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Programmed Inequality

Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing.
By Marie Hicks. London, U.K.: M.I.T. Press, 2017, 239 pages.

Our awareness and understanding of the key role that women played in codebreaking and computing efforts during World War II has grown significantly over the last decade. While some stories, like that of pioneer computer programmer Grace Murray Hopper, have been known for some time, a more extensive story of women's impact has been painted in the last five to ten years by documentaries

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like *Top Secret Rosies: The Female "Computers" of WWI* (1), popular movies such as *The Imitation Game* (2), and books, including Margot Shetterly's recent *Hidden Figures* (3). Marie Hicks' book, *Programmed Inequality* adds to this narrative by telling the story of the

critical role that women "computers" played in Britain from World War II through the 1970s. However, Hicks seeks to go farther, recording not only the impact of women on the rise (and fall) of the computing industry in the U.K., but showing how the fortunes (or more accurately, the lack thereof) of women in the computing workforce were intertwined with Britain's inability to capitalize on the worldwide lead they enjoyed in computing at the end of WWII. Hicks also argues that this story is relevant today, given burgeoning U.S. computing workforce needs, positioned against the shortage of qualified computing workers. Indeed, like Britain, the U.S. worker shortage is exacerbated by the outmigration of women from the computing workforce that started at the end of WWII and accelerated in the early 2000s with the rise of the computing gamer culture (4).

How does Hicks's story go? Starting in the late 1800s, human "computers" (the term was originally coined to describe *women who did mathematical computations by hand*), were employed to support weather applications and astronomical research. Their calculations were done by hand and, later, with the aid of a series of desktop (electro)-mechanical machines (the predecessors of what we today think of as "computers"). Computing was actually viewed as a viable career path in the late 1800 and early 1900s for young women who showed mathematical talent. Around the 1920s in the U.S., the number of women entering college had grown to the point that people feared there would soon be too few slots for men, so a quota system was implemented to keep women out of fields like mathematics and science. But computing with the aid of desktop machines, even large floor-standing models like the IBM tabulator, were viewed as "secretarial work" — low-skilled, rote, minimally-valued. Therefore computing continued to be considered suitable work for women into the 1930s. Even the manufacture of computing machines at IBM in Britain was dominated by female employees, so much so that IBM measured its production in the U.K. in "girl hours," instead of the more common "man hours" until the 1960's. Layered on all of this was the gendered expectation that women's primary goal in life was to marry and have children. Working was a temporary diversion for young women in their late teens, early twenties. When women married, they were expected to drop out of the workforce. After all, their

husbands should be able to financially support them. A workforce culture built on these assumptions meant that women's pay was kept low and opportunities for promotion or positions in management were all but non-existent.

World War II dramatically challenged the artificial rules about the suitability of women in the workplace. With vast sectors of male workers siphoned off to the military by the draft, countries like Britain had no choice but to open the doors of the workplace to women. Hicks notes that by 1942, Britain was relying so heavily on women in the workforce that it was forced to open up all jobs to women, including the heretofore male bastions of engineering and welding. While employers surprisingly found women perfectly capable of doing such work, they still treated only the most talented women equal to their average male counterpart. Yet industries in the U.K. went so far as to reorganize how work was done and how training took place, in order to make it easier for women to participate. After all, as Hicks points out, 1.1 million women (80% of single women 41% of wives and widows, 13% of mothers with children under 14) were hired in 1942 in the British armed forces and munitions industries alone. The numbers only increased as the war dragged on.

Over 10 000 women worked at the famous Bletchley Park, mostly young, single, white, and middle class. These women worked on decoding German communications, much of it using British Colossus computers. The Colossus preceded the creation of the U.S. ENIAC computer at the University of Pennsylvania, which means Britain led the world in the development of the modern computer. Despite the centrality of their work to the war efforts, women at Bletchley Park were not promoted into positions that reflected their newfound skills,

the type of work they performed, or their future potential. Even severe wartime manpower shortages were not enough to completely override the gendered work culture in the U.K. Underage and inexperienced teenage boys, for example, were recruited and trained to be maintenance engineers for the computers at Bletchley, bypassing the older, experienced women. Indeed, the overarching message of Hicks' book is the length to which Britain went to maintain its gendered work rules and culture, no matter how damaging the consequences. Hicks illustrates how these same gendered rules were one of the key sources of the country's computing workforce woes in the latter half of the 20th century.

The complete secrecy — long after hostilities ended — of wartime activities at Bletchley Park and similar installations in both Britain and the U.S. meant that the accomplishments and skills of women in the wartime computing effort were never acknowledged or made public. This fueled for many more decades the faux storyline that women were not interested in, nor capable of performing computing and related technical tasks. At the end of WWII, only several hundred of the thousands of women at Bletchley were allowed to transition over to the then-coveted government Civil Service computing jobs, the first of what would grow to be Britain's enormous postwar, largely female computing workforce. At odds with reality, however, the women's computing work inside the Civil Service system was regarded as low level and subordinate to the "real work," instead of squarely at the core, of postwar computing. The roles women were allowed to fill were seen as separate and beneath the work in which their male cowork-

ers engaged. Consequently, the Civil Service system in Britain was, for decades, among the worst perpetuators of the unequal categorization of men's and women's computing work. Campaigns for equal pay and other opportunities for women arose time and again in postwar Britain, yet the country repeatedly managed to dodge any real change. Between the end of WWII and 1946, married women were prohibited outright from working in Civil Service jobs (due to the so-called "marriage

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bar"), even though other industries began to relax such rules since they had been ignored during the WWII. The 1946 Equal Pay Report removed the marriage bar, yet still assumed that the number of women in the workforce would be inconsequential and only allowed under certain restrictive circumstances, certainly not a key part the nation's postwar economy. Because women in Britain had few opportunities for advancement or interesting work after WWII, many who had worked during the war years left the workforce voluntarily after they married.

After repeal of the marriage bar in 1946, the British Civil Service created a substandard system called "machine grades" for women's computing work, in a deliberate effort to limit women's pay and advancement opportunities. Women's work still largely consisted of working with machines, perpetually viewed as low-skilled secretarial work and therefore

appropriate for women but beneath men. The "machine grades" succeeded in devaluing women's work, pay, and computing careers in the U.K. for decades. The creation of the "machine grades" also successfully convinced the British people that computing was a low-level occupation that required no real education or skills. By the time the British government realized that computing was revolutionizing how work was done in the latter part of the 20th century, it was too late. No one believed the new government propaganda that computing was a high-level job offering a lifetime of career opportunities.

After WWII, the British government took over about one-fifth of the country's private industries and continued to enforce wartime practices such as rationing. The socialist agenda of the British government during the post-WWII period did not encompass equal pay for women. Although this issue was revisited

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multiple times in the ensuing years, the perpetual argument was twofold. First women did not need to make as much as men (who had to support a family). After all, a single woman only had to take care of herself and a married woman had her husband's salary on which she could rely. The second argument against equal pay was that the government could not afford to pay women the same salaries that they paid men.

Neither of these arguments was accurate. Many families needed the extra income that a working woman provided. In fact, Hicks points out that the government spent far more than needed to fund equal pay for women on social programs aimed at accomplishing the same results that equal pay would have achieved. The British Civil Service worked to implement major cost reductions during this time, but believed that keeping inflation in check could be accomplished by hiring cheaper women workers and by transferring much of their work from humans to computers. Therefore, Britain was vested in keeping women's pay artificially low as a matter of national economic policy and they devoted enormous resources over several decades toward that goal. Britain failed to foresee that their computing needs, in terms of both equipment and trained workers, would mushroom and consequently so would the financial resources required to maintain them. In the end, neither artificially depressing women's wages nor relying on computers as a cost reduction measure was a viable economic strategy.

In the 1960s and 1970s the British government sought to rebuild its wartime dominance in the computing sector to restore its position as a global power. As noted above, this plan necessitated a gender power shift in computing, from viewing computing as low-wage, unskilled secretarial, or "machine grade" work performed by women, to seeing it as high pay and prestigious work performed by men. In Britain's effort to rebrand computing as "high value men's work" they booted out their qualified and experienced workforce of women and tried to replace them with inex-

perienced and largely uninterested men. The fact that the government's efforts here were a flop necessitated increasing government micromanagement of the private British computing industry. Their inability to attract a sufficiently large male computing workforce (and, of course, now that computing was important work, women could no longer be allowed to engage in it) meant that Britain's enormous Civil Service sector needed powerful supercomputers that could be "controlled" by a small number of high level, trained male executives. Note that this obsession with supercomputers took place while the rest of the world was focused on the emergence of the personal computer or PC. But the British government insisted on dictating the future direction of the U.K.'s computing industries, shoring them up with government funds and eventually forcing a merger into a single computing company capable of designing and building the colossal supercomputers to run the country. Hicks meticulously details the story of Britain's intertwined desire for world power status in computing with its economic woes as well as its stubborn adherence to a strongly gendered workplace. She also demonstrates why this approach caused Britain to fail, sealing the demise of both its reemergence as a world power and its dominance of worldwide computing. Instead of being a fix for Britain's economic and political power woes, computing and the changes it ushered in simply exacerbated the inherent problems embedded in both systems. Only in the late 1980s did the British government finally engage in efforts to specifically recruit women into formerly male computing jobs. They hoped to alleviate the decades-long computing worker shortages and outflow of even minimally trained men to the more lucrative private sector. Yet

these efforts to re-engage women in the British computing workforce failed by the end of the 1980's and never recovered. This loss of what once was an enormous female Civil Service computing workforce finally succumbed to decades of intentional discrimination.

How is this story relevant today? Hicks rightly notes that the number of college-aged women pursuing a career in computing has plummeted in the last 15 years in the U.S. [4]. But the problems start long before women get to college. By the time U.S. children are in second grade, research shows that they all know math is for boys and reading is for girls. By the time children reach high school, boys outnumber girls a stunning four-to-one among Advanced Placement or AP Computer Science test takers. In 2014 three U.S. states (Mississippi, Montana, and Wyoming) had zero girls take (not pass, just take) the AP Computer Science exam. Zero [4]. Efforts to attract girls to computing starting in elementary school in the U.S. are numerous to be sure, from coding organizations girls like Girls Who Code and Black Girls Code to recognition efforts such as NCWIT Aspiration Awards programs to K12 robot competitions like FIRST and Vex Robotics. It will be some time before we can truly assess the long-term impact of such efforts. Programs to recruit and retain college women in computing-related majors have been around for decades, as well. There are some success stories at institutions such as Harvey Mudd College, where more than half of the computer science graduates in 2016 were women [5], but these stories are the exception, not the rule. Computer science programs in college rank among the lowest in terms of percentage of women majors, often hovering not far above the single digits. Like postwar Britain, the computing workforce needs in the U.S. are huge and growing rapidly, with an estimated 1 million more computing jobs than qualified applicants by 2020 [6]. Combine all of this with the fact that women now outnumber men in college two-to-one [7], and it's not hard to see that U.S. is already riding a tsunami fueled by the shortage of qualified computing workers. It's just that the bulk of the water hasn't obliterated the shoreline ... yet. Given that the bachelor's degree college graduates of 2020 arrived on U.S. college campuses in fall of 2016, we will have to increasingly rely on alternate training, such as coding camps, two-year programs, retraining of older workers and, yes, successfully cracking our own gendered computing norms in the U.S., to survive. The country with the best trained and largest computing workforce will likely rule the world in the not-too-distant future. We daily see increasing threats and damage by hackers on critical industries and infrastructure dotting the daily news.

As a female professional who works hard to attract and retain women in STEM careers, I certainly hope that we can pull it out in the end. But I am afraid that it is already too late and Hicks' warning will simply go unheeded. Because, like postwar Britain, our cultural gender norms about who can and wants to do computing in the U.S. have actually grown more restrictive over the decades (just look back at those AP Computer Science test takers!), hurling us in the opposite direction of where we need to go, driving women away from computing fields at the very time we desperately need to be drawing throngs of

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women toward careers in computing with open arms.

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References

(1) L. Erickson, *Top Secret Rosies: The Female "Computers" of WII*. PBS (Film), 2010.
(2) M. Tyldum, *The Imitation Game*. The Weinstein Company (Film), 2014.
(3) M. Shetterly, *Hidden Figures: The American Dream and the Untold Story of the Black Women Who Helped Win the Space Race*. New York, NY: William Morrow, 2016.
(4) "The current state of women in computer science," *computerscience.org*; http://www.computerscience.org/resources/women-in-computer-science/, accessed July 9, 2017.
(5) M. O'Sullivan, "Women thriving in computer science at California college," *Silicon Valley & Technology, Voice of America*, Feb. 5, 2017.
(6) J. Swartz, "Businesses say they just can't find the right tech workers," *USA Today*, May 9, 2017.
(7) M. Whaley, Men saying "no thanks" to college," *Denver Post*, June 5, 2017.