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Patents and the Gendered View of Computer Programming as Drudgery or Innovation

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Women were the original computer programmers. Women programmed the ENIAC, the first programmable, electronic, general purpose computer. Women implemented the design to convert that computer into the first stored program computer. And a woman wrote the first compiler program. Despite these many programming firsts, the patent often recognized as the first patent for a computer program, or "software," was granted to a man. While many argue that the waters surrounding the patentability of computer programs are murky even today, the history of computer programming and patents makes clear that judgments about what activity results in patentable subject matter is tied to gendered values society places on different types of work. When women were doing the work, programming was viewed as drudgery, merely the use of a machine, not the innovation or creation of technology that the patent system is designed to reward. As computer programming was professionalized and masculinized, that assessment was reversed, suggesting that at least in the history computer programming, to a large extent gender has determined who gets to invent.

Fundamentally, patents grant an economic right: the right to exclude others from making, using, or selling your invention for the term of the patent. If those rights are violated, patent holders are entitled to monetary damages. But patents are important for other reasons. Patents are used to measure the innovation taking place in society. To many they represent ingenuity, creativity, autonomy. Patent holders list their patents on resumes. In computer programming as in any other industry involving patentable technology, patents influence hiring, determine pay, and impact promotions.[1] Indeed, patent counts have been used as a proxy for "meaningful participation" in the computing field.[2]

On the law's surface, society's reliance on patents to measure and reward innovation should present no problem for women because patent law appears to be gender neutral. The patent statute lays out the requirements for a patent. New and useful processes, machines, manufactures, or compositions of matter, as well as any new and useful improvements are inventions entitled to recognition and exclusive rights.[3] In contrast to these requirements on the subject matter of an invention, patent law has minimal limitations on who can invent. An inventor is simply an "individual" who invents.[4] There are no other qualifications. The Federal Circuit Court of Appeals, the federal court that hears all patent appeals, recently decided that an inventor must be human, but that is an undeniably low bar.[5] So, if the system works according to the text of the law, whether the subject matter of any particular activity is judged to be an "invention" and worthy of a patent should depend on the subject matter that the activity produces not on who performed the activity.

However, the parallel histories of the computer programming profession and patents demonstrate that patent law is far from agnostic with respect to the gender of those who engage in inventive activity. The subject matter of patents both reflects and perpetuates society's judgments about the nature and the relative value of the work that women do. In the early days of computing, women were recruited to program computers because they were considered careful and detail oriented, excelling at repetitive and mundane tasks. Women used technology to make their chores easier. Men, on the other hand, were given the opportunity to develop the hardware of computer systems. Men were considered innovators. Men created technology. Men did the work that patents exist to reward and incentivize. The patent system both perpetuated and reflected those faulty assumptions. This chapter takes advantage of the unique history of computer programming as an activity in which the primary gender of its participants shifted at an identifiable moment from almost exclusively women to largely men. Examining this history in parallel with the history of patenting activity sheds light on how patents reflect and perpetuate society's gendered views of activity as drudgery or innovation. Given the power of patents in the economy and society in general, those working in the patent system should be educated to recognize gendered views of inventive activity, or alternatively patents must be replaced by better measures of innovation in society.

THE HISTORY OF GENDER IDENTITY IN COMPUTER PROGRAMMING

Unlike the current composition of the programming workforce, the majority of computer programmers in the early days of computers were women. The Electronic Numerical Integrator and Computer (ENIAC), developed during World War II to solve the mathematical equations necessary to determine the ballistics trajectories, is widely recognized as the first programmable, electronic, general

purpose computer. The original programmers of the ENIAC were all women—Kay McNulty, Betty Jennings, Betty Snyder, Marlyn Meltzer, Fran Bilas, and Ruth Lichterman. They derived the programs based on block diagrams constructed by another woman, Adele Goldstine.[6] Indeed, according to Herman Goldstine, a senior member of the ENIAC team and Adele's husband, Adele (and, of course, himself) were the "only persons who really had a completely detailed knowledge of how to program the ENIAC."[7]

At the time, women were the obvious choice to program the ENIAC. Before the ENIAC was developed, women manually calculated ballistics trajectories, which was the task the ENIAC was initially designed to perform. These women "computers"[8] already used much simpler machines, such as slide rules and basic calculating machines,[9] to perform what was viewed as their rote, dull, and low status job.[10] They were now just provided a much superior machine in the ENIAC to help them perform the same function.

At the time that women were working to program the ENIAC computer, their government job rating was SP, meaning "subprofessional."[11] They were initially prohibited from entering the ENIAC room because of security concerns, forcing them to learn the machine from wiring diagrams. The account of Herman Goldstine of the history of the ENIAC demonstrates how the contributions of women in the development of the ENIAC were discounted. Goldstine writes, "Holberton [the man in charge of the six women programmers of the ENIAC] and his group had been assigned the responsibility . . . of becoming the programming staff. . . . They were trained largely by my wife, with some help by me."[12] Holberton's "group" was composed of women, here unnamed. During the first public demonstration of the ENIAC, the women programmers were not acknowledged at all.

Other women followed the path of those original ENIAC programmers. Klara von Neumann and Adele Goldstine worked together to convert the ENIAC into the first stored program computer. The first stored programs run on the ENIAC, complex calculations called Monte Carlo simulations tracing the paths of neutrons through an atomic bomb, were written by a woman and run by Klara von Neumann. Klara Dan was the primary programmer of the Mathematical Analyzer, Numerical Integrator, and Computer (MANIAC I), a computer in the 1950s initially designed to perform calculations of the thermonuclear process at Los Alamos National Laboratory. In 1952, Mary Tsingou programmed the first experiment conducted entirely on a computer on the MANIAC.[13]

After the war, Grace Hopper joined the Eckert-Mauchly Computer Corporation and in 1953 wrote the first compiler, written for the COBOL language. Female computer programmers were vital to the computer language development taking place in the 1950s at Bell Labs. Dolores C. Leagus codeveloped the L1 language, and Ruth A. Weiss codeveloped the L2 language. The two languages were used on more the half the IBM computers doing scientific and engineering work in the late 1950s.[14]

Women were not just co-participants with men in developing computer programs. In the days of the ENIAC computer programmers and into the 1950s, there was a clear gender-based line between software developers and hardware developers. As John Knox has observed, when women were doing the programming, the men thought "it was sexier to be around the hardware than software. . . . No one cared about software; it was 'women's work' in a way, even though nothing would have worked without the software."[15] Even some women believed programming was women's work. In Janet Abbate's interviews of early female computer innovators, Elsie Shutt, who was hired by Raytheon in 1953 noted, "it really amazed me that these [men] were programmers, because I thought it was women's work!"[16]

In the postwar years, the demand for computer programmers increased rapidly as computer manufacturers turned their attention to the commercial market. Initially, both women and men were recruited as programmers. Job titles varied from computing engineer to numerical analyst, data processing specialist, computer, or programmer.[17] Recruiters used college degrees, aptitude tests, and experience in other occupations, such as mathematics, engineering, and business as proxy measures for programming skill, each with differing effects on women's opportunities in the field.[18] Some companies and universities affirmatively recruited women by equating the skills necessary for programming to the skills necessary for embroidery or knitting. According to an article in the Guardian, programming required "patience and tenacity, and a common-sense sort of logic. Much of the work is tedious, requiring great attention to detail, and this is where women usually score."[19] But the questions remained, "was computer programming a job for highly skilled scientists, or for clerical workers like secretaries and typists?"[20]

Despite these recruiting efforts, by the late 1960s, discussions about the future of the computing industry were dominated by warnings about the shortage of programmer labor. As more corporate or academically oriented men entered the profession, they "worked to establish professional societies, publish academic journals, develop credentialing programs, and lobby employers and governments for recognition and legitimacy."[21] As late as 1966, computer facilities were funded as tools in other scientific disciplines rather than as research in computing itself.[22] By 1967, the Office for Computing Activities was established at the National Science Foundation, and in 1968, funding for the OCA was increased by 73 percent.[23] The 1969 report proclaimed "the emergence of computer science as an academic discipline."[24]

Nathan Ensmenger has argued that as part of the professionalization of computer programming in the 1960s, computer programming was made masculine as a way to pursue status and autonomy by male programmers.[25] Male academics successfully transformed computer programming, previously viewed as routine and mechanical, into a "highly valued, well-paying, and professionally respectable discipline."[26] Mar Hicks has made a similar case for the masculinization of computer programming work in Britain in the 1960s.[27] "As computer programmers

constructed a professional identity for themselves during the crucial decades of the 1950s and 1960s . . . they also constructed a gender identity."[28] The term "software engineering" was adopted in the late 1960s in order to associate programming with a highly masculine occupation. Predictably, the identity of computer programmers became more masculine.[29]

During this time, women were not only replaced by men as programmers. They were also replaceable by computers. Physical computers, which were designed to replace female "computers," were now explicitly marketed as a substitute for women's work and without the distractions that women presented in the workplace. A series of ads by Recognition Equipment Incorporated in the 1960s proclaimed, "Our optical reader can do anything your keypunch operators do. (Well, almost.)"[30] Each ad then recited a presumably annoying skill of female keypunch operators that the optical reader lacked, such as taking maternity leave, suffering from morning sickness, getting mad and making silly mistakes, pouting for days or crying, or being a social butterfly.[31]

WOMEN AS SIDELINED INNOVATORS AND EXCLUDED INVENTORS

In interviews conducted by Janet Abbate for her book *Recoding Gender*[32] and, more recently, by Kathryn Kleiman,[33] the story of early women computer programmers is starting to see the light of day. However, a search of the patent records for the names of these women programming pioneers reveals a puzzling fact: none of them have a patent to her name to recognize her contributions. The patent often recognized as the first patent for a computer program was granted in 1968 to a man.[34] Over the last thirty years, the number of patents granted yearly to inventors working in computer software ranged from thirty thousand to over two hundred thousand.[35] Why were those women innovators not similarly recognized as inventors?

It wasn't because patenting considerations were absent from the programmers' working environment. John Presper Eckert and John W. Mauchly, who have been credited with inventing the ENIAC, applied for a patent for a numerical integrator and computer in 1947.[36] After the patent was finally granted in 1964,[37] Sperry Rand Univac, the assignee of the patent, charged a 1.5 percent royalty on every electronic computer sold in the United States.[38] Several people resigned from the ENIAC project due to disputes over patent rights.[39]

Rather, the inventing was deemed complete once the computer hardware was developed. As John Eckert was quoted claiming, "[John] Mauchly and I achieved a complete workable computer system."[40] No mention was made of the software and the many women who developed it.

In those early days of computing, a clear line divided attitudes about the development of computer hardware versus the development of computer software. The

development of hardware was considered inventive enough to warrant a patent, while computer programming, or the development of software, was not. It's possible that this difference in perception was due to the different activities themselves. Perhaps it was easier to conceive of a machine rather than a series of steps as an invention. But the history of computer programming shows that the gender of the people doing the work also influenced that assessment.

When computer programmers were principally women, they were not perceived as inventors. The women who were programming the ENIAC were simply continuing the task of calculating trajectories, now with the technology made possible by the innovation of brilliant men. Photos of the women "programming" the ENIAC depict them standing in front of hundreds of cables resembling an old-time telephone switchboard, programming the computer by plugging and unplugging the cables to alter its functionality.[41] The similarity of the ENIAC's wires and plugs to a telephone switchboard may have made the programmers seem like familiar women telephone operators. Even authors of current feminist retellings of computer history refer to the early programmers of ENIAC as "operators" of the machine.[42] Despite the incredible innovation that was required to develop the logic behind the steps of the calculations and devise ways to program, use, and debug it, the women programmers appeared to be merely operating the "switchboard" of the ENIAC.

Later, as the makeup of computer programmers became more masculine, computer programming took on a different gloss. As described earlier, computer programmers became software engineers tasked with creating rather than merely operating. In addition, the United States Department of Justice began an investigation into whether IBM was committing antitrust violations by selling hardware and software as a "bundled" single product. In 1969, in an attempt to foreclose an antitrust lawsuit against it, IBM announced that it would unbundle software from hardware thus creating a market for computer programs separate from the computer hardware in which they were incorporated. Lawyers and their clients pursued patent protection for computer programs in order to protect their value in the marketplace.

Patent law in the context of computers reflected earlier notions about the primacy of hardware. In the mid-1960s, the Patent Office's guidelines were largely interpreted to exclude computer programs from patentable subject matter because they were either "abstract concepts" or "mental processes." Only when programs were viewed as closely tied to a machine were courts willing to see them as patentable subject matter. In 1969, the US Court of Customs and Patent Appeals, which preceded the Federal Circuit, held that a specialized computer created by programming a general purpose computer was patentable but the computer program itself was not.[43] In response, patents seeking protection for the substance of a computer program were carefully crafted to claim the invention of a machine (in practice, a physical computer together with software) that carried out a particular

process. In Gottschalk v. Benson, the first Supreme Court case addressing the patentability of computer programs, the justices focused on whether the program was part of the machine. In oral argument, they repeatedly asked whether the programmed computer was the same or a different machine from the computer before it was programmed.[44] They challenged the assertion that the computer program for which the respondent claimed patent rights should be considered part of the physical computer. Ultimately, the Court sided with the government, which argued that the program was completely separate from the computer, and invalidated the patent. Subsequent Supreme Court cases have been interpreted as either expanding or contracting the patentability of computer programs, but in order to increase the likelihood that their patents will be upheld by a court, patent attorneys today still include some hardware component when writing patents that cover computer programs.

Courts interpreting patent law in the context of computers singled out "technology" as deserving of patent protection. In Application of Musgrave, a case decided in 1970, the US Court of Customs and Patent Appeals considered whether a process is subject matter that can be patented and decided that a sequence of steps was the appropriate subject matter for a patent as long as "it be in the technological arts."[45] Scholars have also argued that patentable inventions should be limited to those that "involve technological contributions" to guard against "render[ing] all human endeavors subject to patenting."[46]

Patent law's requirement that inventive activity must relate to the machine or "technology" made patent lawyers, scholars, and judges party to the agenda of those who sought to professionalize computer programming in the '60s and '70s. Rather than being viewed as simply the use of a machine, programming had to be part of the machine. Only then would it be viewed as creative and innovative (as well as a respected profession). As they argued for the patentability of computer programs, they reinforced the idea that only constructing something that was a part of the machine was inventive. If the machine, or "hardware," is the important contribution, then to be patentable, programming must be a part of that machine. A program, they argued, in its "soft form" was nothing less than instant hardware.[47] Those seeking patents for computer programs also argued that those programs related to "technology," making them more likely to be viewed as the innovation that society values enough to reward with a patent.

Participants in the patent system were quite successful in arguing that computer programming should cross the threshold into machinery, technology, and invention. But when that happened, women were left standing at the door. In asserting that computer programming is part of the machine and related to "technology," participants in the patent system reinforced arguments made by the Association for Computing Machinery (ACM) and other professional organizations and university departments who advocated for treating computer programming as a more technical, and more masculine, occupation. As the perception of computer

programming shifted from simply using or operating the machinery of the computer to inventing technology, it was no longer women's work.

COMPENSATING FOR GENDERED ASSESSMENTS OF INNOVATION

Starting in the 1960s, "the problems associated with exploiting fully the potentialities of present and projected computers" were now "difficult and intellectually challenging."[48] The solutions were innovative and creative. They were inventions, and the inventors were male. A 2019 report by the United States Patent and Trademark Office, which provided information inferred from the assumed gender of inventors' names, found that the percentage of patents by either an individual woman inventor or a team of all-women inventors was about 4 percent and has shown little growth since 1976.[49] A 2012 study found that only 1.9 percent of information technology patents listed a woman as sole inventor.[50]

Suggested causes range from the lack of women in senior positions to the particular scientific occupations women pursue to a lack of resources to access the patent system.[51] But the history of computer programming and patents suggests that there is another explanation behind the dearth of patents granted to women in information technology—something an individual inventor can do very little to counteract. Activities performed by women were seen as less innovative and less related to technology and therefore less deserving of patent protection. In addition, patents were only granted to computer programmers once an economic market existed for computer programming. But, as soon as that market was established, women were forced out. Rather than an accurate measure of innovation, patents were part of the system that rewarded the participants, now mostly men, in that market. If the history of computing is representative, these current day patent statistics hide the rich history of women's contributions to innovation, and invoking patents to measure innovation continues to devalue women's innovation.

Computer programming provides a unique case study to examine these attitudes as a single technological field in which patenting once languished when it was predominantly female and later boomed when it became predominantly male. The history of patents and computer programs challenges the notion that the innovative activities of women determine the number of patents they are granted. Efforts to address the gender imbalance in patenting, including the recommendations of the Success Act Report written by the Patent Office focus on resources to assist women in accessing the patent system to increase gender diversity in innovation. Is this the right tactic? Perhaps rather than focusing on levers to increase the likelihood that women will do more to increase patent activity: do more to educate themselves about the patent system, do more to utilize pro bono services to file patent applications, do more innovating; we should be educating men at the Patent Office about women's abilities.

Or should we decouple perceptions of innovation from patenting entirely? If patent protection depends in part on the gender of the person doing the work, are patents even the right tool to measure innovation? Patents are not gender neutral instruments but rather reflect the value that society places—or doesn't place—on women's work. If women do not obtain patents, their contributions are not recognized.[52] While it is important to advocate for space and opportunity for women within the current organizational structure of knowledge production and ownership, a critical evaluation of those structures through a feminist lens shows that rather than measuring innovation, the patent system more accurately measures the value our society places on certain activity—with sexist results.

The view of women's work as less valuable continues today even among different types of computer programming. Women have made some headway in participation in front end programming, but salary in that area tends to be lower than other areas of computer programming.[53] A wage discrimination suit against Google, LLC, alleges that female "Program Managers" are paid less than male "Technical Program Managers" despite performing equal work,[54] and that women are channeled into lower paying roles in the Operations family rather than higher paying roles in the Engineering family.[55] The situation of women of color, particularly non-Asian women, is even worse. Google's recent diversity report acknowledges that gains in women's representation in its workforce have largely been driven by increases in the representation of White and Asian women,[56] and Black women represent only 2.3 percent of Google's workforce in 2022.[57] This recent data makes clear that at least one legacy of the ENIAC programmers lives on. As Miriam Posner, professor of computer science, put it, the industry simply regards anything being done by a woman as easy.[58]

NOTES

1. Rhaina Cohen, *What Programming's Past Reveals about Today's Gender-Pay Gap*, The Atlantic (Sept. 7, 2016), https://www.theatlantic.com/business/archive/2016/09/what-programmings-past-reveals-about-todays-gender-pay-gap/498797/.

2. Catherine Ashcraft & Anthony Breitzman, National Center for Women & Information Technology, Who Invents IT? Women's Participation in Information Technology, 2012 Update 3 (2012) [hereinafter Who Invents IT?], https://rdw.rowan.edu/cgi/viewcontent.cgi?article=1005&context=csm_facpub.

3. 35 U.S.C. § 101.

4. 35 U.S.C. § 100(f).

5. The Federal Circuit Court of Appeals has held that "a particular type of connectionist artificial intelligence" computer program known as a "Creativity Machine" cannot be an inventor. Thaler v. Vidal, 43 F.4th 1207, 1209 (Fed. Cir 2022).

6. Adele K. Goldstine, Electronic Numerical Integrator and Computer (ENIAC): ENIAC Technical Manual (1946).

7. Herman Goldstine, The Computer from Pascal to Von Neumann 330 (1972).

8. W. Barkely Fritz, *The Women of the ENIAC*, 18 IEEE Annals Hist. Computing 13, 13 (1996).

9. Sarah McLennan & Mary Gainer, *When the Computer Wore a Skirt: Langley's Computers, 1935–1970*, 29 NASA Hist. Program Off. News & Notes 25 (2012), https://history.nasa.gov/nltr29-1.pdf.

10. Clive Thompson, *The Gendered History of Human Computers*, Smithsonian (June 2019), https://www.smithsonianmag.com/science-nature/history-human-computers-180972202/; *see also* Mar Hicks, Programmed Inequality (2017).

11. Janet Abbate, Recoding Gender × (2012) (hereinafter Recoding Gender).

12. H. Goldstein, see *supra* note 7, 229–30.

13. *A Short History of Women at Los Alamos*, Los Alamos Nat'l Lab'y (Mar. 22, 2018), https://trace.tennessee.edu/cgi/viewcontent.cgi?article=1163&context=ijns.

14. Bernard D. Holbrook & W. Stanley Brown, Bell Laboratories, Computing Science Technical Report No. 99: A History of Computing Research at Bell Laboratories (1937–1975) 9 (1982), https://research.swtch.com/cstr99.pdf.

15. Sarah Witman, *The Unheralded Contributions of Klara Dan von Neuwmann*, Smithsonian (June 16, 2017), https://www.smithsonianmag.com/science-nature/meet-computer-scientist-you-should-thank-your-phone-weather-app-180963716/.

16. Abbate, *supra* note 11, at 1.

17. *Id.*, at 43.

18. *Id.*, at 44–64.

19. Maureen Epstein, *Computer Women*, in Recoding Gender, *supra* note 11, at 67.

20. *Consuming Women, Liberating Women: Women and Advertising in the Mid 20th Century*, Duke Univ. (2019), https://sites.duke.edu/womenandadvertising/exhibits/tech-ads-and-women/advertisements-for-technology/.

21. Nathan Ensmenger, *"Beards, Sandals, and Other Signs of Rugged Individualism": Masculine Culture with the Computing Professions*, Osiris (2015), at 52.

22. Janet Abbate, *From Handmaiden to "Proper Intellectual Discipline": Creating a Scientific Identity for Computer Science in 1960s America*, in Communities of Computing, Computer Science and Society in the ACM 31–32 (Thomas J. Misa, ed., 2017) [hereinafter *Handmaiden*].

23. *Id.*, at 43.

24. *Id.*, at 45.

25. Ensmenger, *supra* note 21. at 65.

26. *Id.*, at 38.

27. Mar Hicks, *Meritocracy and Feminization in Conflict: Computerization in the British Government*, in Gender Codes: Why Women Are Leaving Computing (Thomas Misa, ed., 2010), 95–114.

28. Nathan Ensmenger, The Computer Boys Take Over Computers, Programmers, and the Politics of Technical Expertise 239–40 (2010). A later article extends Ensmenger's work and concludes that "beginning in 1975, new editorial attention to the issues faced by women in the field replaced the open misogyny of a few years before." Although the author notes this interest diminished by the 1980s. William F. Vogel, *The Spitting Image of a Woman Programmer": Changing Portrayals of Women in the American Computing Industry, 1958–1985*, 39 IIEE Annals Hist. Computing 49 (2017).

29. Liana Christin Landivar, *American Community Survey Reports, Disparities in STEM Employment by Sex, Race, and Hispanic Origin*, US Census (2013), https://www.census.gov/library/publications/2013/acs/acs-24.html.

30. Nathan Ensmenger, Slides from *Making Programming Masculine: A Gendered History of the Computing Professions Presentation at Stanford University* (Mar. 3, 2011), 64–66, https://homes.luddy.indiana.edu/nensmeng/files/stanford-gender.pdf.

31. *Id.*

32. Abbate, *supra* note 11 at 177–78.

33. *See* Kathryn Kleiman, Proving Ground: The Untold Story of the Six Women Who Programmed the World's First Modern Computer (2022).

34. Gene Quinn, *The History of Software Patents in the United States*, IP WATCHDOG (Nov. 30, 2014), https://ipwatchdog.com/2014/11/30/the-history-of-software-patents-in-the-united-states/id=52256/.

35. Raymond Millien, *Seven Years After Alice, 63.2% of the Patents Granted in 2020 Were Software-Related*, IP WATCHDOG (Mar. 17, 2021), https://ipwatchdog.com/2021/03/17/seven-years-after-alice-63-2-of-the-u-s-patents-issued-in-2020-were-software-related/id=130978/.

36. U.S. Patent App. No. 757158.

37. U.S. Patent No. 3120606.

38. International Business Machines was the only firm exempt from royalty payments due to a cross-licensing agreement between the two companies. The patent was later invalidated by a court because, among other reasons, the invention was derived from work by Dr. John Vincent Atanasoff and the invention was disclosed by John von Neumann too early before the patent application was filed. The decision by the court discussing who among these men invented the electronic computer was over 248 pages long and was preceded by six years of litigation with over thirty thousand exhibits and thousands of pages of deposition testimony. Despite the outcome of the litigation, President Lyndon B. Johnson awarded Eckert and Mauchly the US National Medal of Science for inventing the computer.

39. Nancy Stern, *The Eckert-Mauchly Computers: Conceptual Triumphs, Commercial Tribulations*, 2 TECH. AND CULTURE 569, 571 (1982).

40. J. Presper Eckert, *Co-Inventor of Early Computer, Dies at 76*, NEW YORK TIMES (June 7, 1995); Eckert's obituary is a particularly blatant example of the erasure of both the women "computers" who calculated ballistics trajectories before the ENIAC and the programmers who were critical contributors to the ENIAC's success. According to the obituary, "artillery officers" labored over the calculations, and "ENIAC" was the solution to the problem.

41. *Id*.

42. Abbate, *supra* note 11, at 13 ("Both [Colossus and ENIAC] made important technical advances, both influenced the development of computers after the war, and both employed teams of women to operate the machines").

43. *In re Prater*, 415 F.2d 1393, 1395 (U.S. C.C.P.A. 1969).

44. Gottschalk v. Benson, 409 U.S. 63 (1972), https://www.oyez.org/cases/1972/71-485.

45. Application of Musgrave, 431 F.2d 882 (U.S. C.C.P.A. 1970). As Judge Baldwin points out in his concurrence, this requirement may generate the new problem of "interpreting the meaning of 'technological arts.'"

46. David J. Kappos, John R. Thomas & Randall J Bluestone, *A Technological Contribution Requirement for Patentable Subject Matter: Supreme Court Precedent and Policy*, 6 NW. J. OF TECH. & INTELL. PROP. 152, 153 (2008).

47. Irving Kayton, *Patent Protectability of Software: Background and Current Law*, 9 JURIMETRICS JOURNAL 127, 134 (1969); L. Smilow, *Comments on Computers-in-Law Institute's First Annual Conference*, 50 J. PAT. OFF. SOC'Y 779 (1968).

48. *Handmaiden, supra* note 22, at 38.

49. US Patent & Trademark Off., REPORT TO CONGRESS PURSUANT TO P.L. 115–273, THE SUCCESS ACT (2019), https://www.uspto.gov/sites/default/files/documents/USPTOSuccessAct.pdf.

50. WHO INVENTS IT?, *supra* note 2, at 10.

51. Women are similarly underrepresented as attorneys and agents licensed to practice in the Patent Office. There are more patent practitioners named Michael than racially diverse women. Elaine Spector & LaTia Brand, *Diversity in Patent Law: A Data Analysis of Diversity in the Patent Practice by Technology Background and Region*, 13 LANDSLIDE 1 (2020), https://www.americanbar.org/groups/intellectual_property_law/publications/landslide/2020-21/september-october/diversity-patent-law-data-analysis-diversity-patent-practice-technology-background-region/.

52. Lost Women of Science Podcast put out a request for anyone who knows early computer pioneers. *See* https://lostwomenofscience.org/season-2.

53. The Bureau of Labor Statistics lists the average salary for software developers (designers of computer applications or programs) as $109,020. The average salary for web developers (developers, creators, and testers of website or interface layout, functions, and navigation) is $78,300. US Bureau of Labor Statistics, Occupational Outlook Handbook, https://www.bls.gov/ooh/computer-and-information-technology/web-developers.htm (accessed Sept. 21, 2022).

54. First Amended Complaint at 12, *Ellis v. Google, LLC*, Case No. CGC-17–561299 (Cal. Super. 2017).

55. *Id.*, at 15.

56. Google Diversity Annual Report 2018 11 (2018).

57. Google Diversity Annual Report 2022 34 (2022).

58. Thompson, *supra* note 10.