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WOMEN, GENDER AND COMPUTING

ISSN 3043-095X

ISBN 978-3-906817-14-9

DOI: 10.13098/infoclio.ch-lb-0010

Publication date: 2023

This anthology explores the role of women in computing through the representations, imaginaries and realities attached to the relationship between gender and computing, and it analyzes how these issues have evolved from the 1940s to the present day.

The academic resource that opens the first part of this anthology, a [keynote](#) held by Janet Abbate at the 2021 "Women in Science and Engineering Meeting", sets out from the start the issues that challenge our subject. The historian looks back at the decline of women's presence in the field of computer science from the 1980s onwards and relates gender issues to the evolution of computer science. The choice to open this anthology with Janet Abbate was also motivated by the role she has played in the reflection on these issues for several years. Particularly, in 2001 she conducted a series of oral interviews with women invested in computing (see the interview with Elsie Shutt, but also the [Charles Babbage Institute's](#) rich collection on the subject), and in 2012 she published the book *Recoding Gender. Women's Changing Participation in Computing*¹, two years after another seminal book on the topic, edited by Tom Misa, *Gender Codes, Why women are leaving computing*². We should also mention her recent participation in two books that broaden the reflection: *Your Computer is on Fire*³, which questions the inequalities, asymmetries, marginalizations and biases at work in technological systems, and *Abstractions and Embodiments*⁴, which she co-edited with Stephanie Dick and that questions practices and physical experiences in computing. From the able-bodied at work to the aging or disabled body, from the invisible body to the racialized body, this approach to the computer in society obviously has a strong gendered and intersectional dimension. It is this gendered dimension, which is obvious in representations, professions, uses, programs, and algorithms, that this Living book seeks to present.

Thinking about the relationship between women, gender and computer science cannot focus exclusively on valuing the - very real - contributions of women to computer science and bringing them out of an invisibility that has become more relative in view of recent works

devoted to the topic. The challenge is also to better understand the evolution that has led to the current situation, characterized by the disaffection of women from computer science studies and professions. This unprecedented evolution presents a striking contrast with an [article published in 1967](#) in *Cosmopolitan* magazine, which was enthusiastic about the numerous opportunities offered to women in the computing field. Above all, this evolution is not without consequences on the digital uses and online content. Finally, we must also ask ourselves what the history of women in computing tells us about computing itself: "*namely, what has the history of women in computing had to say about computing*", as Nathan Ensmenger has pointed out⁵.

Computing is a complex object to grasp, as it has evolved from the 1940s to today. From punched cards ([INA, 1960](#)), human computers and big computers on which the ENIAC Girls worked in the post-war period to mini and then micro-computers from the 1980s onwards, computing is both a science and an industry in rapid evolution. Moreover, these evolutions also influence the practices.

The choice of this anthology was to consider not only the gendered relations within computer science studies and the related professions, but also the uses that develop around computers, their democratization and their networking.

In disciplinary terms, this Living book mixes historical, communicational, sociological, and anthropological approaches. In terms of its geographical framework, this project has sought to move away from a vision centered solely on the United States to make room for analyses of European countries. Selected excerpts thus concern [Great Britain, Finland, West Germany](#) or [France](#). The approach covers work, practices, as well as uses, with the choice of considering both women and men experts, workers and users of IT. The intention is to go beyond the often limiting vision, [noted by Isabelle Collet](#), which associates the computer scientist with the programmer, and computer science with programming.

The issue is not only the place of women, but also that of gender relations and masculinity, in advertising and computer associations for example (see the example of the [National Machine Accounting Association](#) in this anthology), and *in fine* it is a question of understanding the evolution of the place of women as much as that of computing in our societies.

A collective achievement

This anthology was produced by a small group of students from the MAHEC (Master in Contemporary European History) at the University of Luxembourg, namely Merima Bahovic, Yan Kremer, Emily Griffin, Andrew Pfannkuche and Timo Wenzel, with the support of two PhD students (Matthias Höfer and Carmen Noguera).

The creation of the Living Book took place during the winter semester of 2022 (14 sessions of 1h30), in a collaborative work, prepared by a state of the art and a general presentation of the topic by the teachers over 5 sessions, with two interventions of specialists, Josiane Jouët and Fred Pailler, and specific insights, for example on the glass ceiling or the gendered uses in advertising.

The plan as well as the choice of sources was made by the students, who were however constrained to introduce a certain number of designated works by the teachers. The selection of sources also had to meet the constraints of accessibility and openness of the resources, and the students were instructed to try to vary the types of sources as well (films, advertisements, posters, web content, oral interviews, etc.). They were also asked to write the descriptions, which were reviewed as a group to harmonize the narrative. These moments of collective rereading allowed the introduction of the notion of *peer-review*.

This original pedagogical experience went through some trial and error at the beginning of the project when the students did not yet have a detailed knowledge of the literature. It is the structuring of the Living Book that posed the most difficulties for the group to reconcile the wishes of thematic and chronological approaches, or to choose between a narrative centered on computer science and digital technology or one more oriented towards the *longue durée* of information and communication technologies, including the telephone or the telegraph.

The choice of research texts, usually done in pairs and then discussed in groups, as well as the choice of sources, was then rather fluid, with difficulties relating more to the balance to be given between the parts and documents, or to the choice between several academic texts (for example for *Gamergate*) than to a lack of resources.

At the crossroads of the history of computer science and gender, but also of digital and public history, this Living Book has allowed for scientific learning and reading, and for the development of skills related to the analysis and criticism of sources, to scientific mediation, to digital publishing (openness, licenses, etc.).

A three-step structure

A chronological approach would have been possible, describing a so-called "golden age" in the 1960s and 1970s, followed by a shift in the 1980s and a current situation characterized by forms of empowerment and activism, online movements of expression (#MeToo from 2017 onwards), but also reinforced biases, for example in algorithms and artificial intelligence. This option has finally not been chosen, as ruptures and continuities run through the entire period studied (see the [glass ceiling encountered by Elsie Shutt or Steve Shirley](#) in the 1950s and 1960s, and which has still not disappeared today in some companies).

Therefore, we have chosen a different structure, intertwining past and present around three axes, each composed of a selection of historical sources accompanied by research texts: the question of the visibility and invisibilization of women in computing is addressed in [part 1](#); the question of users, both professional and domestic, and their relationship to technology, correlated to the representations, particularly advertising, is analyzed in [part 2](#); and finally the issue of controversies, activism and empowerment is at the heart of [part 3](#).

(In)visibility through time

The first part looks back at the invisibility and invisibilization of women. [Jennifer Light's article](#) sheds light on the way in which women's contribution to the development of computer science has been progressively minimized or even invisibilized. She enlightens the role of the six women who helped program ENIAC, the first American electronic computer, during the Second World War. Indeed, within "Project X" (the code name given by the *US Army* to ENIAC), the *ENIAC Girls* were entrusted with what the mathematicians and physicists Goldstine and von Neumann defined at the end of the 1940s as the "sixth task" of programming, i.e. coding. The other steps⁶ are reserved for men, who have a higher status within the organization. The programming of ENIAC was assimilated to clerical work, even if it required advanced mathematical skills; women were trained for several months in ballistic calculations.

Two distinct tasks were assumed by the women: they were human computers and six of them were programmers and trained to transfer information into the machine. As Nathan Ensmerger notes, there is no doubt that the work of the *ENIAC girls* was largely underestimated because they were women⁷. Their subordinate position, however, was also due to the fact that they worked in the field of software and not hardware, although the two were closely related. The work of programming was less recognized than that of *hardware*. Programming was considered a relatively trivial and mechanical activity; its recognition and its rise in status would then go through a masculinization to which the professional associations contributed. The issue of invisibility is also addressed by Giuditta Parolini in an article on the contributions of women in the work of the *Rothamsted Statistics Department*⁸. She focuses on the invisibility of 200 women who worked as computing assistants in the Rothamsted statistics department from the 1920s until 1990. At the same time, she examines how their tasks shifted alongside the evolution of computing technologies, going from human computers to data processors. No matter the change of functions, during all these years, they were rarely named in the reports of the scientific activity of the department. They had low salaries and an absence of career prospects. The author unveils several factors that contributed to their invisibility. First, there is a cultural component exemplified by the imaginary created by the British advertising, which represented computer operators as female, low-cost, and unskilled workforce. Second, there is a factor inherent to laboratory

practices, which is technicians' invisibility. Her case study demonstrates the intersectionality of these issues. Women's invisibility is as much about their status as women as it is about their status as "invisible technicians"⁹. This disqualification of women's tasks, which can be found in the articles by Jennifer Light, Nathan Ensmenger and Giuditta Paroloni, is also addressed in the paper by [Corinna Schlombs](#), who focuses on data entry on punch cards, a task mainly performed by women in West Germany from the 1950s to 1970s. She explores the motivations and working conditions of these women in the financial sector, while emphasizing the importance of their inclusion in the history of computing.

Female contributions to the history of computing have recently come out of the shadows thanks to individual or collective works, which highlight famous figures such as [Ada Lovelace](#), [Grace Hopper](#) or even [Margaret Hamilton](#) and pervaded into the general public. The 2015 celebration of the 200th anniversary of Ada Lovelace's birth marked a renewed interest in this singular figure. Ada Augusta Byron (1815-1852), daughter of Lord Byron, better known as Ada Lovelace, collaborated with Charles Babbage, a British mathematician and precursor of computer science, and has gone down in history as the "first female programmer in history" (not without controversy). Other examples include the release of the film *The Imitation Game* (adapted from the biography *Alan Turing: The Enigma* by Andrew Hodges), in which Keira Knightley plays the crypto analyst Joan Clarke (1917-1996), who contributed to the decoding of the Enigma machine used by the Germans, the series *Coded Investigations (The Bletchley Circle)*, which places the codebreakers of Bletchley Park during the Second World War at the center of its story, the film *Hidden Figures* (2016) and *Halt & Catch Fire*, which focuses on the arrival of personal computing in the 1980s and, [starting in season 2](#), features a start-up run by two women. That being said, as Thomas Haigh and Mark Priestley [point out](#), the emphasis on a few heroic figures also has its downside and should not hide the masculinization of the programming sector as a whole, or the gendered roles assigned to women and men. These are notably explicit in the video games that are mentioned in our three parts, from the sexualization of characters in games (see the [source](#) devoted to Dinosaur Planet) to *Gamergate*, via [the article](#) by Laine Nooney.

Users and gendered representations

The second part provides elements to understanding the decline in the number of women in the IT professions, which is evident in the statistics from the 1970s onwards. In her study on the case of Great Britain, Mar Hicks shows that in the aftermath of the Second World War, women were numerous in computing, with equal pay and chances of promotion as men. However, from the 1970s onwards, the doors closed for them, while there was a voluntary masculinization of the field¹⁰.

Advertising and its gendered representations, discussed extensively in an [article](#) by Mar Hicks, are also present in the Living Book via a selection of sources, including an [advertisement](#) for the Smith-Corona electric typewriter (1964-1965) and [another](#) from the 2000s for QSOL.com.

When the desktop computer was developed in the 1970s, it was initially in the lineage of typewriters, and was therefore perceived as an office machine, dedicated primarily to secretaries, to women¹¹. Lois Mandel's 1967 [article](#) in *Cosmopolitan* promoted the possible careers for "Computer Girls". Mandel emphasized the unlimited opportunities that were opening for women in the computer industry. According to her, the industry would not discriminate, women would be treated as equals to men and would have the same benefits as their male colleagues. The journalist used a quote from the computer scientist Grace Hopper¹² who explained that "programming is like planning a dinner party": you had to plan ahead, so that you had everything you need once you want to sit down at the table, and you had to have patience and the ability to pay attention to the smallest detail. Women would thus naturally have an aptitude for computer programming. Of course, these conclusions, which try to present women as having a natural aptitude for computer programming, are open to criticism, because they imply a form of naturalism, namely the idea that women have an innate aptitude for this or that job; an argument often used to characterize women's work.

Additional elements to explain the masculinization of the computing profession are provided by the [comparative analysis of Chantal Morley and Martina McDonell](#), as well as by [the more sociological analysis of Isabelle Collet](#). Since the 1980s, state measures, the role of professional associations, the evolution of the status of programmers, the development of personal computing and of geek culture have combined to produce gendered biases in the professions, representations and uses of computing.

Finally, the texts by [Laine Nooney](#), [Sherry Turkle](#) and [Safiya Noble](#) also raise intersectional issues, extending the question to the situation of black women, to the production and reception of content, and to the influence of algorithmic biases on the uses of users.

Empowerment, ownership, activism

Our third section examines the controversies, negotiations, and strategies that have been implemented over time to circumvent the glass ceiling, [the Matilda effect](#), or to deal with gender-based violence. The chapter discusses the online confrontations, sometimes violent, that emerged during the discussions around same-sex marriage and "gender theory" (a pejorative term) in France, or during *Gamergate*. The development by feminist movements of their own [online communication strategies](#) is also presented. This can be done through the use of humor or provocation, as in the case of the [hijacking of the Barbie album](#) or the actions of the [Guerilla Girls](#).

The heightened sensitivity to gender bias and violence, which was strongly expressed for example online at the time of the #MeToo movement, is now very visible in the media sphere. But if gender biases are regularly denounced, they have not disappeared from representations, as shown by several of our sources, especially the video-game ones.

Digital literacy activities and actions currently being implemented by some universities to make computer science majors more attractive and inclusive to women, or the fates of [Elsie Shutt](#) and [Stephanie Steve Shirley](#), as recounted in Janet Abbate's book *Recoding Gender*, illustrate how empowerment has also taken other creative forms. The book opens with a recollection of Elsie Shutt, who was surprised by the presence of male programmers in 1953 at Raytheon, where she was hired: "*It really amazed me that these men were programmers, because I thought it was women's work*¹³". Elsie Shutt founded *Computations, Incorporated* in 1958, a company that at first employed only freelance women programmers working from home. Another protagonist of the book, Stephanie Shirley, founded her own software company in Britain in 1962 at the age of 29, with the intention of taking economic, political, and social action. Faced with the glass ceiling and the impossibility of promotion on several occasions in her previous jobs, she used the name Steve Shirley, so that her potential clients would not know she was a woman until they met her face to face. She also focused on hiring women who want to work part-time and from home so they could continue to care for their children (a topic which is also addressed by [Corinna Schlombs](#) in her article). Her company quickly became a success: in 1965 it already had 65 employees, all women, before a decree intended to avoid discrimination in companies forced her to employ men! In 1986, 16% of its employees were men. In 2009, the company has 1000 employees spread over three countries: Great Britain, Denmark, and the Netherlands. It should be noted that the problem of employability of young mothers in Great Britain, which Stephanie Shirley's company is trying to address, is presented differently in Denmark, where the childcare infrastructure is much more developed, which recalls both the spatial and temporal nuances that run through our study.

It is all these nuances, beyond statistics or binary visions, sometimes even caricatural in advertising, that this Living Book invites us to explore. It allows us to plunge into the heart of the history of computing and to think about computing and digital technology in society, in a diachronic vision that sheds light on turning points, but also on certain continuities. If the state of research has made it possible to fully grasp the issue - and many other readings could have been proposed within the framework of this Living Book - if the actions of associations, universities, and those taken in certain companies are moving in the direction of greater inclusion, this is far from being the sole concern. As several texts and sources show, the issues of intersectionality are certain, in addition to those related to gender, and it goes far beyond the question of women, inviting us to think about the masculinities at work, as

well as the place of LGBTQIA+ communities. Considering the multiple issues related to social diversity, power asymmetries, digital divides (geographical but also internal to societies, seniors, minorities, etc.), participation, or societal responsibility is far from being a given, and a reflection on values, governance, creation within the digital world, its uses and its appropriations remains fully relevant.

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¹Abbate, Janet: Recoding Gender. Women's Changing Participation in Computing, Cambridge, Massachusetts 2012.

²Misa, Thomas J. (Hg.): Gender Codes: Why Women Are Leaving Computing, Hoboken, NJ. 2010.

³Mullaney, Thomas S.; Peters, Benjamin; Hicks, Mar u. a. (Hg.): Your computer is on fire, Cambridge, MA; London 2021.

⁴Abbate, Janet; Dick, Stephanie (Hg.): Abstractions and Embodiments. New Histories of Computing and Society, 2022.

⁵Ensmenger, Nathan: Making Programming Masculine, in: Misa, Thomas J. (Hg.): Gender Codes, Hoboken, NJ, USA 2010, S. 115–141. Online: <<https://homes.luddy.indiana.edu/nensmeng/files/Ensmenger2010-MPM.pdf>>, Stand: 26.01.2023.

⁶This involves mathematical conceptualization, algorithm selection, accuracy and approximation error analysis, determination of scaling factors so that the mathematical expression fits within the computational capabilities of the machine, and finally the analytical prediction of the computational work of the machine.

⁷Ensmenger, Nathan: Making Programming Masculine, in: Misa, Thomas J. (Hg.): Gender Codes, Hoboken, NJ, USA 2010, S. 122–123. Online: <<https://homes.luddy.indiana.edu/nensmeng/files/Ensmenger2010-MPM.pdf>>, Stand: 26.01.2023.:

"There is no question that the work of the ENIAC women was disregarded in large part simply because they were women. But almost as significant as their gender was their subordinate position as "software" workers in a hardware-oriented development project. Obviously the two are closely related. (...) In the status hierarchy of the ENIAC project, it was clearly the male computer engineers who were significant. The ENIAC women, the computer "programmers," as they would later be known, were expected to simply adapt the "plans of computation".

"There is no doubt that the work of the women of ENIAC was overlooked, largely simply because they were women. But their subordinate position as 'software' workers in a hardware-oriented development project was almost as important as their gender. Clearly, the two are closely related. (...) In the status hierarchy of the ENIAC project, it was clearly the male computer engineers who were most important. The women of the ENIAC, the "programmers", as they were later called, were simply to adapt the "calculation plans". (Our translation)

⁸Parolini, Giuditta: From Computing Girls to Data Processors. Women Assistants in the Rothamsted Statistics Department, in: Schafer, Valérie; Thierry, Benjamin G. (Hg.): Connecting Women. Women, Gender and ICT in Europe in the Nineteenth and Twentieth Century, Cham 2015 (History of Computing), S. 103–117.

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¹⁰Hicks, Marie: Programmed Inequality. How Britain Discarded Women Technologists and Lost Its Edge in Computing, Cambridge (Mass.) 2017.
(Marie Hicks changed her name to Mar Hicks).

¹¹ On the history of office workers, see: Gardey, Delphine: La dactylographe et l'expéditionnaire. Histoire des employés de bureau, 1890-1930, Paris 2002.

¹² Grace Hopper earned a doctorate in mathematics before turning to computers and joining the U.S. Navy in 1943. There she worked on the *Mark I*, *Univac*, IBM machines, invented the COBOL programming language, and worked on the Fortran language. An international technical conference, organized since 1994 by the *Anita Borg Institute for Women in Technology*, is named *Grace Hopper Celebration of Women in Computing* in her honor.

¹³ Abbate, Janet. 2012. *Op. Cit.* at 1.