian. The story of the early female programmers is unique because it shows how even a new profession can be molded to fit older ideas about gender and the division of work.

The sexual division of labor in the early 20th century affected women's career choices; Susan Thistle argues that even when women entered the workplace, they were still expected to perform domestic chores and keep a suitable home. It was these domestic tasks that had previously earned them their keep, as men were expected to provide for their wives. This arrangement was maintained even as women began to work outside the home for wages, and employers were therefore unwilling to pay women a living wage.

Instead, they expected that a man would support the female employee and that her income was merely supplemental. Consequently, many workingwomen prioritized their duties in the home at the expense of their paid work because they were overburdened with work. Many feminists and advocates for women wanted to deny employers the cheap female labor that was adding to women's labors; "the fundamental issue was ... not whether women could escape from their domestic role, but whether such new claims on their time could be resisted."[15] Thistle bases her analysis on the intersection of race and gender and how these factors influenced women's experiences in the job market.

It was in this context, this understanding of women and work, that the women who programmed the ENIAC and the UNIVAC were raised. These social expectations affected how they viewed their position in the workforce and the choices they made. Grace Hopper never remarried after her divorce at the start of WWII, choosing to dedicate herself to her work; she recognized that in the society in which she lived, it would be difficult to live a traditional family life and accomplish her goals in the world of computing. However, many of the original programmers did go on to marry; in a deposition used in the 1973 Honeywell vs. Sperry Rand patent trial to determine the inventor of the electronic computer, Meltzer is embarrassed to admit that she is now a housewife, saying that she "hates to say it" when asked her current occupation.[16] Others, though married, continued working in the computing field. Holberton, for example, married John Holberton, a prominent figure in the computing industry, and went on to

[15] Susan Thistle, *From Marriage to the Market : The Transformation of Women's Lives and Work* (Berkeley: University of California Press, 2006).
[16] "Deposition of Ruth Teitelbaum," Box 16, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], Record Group 8.10, University of Pennsylvania Archive.

work for EMCC and Remington Rand, though she felt resented for her gender and success at the latter.[17] These women chose different paths but all had to negotiate the expectations placed on women in both the workplace and the home.

Economic conditions also limited choices women's choices in the job market in the early- and mid-20th century. Julia Blackwelder begins her analysis of women in the working world by looking at the demands the economy placed on the workforce in general and then expanding her inquiry to understand how these demands affected female employees and the genderization of work. She discusses how the ideal of women staying in the home and caring for children is not as traditional as those who pine for it assert; women have worked for pay throughout history and ideas of domesticity and femininity are modern inventions. However, when many men were unable to find jobs during the Depression years, employers were less willing to hire women, especially married women. These restrictions were reversed during WWII when the market placed a greater demand on female labor, creating an environment in which married women were not forced out of their jobs. Women's employment was still viewed as a temporary situation as wartime propaganda promoted the imminent transition of women from workers to consumers, claiming that once victory was achieved, women could return to their rightful place in the home. In the early 1940s, 6.5 million women joined the workforce; by 1946, 4.6 million of them had returned to the home. Of those who remained, many worked in jobs that were considered women's work.[18]

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[17] Beyer, "Grace Hopper and the Early History of Computer Programming".
[18] Julia Kirk Blackwelder, *Now Hiring : The Feminization of Work in the United States, 1900-1995* (College Station: Texas A&M University Press, 1997).

However, Blackwelder argues that technology began to blur the lines in the gendered division of work. "Automation, while solidifying the transfer of work-process control from workers to management, simultaneously removed the rationale behind occupational segregation in many manufacturing settings."[19] The machine-assisted de-skilling of factory work opened these positions up to women so that men could pursue more respected occupations. This process masculinized the programming field: as the lower-level tasks of the job which had previously required female interaction with the machine—plugging in cables, coding repetitive subroutines—were automated, the job was seen as more intellectual and therefore more suitable for male employees. As the profession gained more prestige, men were hired to fill the positions that had been defined by women. A facet of the programmer's job had been so deskilled that its tasks were assigned to electronic computers, eliminating opportunities for women to work within the confines of the gendered expectations and limitations. Some women, including the most prominent example, Grace Hopper, were able to break out of these restrictions and work alongside men in the changing field, but perceptions of the job had shifted so much that it was no longer considered primarily a woman's domain.

Although few scholars have examined how such early developments in computing technology as the invention of the compiler and higher-level coding languages affected women in the field, research on the interactions between women and technology provide an essential perspective to this study. In *When Computer Were Human*, David Alan Grier discusses the history of human computing through its attempts to professionalize and how these attempts were thwarted when electronic computers eliminated the need for hand

[19] Ibid.

computation. He explains how human computing, which was originally performed by male employees, became feminized during the war. By 1944, male directors of computing programs generally referred to their employees as "girls." Even before the war, in the nineteenth century, woman computers were underpaid and treated in a condescending manner. At the Harvard Observatory in 1880, Edward C. Pickering employed a staff of female computers, who were paid half the going rate for a male computer and were often referred to as "Pickering's Harem." Later, at Bell Telephone Laboratories in the 1930s, "laboratory scientists turned their gaze on the computer staff of Clara Froelich and saw them as a model for some new calculating device."[20] Viewing female computers as analogous to machines, these scientists created devices to speed up the women's work and eventually remove them from the equation. Grier describes many similar instances in which employers viewed their female staff as frivolous, interchangeable objects.

With the invention of the compiler and programming languages, programming became a less tedious, rote task. As the electronic computers took over the repetitive parts of the job and the physical interaction of the programmer with the machine lessened, the field became more male-dominated. In a continuation of the process by which desk calculators made female computers more efficient and the job less skilled, electronic computers sped up the process of writing subroutine code, taking this task over from the women who had invented it. In this way, the planning and flowcharting tasks of programming were elevated to become male jobs, while the rote coding and wiring tasks were delegated to the machines. As shifts in technology and corporate culture divided and

[20] Grier, *When Computers Were Human*.

specialized the individual tasks of their jobs, the original female programmers were left without credit for the work they had done and without a place in the new industry.

The association of women with repetitive tasks and machinery extended beyond the field of human computing. Sharon Hartman Strom discusses how the introduction of office machines like desk calculators and typewriters into the workplace affected female employment. She argues that the increase in accounting and record keeping practices at the start of the twentieth century led to a need for more office workers and more office machines. The goal of mechanization was to reduce labor costs but putting more work on the machines. However, the ability to do more work that would have been impossible by hand required more employees to be hired to operate these machines. In 1933, the labor office determined that the introduction of office machine often led to an increase in personnel. According to human capital theorists, women were ideal for these mechanized, rationalized jobs because everyone expected them to marry and stop working so they would not expect career advancement. Women were already stereotypically associated with light manufacturing work, so by framing office machines as production work, women seemed well suited. Also, unlike young men, women did not expect a promotion. By hiring a mix of men and women, employers could promote the men and pay the women less, giving them more routinized work. “Women were more likely than men to be assigned to routinized tasks, whether performed in conjunction with machines or not. It was suggested through advertising, job titles, and sex segregation in the office that the more interesting and varied jobs were reserved for men."[21] For example, when desk

[21] Sharon Hartman Strom, *Beyond the Typewriter: Gender, Class, and the Origins of Modern American Office Work, 1900 - 1930* (Urbana and Chicago: University of Illinois Press, 1992).

calculators were used for the first time to tabulate the 1890 census, both men and women were hired to do the rote adding work, but many of the men disliked the work and quit, while the women worked faster and more efficiently. It was assumed that the women performed better they had more delicate fingers and greater exactness of touch. However, Strom argues that it was more likely that the women could not afford to complain about the jobs they were allowed to have, while the men had other options.[22]

This principle applies directly to the experiences of the earliest female programmers who worked on the ENIAC and UNIVAC computers. The more routinized tasks, like those performed by the ENIAC programmers, were assigned to women. Later, the compiler stripped away programmers' routine duties, leaving them free to devote more time to logical design, and more men became interested in the profession..

Ruth Milkman makes a similar argument, focusing on the automobile and electrical manufacturing industries. She writes that after WWII, common sense implies that capitalist firms should have continued to employ women because they were cheaper, leading to greater gender equality in the work place. However, many women were pushed out of manufacturing jobs as men returned to the labor pool. She argues that the sex-typing of jobs is industry specific and tends to be formed when the job is created. Factors such as the economic, political, and social conditions when the labor market forms, labor intensity of the industry, supplies of male and female labor, costs, and resistance to hiring women contribute to a specific industries sex-typing. For example, electrical manufacturers employed a high proportion of women even before the war because much of their labor involved small piecework that was deemed more suitable for women. This

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[22] Ibid.

assumption “centers on such qualities as manual dexterity, attention to detail, ability to tolerate monotony, and, above all, women's relative lack of physical strength.”[23] Milkman writes that after the war, management made an effort to keep women out of "men's work" now that men were home. Employing women had been an experiment, and now it was over. They pushed them out because they still clung to the prewar logic of sex-typing, and the advances women had made in the work-place were set back. Jennifer Light applies Milkman’s argument to the employment of female computers as programmers in the 1940s and 50s. She argues that the common explanations of “women’s work” did not apply to the actual work involved in these jobs. Ballistics computer and programmer were considered clerical and therefore women’s jobs even though they required mathematical knowledge.[24]

These arguments provide an explanation of how rigid ideas of sex-typing were applied in the newly developing computing programming field. Women were welcome in the profession in its earliest years when the state of the technology allowed employers’ perception of the job to be feminized because it fit the narrative of women performing mechanized tasks with assistive machines. As the technology changed, however, the narrative shifted to one in which men planned and managed feminized machines, leaving no place for actual women. An examination of how the changing nature of the job and a growing awareness of the intellectual prowess required changed the genderization of programming is missing from the research on women in the technological fields. An analysis of the programmers’ perceptions of their own work will reveal how the act of

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[23] Milkman, *Gender at Work: The Dynamics of Job Segregation by Sex During World War Ii*.
[24] Light, "When Computers Were Women."

programming and its gender have changed with technological improvements and the widespread popularity of computers.

Historical Context: Women and Human Computing in WWII

During WWII, many jobs that had previously considered "mens' work" were recast as suitable for women, shifting the boundaries of gender division but not eliminating them. Often, news stories and public relations publications celebrating women's work on the home-front compare the tasks involved in these jobs to domestic labor. This re-gendering was facilitated by the introduction of new technologies into the workplace, which changed the nature of the jobs and sometimes created new jobs. Because these jobs were not identical to the jobs that had been done by men, it was easier to portray them as women's work. The recruitment of women for human computer jobs—and later programming jobs—provides an excellent case study of this phenomenon. The Army Ballistics Research Laboratory (BRL) in Aberdeen, Maryland had employed over 200 female computers by the end of the war, and began using the facilities of the Moore School of Engineering at the University of Pennsylvania in Philadelphia. Until 1945, computers were people, and the skill set fit stereotypical ideas about women's work; computers used desk calculators to solve for ballistics trajectories under variable conditions, a tedious and repetitive process.

Later, when some female computers found employment as programmers, their work on the earliest electronic computers involved the long process of wiring up the machine to follow the proper instructions.[25] Many of the human computers working with the BRL did not want to be transferred to work on the ENIAC because they felt that working with a machine would be a demotion. To them, the electronic computers devalued their work.[26] WWII did not permanently break down the lines between men's and women's occupations as the popular perception suggests. Women were not hired to fill jobs as they emptied, but were hired to fill newly created or redefined jobs that had been framed as women's work.[27]

Mauchly and Eckert were able to obtain support to build the electronic computer they had been planning when a backlog of ballistic trajectories tables built up at the BRL. The human computers simply could not work fast enough to satisfy the needs of the war, and so the electronic computer was proposed as a solution.[28] Ballistics trajectory tables were essential during WWII because gunners needed to know where to aim. To construct the tables, the human computer had to determine the trajectory in standard atmospheric conditions, and then re-solve the equation with a different correction for each condition. One trajectory could take two full workdays.[29]

BRL began relocating some of their projects to Philadelphia because the Moore School has a differential analyzer, a precursor to the electronic computer. The differential analyzer and other more advanced computers that had been build up until that point had

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[25] Jennifer S. Light, "When Computers Were Women," *Technology and Culture* 40, no. 3 (1999).
[26] Kurt William Beyer, "Grace Hopper and the Early History of Computer Programming" (University of California, Berkeley, 2002).
[27] Milkman, *Gender at Work: The Dynamics of Job Segregation by Sex During World War Ii*.
[28] McCartney, *Eniac, the Triumphs and Tragedies of the World's First Computer*.
[29] Harry Polachek, "Before the Eniac," *IEEE Annals of the History of Computing* 19, no. 2 (1997).

all been analog machines, which used measurable quantities to represent numbers instead of the discreet binary switches of digital devices.[30] The Mark I analog computer at Harvard University actually included some features that the ENIAC did not, such as dual processor, but was less accurate and reliable than its digital cousin. The ENIAC was the first digital computer, but Eckert and Mauchly would eventually incorporate some of the concepts used in the Mark I into their later computers.[31]

Some of these concepts were instrumental in beginning the process of automating programming, which affected how the field was perceived and the gender of the participants. By the time the ENIAC was completed, its inventors had already moved onto the stored program concept of the Electronic Discrete Variable Automatic Computer (EDVAC).[32] This machine was never completed and eventually Eckert and Mauchly decided to leave the University of Pennsylvania to start their own company to make universal use computers to sell to businesses, academic institutions, and the government. They saw the many uses for their invention and didn't want to be tied down by the University.[33] The new Dean of Research at the Moore School, Irvin Travis, felt that faculty should not benefit financially from research conducted while at the university. In exchange for a patent release on the technology, Travis offered Eckert and Mauchly permanent positions, but the two inventors felt their work was too valuable and rejected Travis' offer.[34] They decided to form the Eckert-Mauchly Computer Corporation

[30] McCartney, *Eniac, the Triumphs and Tragedies of the World's First Computer*.
[31] "Interview with Grace Murray Hopper (1906-1992)," January 7, 1969, Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center.
[32] Grier, "The Eniac, the Verb "To Program" And the Emergence of Digital Computers."
[33] McCartney, *Eniac, the Triumphs and Tragedies of the World's First Computer*.
[34] Beyer, "Grace Hopper and the Early History of Computer Programming".

(EMCC) and began work on a Universal Automatic Computer (UNIVAC), which realized many of the goals of the EDVAC project and would be sold for business, scientific, and mathematical applications.

The EMCC provided opportunities to women to influence the programming of the computer; Holberton developed the input mechanism and Grace Hopper created the instruction code language. Hopper later said the she felt this was a time when opportunities were open to women and the field had not yet become male-dominated.[35] Hopper began her programming career at Harvard, working on Howard Aiken's Mark I analog computer, a predecessor to the ENIAC. After becoming the first woman to earn a Ph.D in mathematics from Yale, Hopper returned to her undergraduate alma mater, Vassar College, to teach. However, nine years later, she was moved to serve by the attack on Pearl Harbor. She left her tenured position, divorced her husband, and joined the Navy as a lieutenant. Because she had a strong mathematics background, she was assigned to the Mark I project. Like the women working on the ENIAC project, Hopper was given no instruction in programming the machine with which she worked. She learned to program Mark I by examining the hardware and learning about electronics.[36]

At first, the Mark I group was not especially open to women, but the flexibility of this new profession allowed Hopper to define her own role outside the rigid definitions that existed in other fields. "She actively erased gender differences through her clothing, her language, her drinking habits, and her humor, gaining the trust and respect of Aiken and her peers to the point that she became the most prominent person in the Harvard

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[35] McCartney, *Eniac, the Triumphs and Tragedies of the World's First Computer*.
[36] Beyer, "Grace Hopper and the Early History of Computer Programming".

Computing Laboratory apart from the fiery Aiken."[37] In oral history interviews, Hopper has revealed how gender affected her perception of her work at Harvard. She always carried a small compact mirror in her WAVES purse to check for sparks in hard to reach places on the MARK and refers to the machine in gendered terms. "Mark I was always a 'she' because she behaved like a female; she ran when she felt like it and did not—she was stubborn and so on and so forth."[38] Hopper's ideas about gender norms influenced the way she interacted with the machine. Mark I was transformed from a faulty, temperamental machine into a person, a female person. By categorizing the computer's characteristics within gendered boxes and assigning it a feminine identity, Hopper semantically linked women and machines, a common practice throughout the history of technological advancement.[39]

But gender had an even more concrete effect on Hopper's career; because she was female, she had to leave Harvard after three years. At the time, anyone with a faculty contract who was not promoted within three years was terminated, and women were not promoted. Hopper has stated that she would have loved to stay at Harvard if she could have, but that she was glad she was pushed to join EMCC in 1949. Other companies also offered her work, but she chose to work with Eckert and Mauchly because they already had a functional computer and she wanted the opportunity to start working with the machine immediately.[40] "When Hopper joined Eckert and Mauchly, the sky was the limit

[37] Ibid., 4.
[38] "Interview with Grace Murray Hopper (1906-1992)," January 7, 1969, 12.
[39] Oldenziel, *Making Technology Masculine: Men, Women and Modern Machines in America, 1870 - 1945*.
[40] "Interview with Grace Murray Hopper (1906-1992)," January 7, 1969.

because the field was new, the company was small and flexible, and there were no gender-based roles."[41]

However, this early period of relative gender equality was shortlived; before EMCC had even delivered its first UNIVAC, one of its main backers passed away and the company ran into financial troubles. The Remington Rand Corporation purchased EMCC in 1950 and restructured the floundering company into the UNIVAC division. Along with the purchase came a new corporate culture less welcoming to women. Holberton has stated that she felt unwelcome at Remington Rand because many of the male salespeople were jealous of the esteem and money that she and Hopper had achieved.[42]

Women's Contributions to the Programming Field

An examination of how the female programmers of the ENIAC understood their job's responsibilities and the physical process involved in performing it can provide insight into the nature of programming at its birth and the influence of gender on computer-related professions. Through the depositions these women gave in the *Honeywell vs. Sperry Rand* patent trial to determine the inventor of the computer and oral histories conducted for the Lemelson Center at the National Museum of American History, they reveal their interactions with and contributions to the ENIAC and UNIVAC computers. [43,44] These sources show that programming required considerable analytical work for which these women are not often credited.

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[41] Beyer, "Grace Hopper and the Early History of Computer Programming," 211.
[42] Beyer, "Grace Hopper and the Early History of Computer Programming".
[43] University of Pennsylvania Archive, ENIAC Patent Trial

Before these women began their work, no one had ever programmed a digital computer—not even its inventors. As such, no one could give them directions on how they were to go about instructing the machine. Instead, the ENIAC's engineering team provided the programmers with block diagrams of the computer's inner workings and told them to work it out from there.[45] When working with the ENIAC and other early computers, it was essential that programmers know every detail of what the machine did when given a specific instruction, down to the last electronic pulse.[46] The programmers worked collaboratively, learning parts of the machine in small groups and then teaching what they had found to the rest of the women.[47] During this period of a few months, they were not permitted to interact directly with the ENIAC, and Bartik stated in her *Honeywell vs. Sperry Rand* deposition that she felt that she and her colleagues were allowed to work with an IBM punch card machine to give them the feeling that they were running the machine and participating in the project.[48] The group first worked with the ENIAC in winter of 1945 and began to understand what their new jobs would specifically entail. Holberton, for example, had the responsibility of wiring of the "pre-design cables," which is equivalent to physically setting up the program that the machine would follow.[49] In their earliest interactions with the computer, the women faced some

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Collection, 1864 - 1973 [1938 - 1971 bulk].

44 Smithsonian National Museum of American History Archive Center, Lemelson Center for the Study of Invention and Innovation, Computer Oral History Collection, 1969 – 1973, 1977.

45 "Deposition of Jean J. Bartik."

46 "Interview with Grace Murray Hopper (1906-1992)," February 4, 1969, Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center.

47 "Deposition of Francis Elizabeth Snyder Holberton."

48 "Deposition of Jean J. Bartik."

49 "Deposition of Francis Elizabeth Snyder Holberton."

difficulties reconciling what they had learned from the diagrams with the reality of the machine. They had learned the internal structure of the machine from the back, so when they encountered the hulking machine head-on, it did not fit their current understanding. "We were confronted with the fact that it was physical, not mental," Antonelli later stated in her deposition, adding that the plugs were sometimes difficult to pull out.[50] This realization is crucial to the women's understanding of their work with the computers. They were to be performing small physical tasks, not the intellectual "men's work" of the mathematicians. In the engineering terms discussed by Oldenziel,[51] this work was shop-room labor, left to the lower classes and minorities.

Although a major component of the programmer's job was the physical plugging and rearranging of cables, their work did vary. According to an affidavit read at Meltzer's deposition,

> The duties of a "programmer" were to work with a sequence of computer operations and connections to solve a particular problem and make a schedule thereof from which the switch settings and connections were made and checked. Such programming included the actual setting of switches in the correct number of many positions and the plugging in of trunk trays and lines to make the correct connections between panels.[52]

In her deposition, Teitelbaum states that the ENIAC team called the act of flowcharting and planning ahead "programming," and the physical process of setting up the ENIAC to

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[50] "Deposition of Kathleen Rita Mauchly," Box 15, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], Record Group 8.10, University of Pennsylvania Archive, 103-104.
[51] Oldenziel, *Making Technology Masculine: Men, Women and Modern Machines in America, 1870 - 1945*.
[52] "Deposition of Marlyn Wescoff Meltzer," Box 15, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], Record Group 8.10, University of Pennsylvania Archive, 30.

run the program "plugging in."[53] This explanation conflicts with other sources, which claim that the term "programming" was not used for computers until a few years later, evidence that Teitelbaum's perception of the nature of programming at the time of the deposition may have been influenced by changing attitudes toward the genderization of the profession. She associated programming with the stereotypically male mental process when Holberton had in fact created the standards for flowcharting a program.[54]

In developing of the process of programming, the women of the ENIAC contributed to the development of the hardware. At the time that the women began working with the ENIAC, the machine was not yet working perfectly, so they could not trust its results. The programmers instituted testing standards to check the computer's accuracy because they could not trust the machine; each time they ran a trajectory program, they would run a test program before and after the main program. If both test programs produced the correct results, they could assume that the main program's results were also correct. Often they would hand-check problems as needed to ensure that the computer was running properly.[55] Other methods they used to check the computer were the "breakpoint" method and the "one add time" method. To do a breakpoint check, the programmers would stop the program at a predetermined point by physically pulling out a wire. They would then check the results of the program up until that point before allowing it to proceed. The "one add time" method involved clicking through the

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[53] "Deposition of Ruth Teitelbaum."
[54] "Interview with Grace Murray Hopper (1906-1992)," February 4, 1969.
[55] "Deposition of Francis Elizabeth Snyder Holberton."

program one step at a time and checking the numbers that had been stored in the accumulators after each operation.[56]

The flaws they found in the hardware required them to creatively find new ways to program around faulty sections, which led them to develop to more sophisticated programming techniques. When they discovered a problem, the programmers would report it to an engineer to fix the machine. Homer Spence was always on hand in the computer room to look into hardware issues that went beyond the women's programming tasks. Some problems were difficult for the engineers to diagnose and fix because they were what was called "intermittent faults," meaning they would cause errors erratically and were difficult to eliminate. Because these problems were not quickly fixed, the programmers would mark the areas of the machine containing them and find new ways to use the computer in the absence of the broken hardware. L. S. Dederick, the director of the BRL, relied on the expertise the programmers gained from this error-finding process to keep him informed of issues with the ENIAC while the machine awaited government acceptance, which would approve it for use at the Aberdeen Proving Ground.[57,58] Holberton stated in her deposition that she did not think the ENIAC was ready for acceptance and was approved too early. She tried to influence Dederick to hold out on accepting the computer until more errors could be fixed. This experience led her to an interest in performance testing and she said she "would never let that go again."[59]

Although Holberton may have felt she did not do enough to improve the ENIAC, the programmers' work influenced the design of the machine. By using software to find

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[56] "Deposition of Kathleen Rita Mauchly."
[57] "Deposition of Francis Elizabeth Snyder Holberton."
[58] "Deposition of Jean J. Bartik."
[59] "Deposition of Francis Elizabeth Snyder Holberton," 100.

hardware errors, the female programmers contributed to the improvement of the computer itself at the same time that they developed the programming process. They were an integral part of the ENIAC team and had they not provided this data to the engineers and Dederick, the machine may not have been reliable enough for real-world applications. Although they did not directly plan the specifications for new computers, programmers could influence the evolution of the hardware because new programming techniques require different equipment. In a paper on the influence of software on hardware, Hopper and Mauchly argue that although to the engineer, a computer is obsolete once it is finished and the next project has begun, to the programmer there are always new options. They compare programmers to engineers, claiming, "the programmer is a kind of engineer who uses mathematical equations, system diagrams, flow charts, procedure manuals and instruction codes as the tools of his trade."[60]

Contemporary Public Perceptions of Female Programmers

Despite the contributions these women made to the computing field, the male engineers who managed the project obscured their work from the public eye. the women who had invented this programming process did not diagram or plan out the first program whose results were actually used in a real-world scientific investigation. The flowcharts for this program, a mathematical problem the creators of the hydrogen bomb were having trouble solving at Los Alamos, were created by Los Alamos scientists Nicholas Metropolis and Stanley Frankel, who asked the programmers to wire up the ENIAC for

[60] Grace M. Hopper and John W. Mauchly, "Influence of Programming Techniques on the Design of Computers," Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

their project.[61] The women were excluded from the diagramming process for security and classification reasons, and it was not a conscious attempt to relegate them to strictly rote physical work. Still, it did not bode well for the future of women in electronic computing that the first time scientists from outside the ENIAC engineering team worked with the computer and the women who programmed it, the women's jobs were not presented as intellectually challenging.

The ENIAC team also presented this perception of the women to other scientists and news media at the public demonstrations of the computer's capabilities, held in the spring of 1946. Although they put tremendous effort into preparing for the demonstration, the female programmers received little credit in the public eye. Bartik states that she was very excited to be working on this new project, which motivated her to spend all night working with Holberton to prepare a trajectory problem for the demonstration. Though they worked as fast as they could to debug and plug in the program, they never got it working properly.[62] However, despite all this work, the women were not given the opportunity to participate in the demonstration beyond simply acting as hostesses.[63] The programmers took attendees' coats and directed them to the presentation conducted by the ENIAC engineers, who "tried not to concern [the women] with [the demonstration.]"[64] In this way, the female programmers' technical work went unappreciated by the public because they took on roles that fit gendered expectations of a woman's place.

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[61] "Deposition of Kathleen Rita Mauchly."
[62] "Deposition of Jean J. Bartik."
[63] "Deposition of Ruth Teitelbaum."
[64] "Deposition of Kathleen Rita Mauchly."

Contemporary articles about the unveiling of the ENIAC made little reference to the female programmers, and when they did, their work was reduced to routine tasks. When discussing programmers and computer operators in general terms, the media referred to them as "he," and anthropomorphized the computers—calling them "giant brains" that could "think."[65]After the first public demonstration of the ENIAC, the press reports reflected how the women's role had been minimized for public consumption. Although they had set up the demonstration trajectory for the unveiling, the press made no reference to their accomplishments. Additionally, while some photographs did show the female programmers and were accompanied by captions acknowledging their presence, they were described as doing rote physical actions such as "plugging in cables," "standing at function tables," or "setting switches." These mundane descriptions downplayed the actual complexity of their work.[66] The articles even referred to human computers as male, although at the time many women held that job. For example, the *New York Times*' piece on the unveiling of the ENIAC states that the machine could complete in two hours a problem that would take 100 "trained men" a year to solve.[67] Similarly, an ad for the latest issue of *Popular Science Monthly*, also in the *New York Times*, implies that the magazines story on the ENIAC would appeal solely to men.[68]

After the unveiling of the ENIAC, Louis N. Ridenour wrote a piece for Fortune Magazine that considered the implications of electronic computers for science,

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[65] Will Lissner, "'Brain Speeded up for War Problems," *New York Times*, Dec. 13 1947.
"New 'Electric Brain' Job," *New York Times*, Dec. 8 1950.
Will Lissner, "Mechanical 'Brain' Has Its Troubles," *New York Times* 1947.
[66] Light, "When Computers Were Women."
[67] T.R. Kennedy, Jr., "Electronic Computer Flashes Answers, May Speed Engineering," *New York Times (1857-Current file)*, Feb 15, 1946 1946.
[68] "New Machine Does Man's Life Work in Few Minutes," *New York Times* 1946.

engineering, business, and government in a piece that focused solely on the male contributions and benefits. He compared the computer to previous technological advances, arguing that they would bring about a second industrial revolution by transforming the way we work and interact with technology. For example, he writes that "the desk calculator is a device that *assist a man in performing a complicated calculation*, by freeing him from he necessity of doing arithmetic. A modern computer can *perform a complicated calculation by itself.*"[69] Whereas the first industrial revolution saw machines replacing man's muscle but maintaining human control, the second would place computers at the helm, giving them the decision-making power in day-to-day operations.[70] This comparison ignores the reality of early computers' function and the context in which they were programmed. Though Ridenour looked into the future of computing, he failed to understand its state in that historical moment. The earliest computers were not yet ready to take over for men's minds and run factory operations on their own, but they were standing in for women's bodies. Developments in early computing removed the routine aspects of programming, which eliminated the need for female employees to perform light physical work. This redistribution of programming tasks onto the electronic computers contributed to the de-feminization of programming.

Technological Change and the Masculinization of Programming

In the earliest days of electronic computing, women had opportunities for intellectually engaging work but their accomplishments were ignored. In the 1950s,

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[69] Louis N. Ridenour, "Mechanical Brains," 1949, Reprinted from Fortune Magazine, Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.
[70] Ibid.

however, it became more difficult for women to be considered for these positions. New technologies, some of which were invented by women, changed the interaction between programmer and computer, making the position more appealing to men. The computing industry began based on a hierarchy in which men planned projects for women who programmed machines, but eventually the women's tasks were divided between the men and the machines to make the process more efficient. By giving the dull, unappealing tasks to the machines, programming could be reframed as an exciting male career.

This process was aided by the invention of the compiler in the early 1950s, a factor that other histories of computing have not considered as an influence on the place in women in the field. While originally subroutines had to be tediously written and rewritten, Grace Hopper's compiler enabled the computer to write its own subroutines. Her groundbreaking work made programming less repetitive and more intellectual. In her personal papers, Hopper discusses how she felt programming had become dull and unexciting, but by making the computer do the boring work for her, it became fun again.[71] In this case, she subverts the historical practice of assigning tedious work to women to free up the minds of men by assigning the tedious work of women to machines, freeing women to use their minds.

Hopper's earlier programming work had a profound influence on her compiler. When she first started working at EMCC, Holberton taught her how to flow-chart a program and use C-10 code, a basic command code for the UNIVAC created by Holberton and Mauchly. Hopper's first task was to create a library of subroutines to be

[71] "Interview with Grace Murray Hopper (1906-1992)," February 4, 1969.

used by the UNIVAC.[72] This work was a precursor to her revolutionary ideas on compiling and automatic programming. It was there at EMCC that Hopper began work on the world's first compiler.

Although Hopper is famous for inventing the compiler, she considers making computers easier to learn and use to be her greatest achievement; inventing the compiler was just one part of that process.[73] Programming had become too tedious, too prone to human error, and was no longer fun, so she wanted to expedite the process. At the time, programmers kept written libraries of subroutines that they would trade and copy to be used to solve different problems. This method prevented each programmer from having to write each bit of code again and again, but led to copying errors.[74] The first compiler, the A0, did not have a higher-level programming language and was simply a computer program that could write other computer programs. At its heart, it was a library of subroutines sandwiched between input and output generator that would construct the proper order of the subroutines according to the necessary specifications. It was a single pass compiler, an idea Hopper drew from her experience playing basketball. When the compiler came to a decision statement, and needed to go forward into a section of the program that had not been written yet, it would pass the decision into a different memory location—a so-called "neutral corner"—and wait until another section of the program had flagged it down. By letting the computer do this work for her, Hopper was able to change the face of programming. Before the UNIVAC, most programming had been done for

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[72] Ibid.
[73] "Interview with Grace Murray Hopper (1906-1992)," January 7, 1969.
[74] "Interview with Grace Murray Hopper (1906-1992)," November 1968, Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center.

scientific and mathematical applications; however, there was a demand for computing power to perform data processing tasks in the business sector. Hopper separated the data being processed from the program processing it by storing the data in libraries too, so programs could be used for various data sets. Without this development, modern day database management would be impossible.[75]

Data processing demands also inspired Hopper to create the first programming languages, which contributed to the masculinization of the profession. As she read through the data processing tasks business computers would need to perform, she found that many of the same verbs were used over and over again. These verbs formed the basis for the commands her programming language would allow users to execute. One of the A0 compiler's successors, the B0, used FLOWMATIC, a major influence on the first widely used business programming language, COBOL.[76] Before higher-level languages were created, programming was very time-consuming to learn: computers do their calculations in an octal number system and before the invention of the compiler and higher-level programming languages, programmers had to program them in octal accordingly, which Hopper felt was unnecessarily complicated:

> I had to realize that I couldn't work eight hours a day in octal and then live the rest of the time in the normal decimal world. And my answer was not that I learned better octal, as the damn computer could learn decimal. I would instruct it in my own language. They could do the dirty work."[77]

[75] "Grace Hopper Oral History," July 20, 1979, Record Group 1825, Hagley Museum and Library.
[76] Ibid.
[77] "Interview with Grace Murray Hopper (1906-1992)," January 5, 1972, Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center, 44.

The first high-level language, which used commands similar to recognizable English, grew out of the earlier UNIVAC programming code, which used single letters to represent different operations.[78] Advances in programming languages allowed easier communication of instructions between programmer and machine. However, eventually her efforts were appropriated to eliminate women from this process, leaving the machines to the men. As programming became less tedious and more accessible, it became unnecessary for UNIVAC to employ women to do the tedious set-up and copying work that older computers had required. These changes attracted men to programming and allowed Remington Rand to advertise the job as an exciting new opportunity full of potential, a reframing that excluded women.

Although there are no records that elucidate Eckert, Mauchly, and their male colleagues' opinions of hiring female programmers, hiring practices shifted as the responsibilities of the job and its corporate nature changed. An analysis of help wanted ads placed in the newspapers for programmers and computer operators in the decade after the invention of the ENIAC that call for men yields a greater understanding of the personnel decisions managers made as the field developed. Before the ENIAC was even invented, employers looking to hire human computers specifically sought out female prospects. In large part this trend was due to the dwindling male labor pool of the World War II era, but these jobs were framed as specifically suitable for women. L. T. Comrie, a major proponent for the professionalization of the human computing field argued that women made particularly good computers because unless they are told that pure

[78] "Outline for First Lecture Programming Course for EMCC's Engineers," Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

mathematicians dread such work, they will not realize on their own that it is dull.[79] Although such arguments gave women opportunities to enter the workforce, their patronizing nature implied that women were useful but expendable and not capable of real intellectual work. Comrie cements this position by promoting the applicability of computing skills in domestic pursuits: “With a training no longer than that of their sisters who cultivate secretarial or accounting work... they can be made proficient, and give good service in the years before they (or many of them) graduate to married life, and become experts with the housekeeping accounts!”[80] These statements emphasize the perception that women’s work was impermanent, a stepping stone toward married life.

These ideas about female employment in human computing carried over into the era of electronic computing. Bartik came to work for the BRL after seeing an ad seeking young women who had mathematics experience.[81] These ads were specifically geared toward the hiring of women because the employers at the Moore School and in Army felt that women were well suited to the repetitive work involved. When Eckert and Mauchly needed programmers to instruct and operate their new creation, they went straight to the human computing division because these women had the background necessary to understand the tasks the machine would perform.

Later, after Remington Rand purchased EMCC, ads seeking programmers to work with the ENIAC changed noticeably. While earlier job ads implied that programming was a lower level job, requiring only some mathematics experience, these ads are evidence of the growing perception that programming is an intellectually demanding job, and

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[79] Comrie, "Careers for Girls."
[80] Ibid., 94.
[81] “Deposition of Jean J. Bartik.”

therefore suitable only for men. These ads do not ask for girls, they ask for engineers and mathematicians; these requirements are in keeping with the earliest definition of a Systems Engineer, created by Herbert Mitchell for EMCC. Mitchell wrote that the Systems Engineer, who would deal with logical design and programming, should be a male with a graduate degree.[82] While female jobs were often seen as short-term assignments that would end when the woman married, ads for programming jobs at Remington Rand in the 1950s promised opportunities for advancement. For example, an ad that ran in the New York Times in October 1954 and continued to run for several months after stated that the available positions, everything from the hardware jobs that had always been occupied by men to the logic design positions first held by women, "offer personal challenge as well as outstanding opportunities for professional development."[83] Many of the ads purchased by Remington Rand specifically seek men for these positions, and at the time newspapers ran separate help wanted sections for men and women. An ad published in both the New York Times' and the Washington Post's "Help Wanted—Male" sections states that the company is seeking "men with 2 to 3 years Logical Design Experience."[84] This ad also promises opportunities at professional development, something women's jobs lacked. At the same time, the educational requirements for these positions also increased. When the first female programmers were hired, they responded to advertisements seeking women was some mathematics experience or education. By the late-fifties, however, potential Remington Rand

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[82] Herbert Mitchell, "Systems Engineer," August 14, 1952, Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.
[83] Classified Ad, *New York Times* (Oct. 31, 1954): F11.
[84] Classified Ad, *New York Times* (May 31, 1955): 55.
Classified Ad, *Washington Post* (May 29, 1955): A11.

programmers were expected to hold mathematics or engineering degrees.[85] An ad published in The New York Times in 1958 seeks employees holding advanced degrees and categorizes programming and logic design tasks under the "engineer" title,[86] associating these new jobs with a label that had already been thoroughly masculinized.[87] In contrast, Remington Rand specifically advertised secretarial and typing positions in the UNIVAC division in the "Help Wanted—Female" sections.[88] This division of jobs along gender lines in the classified section was very common during this period and the jobs listed in each section reflect ideas about what was appropriate work for each gender.

These help wanted ads show that as programming became more cerebral, Remington Rand was able to apply gendered stereotypes to transform the profession from a lower-level position held by women into a respectable field with exciting potential for highly-educated men. The nature of the technology—and therefore the interaction between programmer and machine—changed. At the same time, EMCC was incorporated in Remington Rand, whose male-dominated corporate culture masculinized programming. While early job ads that sought women patronized them, later ads ignored them entirely. The sexual division of labor is nothing new, but these ads show that rapidly changing technologies in the newly forming field allowed the lines dividing male and female positions in computing companies to be drastically redrawn.

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[85] Classified Ad, *Washington Post* (Feb. 22, 1956): 40.
[86] Classified Ad, *New York Times* (July 13, 1958): F19.
[87] Oldenziel, *Making Technology Masculine: Men, Women and Modern Machines in America, 1870 - 1945*.
[88] Classified Ad, *Washington Post* (June 22, 1957): D4.
Classified Ad, *New York Times* (May 4, 1958): W5.
Classified Ad, *New York Times* (Nov. 24, 1957): 331.

Another force acting on the influx of men into the programming profession was public perception. From the earliest day so electronic computing, news articles routinely ignored women's contributions. The invisibility of the feminine component of the profession could have helped make programming more exciting to young men and boys looking for a career. The press viewed computers as a replacement for routine female work and geared their coverage toward male audiences.

Remington Rand's promotional materials for the UNIVAC also reflected the masculinization of programming. In July 1953, their company newsletter announces the creation of a course in electronic computing run by Remington Rand to educate UNIVAC users and potential buyers about programming and maintenance techniques. This article explains that the classes will be useful to men interesting in computing. A photo accompanying the article features a group of men involved in planning and teaching the course and the female registrar for the program. This image reinforces the idea that programming is a male domain, assisted by a female clerk who stands demurely to the side.[89] The promotional course booklets for this program include photographs of students learning about the ENIAC. Save for one or two women, the classes are entirely male, and all of the teachers are male.[90] These materials reinforced the stereotype that programming was for men and companies should send their male employees to these courses. In doing so, they elevated programming from a female clerical position to a respectable career for men.

[89] "New Courses in Electronic Computing Are Announced," Remington Rand News Vo. IV, No. 20, July 1953, Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

[90] "Catalogue of Courses in Electronic Computers, 1955-1956," Box 372, Record Group 1825, Hagley Museum and Library.

Limitations and Further Research

Programming became re-gendered over time as the job became less tedious and less physical, but further research into what exactly caused this correlation is necessary. Did managers begin to realize the intellectual work involved in programming and fall into traditional sex-typing when making hiring decisions? Were female applicants specifically turned away or discouraged from pursuing programming jobs? To answer these questions, it will be necessary to examine the personnel decisions of the EMCC and other early computer companies and also the public perception of the job and its shifting responsibilities. However, at this time such evidence is unavailable.

More research is also needed to examine how later developments, including silicone microchips and more modern programming languages, affected the genderization of the field. By analyzing how these changes affected the interaction between programmer and machine, and how that interaction was negotiated along gendered lines, scholars could gain a more detailed view of the evolution of programming. Also, research into current efforts to encourage women to study math, science, and related technological fields could help complete the story begun by the women of the ENIAC. How are the tasks of technological work today framed to appeal to young women? Does the interaction between programmer and computer have any bearing on these efforts to promote an interest in technology among women? Applying this type of analysis current issues affecting women in technology would provide a broader view of how these factors have influenced societal perception of women's work over time.

Women, Software, and New Technologies

In her deposition, given decades after her work on the ENIAC, Bartik said, "I mean today what we were doing was not software—it was logic design in today's terms."[91] The distinction she was making in this statement was that the work done by the first female programmers went beyond simple coding tasks that might today be delegated to a project's more inexperienced programmers. They were involved in the higher level planning of what each program was supposed to do and how it would accomplish these goals. This work was by no means dull and routine; it did not fit perceptions of appropriate work for women. From the very beginning, women were involved in the challenging work of creating, understanding, and improving computing technology. The ENIAC women were not taught to program the machine, they created the process of programming themselves by studying the computer's structure in detail. Eckert and Mauchly had not originally considered the impact that software could have on the operation and reception of the hardware. The only way to find all the faults in the machine itself was to use it; in all their programming and testing these women were able to fine-tune the machine, a major factor in its success and the UNIVAC's later success in the nascent computing industry. The importance of programming became more evident as Eckert and Mauchly worked to build the first stored program computers, which would revolutionize the way computers were used to analyze sets of data. The tedious work the women of the ENIAC performed showed the computer's inventors that more efficient methods were necessary and possible.

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[91] "Deposition of Jean J. Bartik," Box 12, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], Record Group 8.10, University of Pennsylvania Archive, 88.

The light physical labor demanded of programmers by the ENIAC computer did not comprise the bulk of their work, but it was presented to the public in what few news articles made any reference to them at all as their main duty. Photos of the ENIAC published in newspapers showed the female programmers plugging in wires and assisting men in various tasks around the computer room, not planning and diagramming programs or debating the most efficient and creative ways to use the faulty hardware with which they worked. At public demonstrations, they worked strictly as hostesses and were not given the opportunity to take credit for the many contributions they had made to the project. As Bartik, Holberton, Teitelbaum, Meltzer, and Antonelli explained in their depositions, it was their tireless testing and debugging of the machine that had made it acceptable to the Army and the public at all. This work, plus the work of Grace Hopper to make computers easier to use and program, helped to change the direction of the computing field from focusing strictly on mathematic and scientific applications to realizing the potential for computing power in business and government.

However, the same improvements that they inspired and invented were used to reframe the identity of a "programmer," a position they had defined through their own hard work. Advanced compilers and higher level programming languages made the work less tedious and more appealing to men. Before these changes, programming was seen as more clerical and repetitive, which are not exciting attributes to job hunters with greater opportunities for education and employment. As the technology matured, Remington Rand could reframe the profession so its technological nature kept in line with the normative ideas about gender and work that permeated the rest of the corporate environment.

Although women were given more opportunities at the birth of the computing industry, the changing technologies and increasingly conservative corporate environment pushed them out of the field. This process solidified over the course of the late 20th century, leading to the stereotype of programming as a male domain. Still, the experiences of the women who worked the ENIAC, EMCC, and UNIVAC show how new technologies that have not yet gained mainstream prominence can provide spaces for marginalized groups to achieve success and professional fulfillment.

Works Cited

Primary:

"Catalogue of Courses in Electronic Computers, 1955-1956." Box 372, Record Group 1825, Hagley Museum and Library.

Classified Ad. *New York Times* (Oct. 31, 1954): F11.

Classified Ad. *New York Times* (May 31, 1955): 55.

Classified Ad. *New York Times* (May 4, 1958): W5.

Classified Ad. *New York Times* (July 13, 1958): F19.

Classified Ad. *Washington Post* (May 29, 1955): A11.

Classified Ad. *Washington Post* (Feb. 22, 1956): 40.

Classified Ad. *Washington Post* (June 22, 1957): D4.

Classified Ad. *New York Times* (Nov. 24, 1957): 331.

Comrie, L. J. "Careers for Girls." *The Mathematical Gazette* 28, no. 280 (1944): 90 - 95.

"Deposition of Jean J. Bartik." Box 12, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], University of Pennsylvania Archive.

"Deposition of Kathleen Rita Mauchly." Box 15, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], University of Pennsylvania Archive.

"Deposition of Marlyn Wescoff Meltzer." Box 15, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], University of Pennsylvania Archive.

"Deposition of Ruth Teitelbaum." Box 16, ENIAC Patent Trial Collection, 1864 - 1973 [1938 - 1971 bulk], University of Pennsylvania Archive.

"Grace Hopper Oral History," July 20, 1979. Record Group 1825, Hagley Museum and Library.

Hopper, Grace M. and John W. Mauchly. "Influence of Programming Techniques on the Design of Computers." Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

"Interview with Grace Murray Hopper (1906-1992)," November, 1968. Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of

Invention and Innovation, Smithsonian National Museum of American History Archive Center.

"Interview with Grace Murray Hopper (1906-1992)," January 7, 1969. Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center.

"Interview with Grace Murray Hopper (1906-1992)," February 4, 1969. Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center.

"Interview with Grace Murray Hopper (1906-1992)," January 5, 1972. Computer Oral History Collection, 1969 – 1973, 1977, Lemelson Center for the Study of Invention and Innovation, Smithsonian National Museum of American History Archive Center.

Kennedy, T.R., Jr. "Electronic Computer Flashes Answers, May Speed Engineering." *New York Times (1857-Current file)*, Feb 15, 1946 1946, 2.

Lissner, Will. "'Brain Speeded up for War Problems." *New York Times*, Dec. 13 1947.

———. "Mechanical 'Brain' Has Its Troubles." *New York Times*, 1947.

Mitchell, Herbert. "Outline for First Lecture Programming Course for EMCC's Engineers." Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

Mitchell, Herbert. "Systems Engineer." August 14, 1952, Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

"New 'Electric Brain' Job." *New York Times*, Dec. 8 1950.

"New Machine Does Man's Life Work in Few Minutes." *New York Times*, 1946, 1.

Ridenour, Louis N. "Mechanical Brains." 1949. Reprinted from Fortune Magazine. Box 4, Grace Murray Hopper Collection, 1944-1965, Smithsonian National Museum of American History Archive Center.

Smithsonian National Museum of American History Archive Center, Lemelson Center for the Study of Invention and Innovation, Computer Oral History Collection, 1969 – 1973, 1977.

<u>*Secondary:*</u>

Beyer, Kurt William. "Grace Hopper and the Early History of Computer Programming." University of California, Berkeley, 2002.

Blackwelder, Julia Kirk. *Now Hiring : The Feminization of Work in the United States, 1900-1995*. College Station: Texas A&M University Press, 1997.

Grier, David Alan. "The Eniac, the Verb "To Program" And the Emergence of Digital Computers." *IEEE Annals of the History of Computing* 18, no. 1 (1996): 51-55.

———. *When Computers Were Human*. Princeton, N.J.: Princeton University Press, 2005.

Light, Jennifer S. "When Computers Were Women." *Technology and Culture* 40, no. 3 (1999): 455 - 83.

McCartney, Scott. *Eniac, the Triumphs and Tragedies of the World's First Computer*. New York: Walker, 1999.

Milkman, Ruth. *Gender at Work: The Dynamics of Job Segregation by Sex During World War II*. Urbana: University of Illinois Press, 1987.

Oldenziel, Ruth. *Making Technology Masculine: Men, Women and Modern Machines in America, 1870 - 1945*. Amsterdam: Amsterdam University Press, 1999.

Polachek, Harry. "Before the Eniac." *IEEE Annals of the History of Computing* 19, no. 2 (1997): 25 - 30.

Stern, Nancy B. *From Eniac to Univac : An Appraisal of the Eckert-Mauchly Computers*, Digital Press History of Computing Series. Bedford, Mass.: Digital Press, 1981.

Strom, Sharon Hartman. *Beyond the Typewriter: Gender, Class, and the Origins of Modern American Office Work, 1900 - 1930*. Urbana and Chicago: University of Illinois Press, 1992.

Thistle, Susan. *From Marriage to the Market : The Transformation of Women's Lives and Work*. Berkeley: University of California Press, 2006.