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The power of code: women and the making of the digital world

Ulrike Klinger^a and Jakob Svensson^b

^aEuropean New School of Digital Studies, European University Viadrina, Frankfurt (Oder), Germany; ^bSchool of Arts & Communication, Malmö University, Malmö, Sweden

ABSTRACT

Most research on gender and digital communication centers on how women use digital media, how they participate online, or how they are treated in online forums and social media. This article, in contrast, approaches gender from a behind the screen perspective. How algorithms and platforms are created, designed, and maintained, the affordances they provide for users and how they govern the ways users communicate with each other, has a major impact on digital communication. However, it is mostly men who create these technologies. Our study approaches technologies as socio-cultural, departing from the concept of network media logic. Empirically, it is based on (1) the review of a diverse body of literature from the history of programming, professional sociology, and computer science and documents such as the diversity reports from tech giants, as well as on (2) 64 semi-structured expert interviews conducted with male and female programmers in seven countries over a time-period of four years. Results show that the gender gap continues to run deep. We report results in four dimensions: professional culture, pervasive stereotypes, lack of role models and typical career paths.

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1. Introduction

That tech has a gender diversity problem has been known for some time (see Wachter-Boettcher, 2017; Chang 2018). Still, as late as December 2020, Google employee and renowned AI researcher Timnit Gebru made public that the company had fired her for openly criticizing Google's insufficient efforts to increase minority hiring and worrying about the biases programmers are building into AI systems. A black woman herself, Gebru had shown in her research how facial recognition does not work well on non-white faces, joined Google to work on the Ethical AI team. Her case is just one more stone in the larger mosaic of an industry and profession that, while creating high-impact technologies like algorithms, search engines, social media platforms or AI, have a severe

CONTACT Ulrike Klinger  klinger@europa-uni.de  European New School of Digital Studies, European University Viadrina, Große Scharrnstraße 59, 15230 Frankfurt (Oder), Germany

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diversity problem. As Gebru points out: ‘They are not only failing to prioritize hiring more people from minority communities, they are quashing their voices.’¹

Feminist researchers, most prominently in the field of feminist technology studies (FTS), have approached the ‘women in technology problem’ as early as in the 1980s (Cockburn, 2009; Wajcman 2010). Since then, researchers have shown that digital divides in front of the screens, including gender divides, are quite persistent, moving from ‘access’ issues to differences in usage (Van Deursen & Van Dijk, 2014). Women write significantly fewer articles on Wikipedia (Hargittai & Shaw, 2015). Twitter users perceived as female are less visible on Twitter, ‘experiencing a glass ceiling’ (Nilizadeh et al., 2016, p. 289). For political journalists, Twitter is not equalizing, but making offline inequalities even worse (Usher et al. 2018). There is a gender gap in who is willing to discuss their political opinions online and on social media, affecting political discussion dynamics (Koc-Michalska et al., 2019). Analyzing career biography data from over one thousand staffers working in political tech in US election campaigns between 2004 and 2016, Kreiss et al. (2020) found that ‘women not only are lagging behind their male counterparts as practitioners in the field, they do not have access to the same leadership and decision-making positions or entrepreneurial opportunities as men’ (p. 51). Gender gaps in political communication are omnipresent, spanning phenomena as different as citizens ‘liking’ of populist parties on social media (Bobbà et al., 2018) to the ‘hijacking’ of feminist discourse such as #metoo by anti-feminist actors (Knüpfer et al., 2020).

The answer to the question why these gender gaps are so persistent most often refers to an offline ‘reality’ and a normalization of bias in society. With this article, we want to provide an additional explanation – extending the focus on norms behind the screens.

We will approach representation in tech through the perspective of the programmers themselves, the people behind the screens. Too often the focus is on what is happening in front of the screens and interfaces, between technology and end-users, citizens, voters. We argue that there is more to that – because behind the screens there is a gendered industry, struggling with diversity, equality and fair production of technology which pre-structures the ways in which we engage, interact, mobilize, participate through digital media. There is power in designing digital platforms and communication technologies. As Oudshoorn et al. (2002) underline, technical objects are inscribed with gender, and designers (programmers) are important in shaping the initial forms, functions, and meanings of objects. Gender gaps in using digital media do not start with people *using* the technology, but with the *making* of this technology.

It is intriguing how little we – tech outsiders in front of the screens – know about the people behind these systems that connected societies depend so much upon. As Ensmenger (2012) puts it: ‘We live in a society that has been so profoundly computerized that even the most basic human activities involve us in constant interactions with computers and computer-based technologies’ (p. 2). Many have therefore underlined the importance to study the people and cultures behind data and algorithms (e.g., Mansell, 2012). Rosenberg (2008) argued that people depend on software while the art of making it remains a mystery: ‘Never in the history of time have we depended so completely on a product that so few know’ (p. 9). While many have called for empirical studies on programmers and their culture, fewer have actually conducted such studies. Hence, this is where our contribution lies. There are exceptions, especially on hackers (see Graham, 2004; Levy, 1984) and famous geniuses (Isaacson, 2014). However, it is not the famous

‘innovators’, but rather those who produce software and code on a daily work basis, who shape the structures of the digitalized public sphere – and thus how communication relationships are created and maintained digitally. In other words, political and other communication are increasingly taking place on various digital platforms, that are shaped by those who design and engineer these platforms, the norms and logics that guide their work.

2. Current state of women in tech

Since the 1980s, women have been widely underrepresented in the tech industry. Kunda (2006) describes tech workers as a homogeneous group of white men in their late twenties to mid-thirties. It seems things haven’t changed much since he conducted his study in the 1980s. Programmers are still in general young, most often white or Asian and male. Only 12% of machine-learning researchers are women (Simonite, 2018). The numerical gender gap is already visible in student enrollment in computational and engineering study programs, known as the pipeline-problem. As Lagesen (2007) has argued, there are several strategies to address this gap, but even if a critical mass of women is reached, a higher enrollment number is ‘not self-increasing or even self-sustaining’ (p. 87). And even if women enter the IT industry: more than half of them leave in mid-career stages, and their turnover rate is more than twice as high as for men.² Only very few women work in tech or leadership positions, known as the endpoint problem (Windley & Pan, 2020).

This is confirmed also in the Diversity Reports of the larger companies (see Table 1). Diversity reports (which are no more than self-reports, mostly without raw data) are a relatively new genre in the IT industry, as large tech companies started to publish them only after public pressure in 2014, thus making the composition of their workforce more transparent, without making much progress in substance.³ Other companies have followed the big players, e.g., diversityreports.org now collects data on gender, race, geography and even sexual orientation in 40 tech companies. As Table 1 reveals, change is slow.

This gender imbalance has not always been the case (Abbate, 2012). Until the 1970s, computer programming was a typical women’s profession – computer was not the name of a device, but a ‘computer’ was a woman writing code and producing punch cards to operate the machine (as with the *ENIAC girls*). Programming (or coding, as it was labeled before a general conflation of the two terms, to distinguish female coders from their male programmer superiors, see Ensmenger, 2012) before the 1980s was seen as laborious, redundant and non-intellectual work – basically translating algorithms to machines by producing punch cards and operating electronic switches. Famously, the first archived ‘bug’ that had been ‘fixed’ by computer pioneer Grace Hopper and her team working

Table 1. Share of women in overall and tech workforce at Google and Facebook.

	2014	2015	2016	2017	2018	2019	2020
Google Global Overall	30,6	30,6	30,6	30,8	30,9	31,6	32
Google Global Tech	16,6	18	19,1	20,2	21,4	22,9	23,6
Facebook Global Overall	31	32	33	35	36,3	36,9	37
Facebook Global Tech	15	16	17	19	21,6	23	24,1

Source: Google Diversity Report 2020, Facebook Diversity Report 2020, <https://diversity.google/annual-report/>, <https://diversity.fb.com/read-report/>

on the Mark II, a computer at Harvard in 1947, was indeed a moth they had found and removed from inside the machine, where it had caused errors.⁴ In other words, coding was a mechanical, low-skilled and low-wage job, hence, seen as perfect for women, particularly for housewives. As Hopper put it in a *Cosmopolitan* magazine article in 1976, ‘programming is just like planning a dinner ... you have to plan ahead and schedule everything so it’s ready when you need it’ (in Ensmenger, 2012, p. 238). Coding was seen as a static process connected to a feminized *software*, in contrast to the male computer engineer that dealt with *hardware*, and could thus be dealt with by a low-level clerical worker (Ensmenger, 2012, pp. 14–15).

When demand for software increased, salaries also rose with the consequence of men starting to populate the profession. Programming was portrayed as incredibly complex and increasingly dependent on creativity and ingenuity. One way of making programming masculine was by underlining skills and reformulating the practice of coding as active, creative and unpredictable. By reference to black magic, programming in the 1950s started to rely on male notions of mastery of the highest of high technologies, creativity and autonomy and not the least on the largely boyish subculture of hacking (Ensmenger, 2012, p. 77).

In his 2015 article Ensmenger attributes this transition to what he labels ‘rugged individualism’, how programming was constructed as distinctively masculine, in which individual artistic genius, personal eccentricity, anti-authoritarian and anti-social behavior were mobilized as sources of personal and professional authority. The exclusivity of university computer labs was sheltered, but unsupervised environments making it possible for a *frat boy culture* to take shape, informed by ‘friendly play, rough hostility and affection through mayhem pranks and emotional aggression’ (Ensmenger, 2015, p. 61). The university labs that harbored the burgeoning hacker culture were places inextricably linked to adolescent masculinity.

Chang (2018) refers to this as a *geek mythology*, a belief that asocial boys obsessed with computers are the best programmers, discouraging women from tech. Graham (2004), comparing hackers to painters, argues that there is a strong correlation being smart and being a nerd. The geek is self-made, a lone inventor ‘struggling against a dominant corporate dinosaur’ or a lonely nerd ‘turned accidental billionaire’ (Ensmenger, 2015), an underdog who against all odds produces tech that’s immediately recognized as revolutionary.

More recently the *Geek* has started to give way to the *Bro* with a kind of rockstar image to it. Chang (2018) traces the start of this transition to Apple and Steve Jobs. But the rockstar image goes further back – Annie Leibovitz has photographed young (male) programmers for the entertainment magazine *Rolling Stone* already in 1972 (see Turner, 2006, p. 116). In a more recent account, Wachter-Boettcher (2017) describes this *Bro* culture as routinely excluding anyone who isn’t male. This is a culture populated by white guys who from a young age have been told they are the best and hence wholeheartedly embrace the idea that they are truly smarter and thus deserve to make choices on others behalf. She calls this *techno paternalism*, a culture built on white male values insisting to serve us all. Similarly, Chang (2018) shows how women face toxic workplaces, marked by discrimination and sexual harassment. She describes how drug-heavy sex parties were justified with references to tech culture’s believed progressiveness and open-mindedness.

3. Technology, culture and media logics

Programmers encode rules, norms and cultural ideas into their products (Oudshoorn et al., 2002), and are themselves embedded in social contexts: the company they work for, their professional community, their own education and socialization, as well as the macrostructures of the society in which they live.

While tech culture today is quite homogenous in terms of age, ethnicity and gender, it is influenced by many cultures (Svensson, 2021). The figure of the ‘hacker’ is important, but also the leftist, hippie and counter-cultural origins of Silicon Valley and personal computing. Certain aspects of these origins, such as freedom of information, individual empowerment and realizing the future through technology, were picked up by liberal and conservative actors in the 1980s, coupling a capitalist logic of profit-making with entrepreneurship and startup values that today are pervasive in tech culture. Turner (2006) argues that tech culture (or cyberculture as he labels it) brings together two legacies, the military industrial research culture of the Cold War (the first computers were war machines and Silicon Valley was initially run on defense department contracts), and the American counterculture of the 1960s. This is where technological and intellectual output of the military industry met with Eastern religions, LSD mysticism and hippie ideas of the back-to-the-land movement (Turner, 2006). Leftist and hippie narratives of free information and holistic networks were embraced in the cheerful optimism of entrepreneurship and start-up culture. Today, tech is marinated in entrepreneurship and start-up hallelujah, with slogans such as *invent the future* and *make magic*. This is sometimes labeled a *Californian Ideology* (Barbrook & Cameron, 1996), combining the ‘freewheeling spirit of the hippies and the entrepreneurial zeal of the yuppies’ (p. 45). A common thread here is believing to be avant-garde, that it is possible to change/disrupt the world, an optimistic faith in the possibilities of technology.

Underlining the socio-cultural and institutional setting of tech, Klinger and Svensson (2018) have argued that digital technologies shape and are shaped by media logics. The concept of media logics rests on the observation that traditional media and networked media each follow their own (albeit overlapping) rules of the game – how information is produced, how content is distributed and how people and organizations use media. Algorithms prestructure information flows and discourse dynamics on social media platforms. It is therefore important to understand the human and non-human agency that goes into designing and programming algorithms. As algorithms and automated systems (still for the most part) are programmed and engineered by human actors, they are outcomes/manifestations of media logics, i.e., of the norms and processes of media production, distribution and usage, as well as how programmers and users perceive these norms and processes that go into the design/programming process. Thus, code and algorithms are not neutral, but they are industrial products shaped by the interests, ideologies and perceptions of those who create and maintain them. Digital platforms and their algorithms impact all three dimensions of network media logic: their affordances shape how information is produced (280 characters on Twitter or video editing features and filters on TikTok), how information flows through the networks, what gets amplified or filtered out, and how users can interact with content and each other. Research has shown that affordances and perceptions about affordances matter for e.g., political communication (Kreiss et al., 2018; Witteborn, 2018). This means that programmers and

their presumably bland or tedious decisions while coding impact all dimensions of media logic and thus communication on platforms.

4. Expert interviews

In the literature review above we have found various reasons why programming as a profession and as an industry has turned to be male-dominated and why it is not necessarily an attractive workplace for women, despite the relatively high salaries and other perks, plus great job security: An aggressive male bro-culture, a closed club of geeks that keep women out, and the small number of women enrolling in (and finishing) academic computer science programs. But does the anticipation of a bro-culture keep women from studying computer science? Is it not easier for them to enter the tech industry with companies seeking to enlarge their female workforce? If they master programming at the same levels, why do only few of them make it to senior positions? Hence, we turn to our expert interviews and ask the following questions:

RQ1: Why are women less likely to enter the tech industry?

RQ2: Why are women more likely to leave the tech industry?

The interviews were semi-structured, conducted with programmers of various gender and backgrounds in seven countries over four years (2016–2020, see table in the appendix for details). The interviews are considered expert as we perceive the interviewees as experts of their professional lives and occupations. Interviewees were recruited with a preference for programmers working in tech companies with a communication focus, including small (e.g., start-ups) and medium-sized companies (e.g., Netflix, Mozilla, LinkedIn) as well as tech giants (e.g., Google, Facebook, Apple, IBM). Recruiting took place via the social media platforms Meetup and LinkedIn that enabled us to search, filter and contact programmers in specific areas and companies and snowballing from these contacts. The sample of interviewees is not representative of the programming community as a whole. As we actively sought to diversify our sample, we suspect our sample contains a larger proportion of women programmers. The sample also reflects where we ourselves have been located. Travels to India and Brazil allowed us to interview a few non-Western programmers, in addition to some migrant programmers from India and China we talked to in Europe and Silicon Valley.

Interviews lasted between 27 and 85 min and all were conducted face to face, apart from two (via Skype, see table in appendix). They were recorded and transcribed, compiling a body of 690 pages. While most of our results below are based on these interviews, it is important to also mention that we have also attended conferences and meetups in Austin, Bangalore, Berlin, Chennai, Copenhagen, Malmö, São Paulo, Silicon Valley and Stockholm to observe and better understand tech culture. Quotes from interviews not conducted in English have been translated by the authors.

The interviews are part of two different, but related research projects, in which each author served as principal investigator. For this article, we only used those parts of interviews that related to gender aspects. As the interviews were conducted for broader projects, they do not focus on gender aspects alone – in fact, in some interviews gender did not come up explicitly. However, in most interviews, diversity regarding gender was a

recurring topic. Most programmers were acutely aware of the lack of diversity in their profession and the industry, and some (male) interviewees even felt pressured and treated unfairly when their companies attempt for more diversity and an inclusive work environment. Gender inclusion was sometimes discussed as a forced type of tolerance.

It is important to underline the epistemic limitations of interviews. Different to data from diversity reports that can only describe how many women and men work in companies or study computer science, interviews provide a richer, thicker description and analysis for the driving forces behind these numbers. However, interviews can only give us the *perceptions* of interviewees – what programmers think and believe the reasons are. They enable us to get closer to what's happening, but do not provide objective truth, as interviewees might be wrong, their observations and experiences might be filtered, biased or distorted. Another limitation is that we cannot draw a systematic comparison between the countries in which we interviewed programmers as the interviews come from two different projects and do not solely focus on gender. Another reason that inhibits cross-country comparison is that many interviewees worked for large, globalized tech-companies with similar work cultures across the globe.

While we cannot draw systematic comparisons across the seven countries in which we conducted interviews, because we did not select the countries for a comparative approach, it is interesting how similar, how consistent the professional experiences of our interviewees are – across countries and various sizes of companies. This is surely due to a skewed sample (not including Malaysia or Eastern Europe). Still, this suggests programming being a global, transnational profession.

Our interview results show that it is mainly four aspects that keep women from the tech industry or effectively hinder their success, making them more than twice as likely to leave the tech industry as men: (1) the professional culture, (2) pervasive stereotypes, (3) lack of role models and (4) typical career paths.

4.1. Professional culture

The literature review revealed a somewhat problematic *bro* culture as one explanation behind the gender imbalance. In our interviews, other factors of tech culture were highlighted. In order to survive in the profession, so-called *grit* seems of importance. Grit is understood as drive, strength of character and not letting yourself be turned down by setbacks. In psychology (Duckworth et al., 2007), grit is considered important for succeeding, alongside with external motivations (such as money or status) and inner motivation (performing an activity because it feels good in itself). Duckworth et al. (2007) conclude that individuals high in grit are able to maintain their determination and motivation over long periods despite experiences with failure and adversity. When experiencing setbacks, programmers get back up again and stick to their guns. Commonly associated concepts include perseverance, hardiness, resilience, ambition, need for achievement and conscientiousness, here understood as being careful or diligent, which requires a great deal of self-discipline. As Brooks underlines in a classic book on programming from 1975, 'with any creative activity come dreary hours of tedious, painstaking labor' (pp. 8–9), because 'each forward step is matched by a backward one' (p. 123).

In many of our interviews, when a professional culture that requires grit was mentioned, grit was male coded. Ted⁵ for instance underlines that it is more appreciated

in our societies when a man becomes obsessed with a topic and is super-focused on one particular thing, than if a woman were to do the same thing. He relates this to his experiences of good programmers having played computer games as kids, and not stopping until they ‘*aced the game, found the princess and solved the problem*’. He refers to this ability to play the same game over and over again, becoming obsessed with the game, learning everything about it in order to crack it, as well as finding pleasure in this, coupled with a belief that he eventually will succeed. Ted says that there are other explanations as well, that many women aren’t as single-minded as men, and are more prone to juggle many projects at the same time. As Graham (2004) argues, if a program isn’t doing what it is supposed to, programmers find out where it went wrong because ‘you know you are going to win at the end’ (p. 29) and women don’t seem to have this same ‘holy calling’ (p. 76) as men.

Kristina connects a general belief in oneself to tech culture’s male-orientation: ‘*We women aren’t trusting ourselves enough*’. She explains that men apply for programming jobs when they match about 60% of eligibility criteria, whereas women think they need to match all requirements to apply. Women in Chang’s (2018) book tell almost exactly the same story, that they feel less confident than men. This also resonates with Ensmenger (2015) underlining the importance of believing in yourself as a programmer and being able to sell yourself and your skills to employers as pivotal in the masculinization of the profession. Self-confidence, masculinity as well as entrepreneurship seem to be interconnected.

Another aspect highlighted was *flow*. Part of the professional culture is the immense workload and the extreme speed of development. In psychology, Csikszentmihalyi (1990) describes flow as optimal experience, complete absorption with the activity at hand and the situation to the extent that nothing else seems to matter. Having a family can be somewhat problematic immersing yourself with the workload and getting in tune with the coding. *Flow* is about forgetting time and bodily sensations. ‘*You totally forget about time, you look at the watch and it is already 4 pm*’, as Python puts it. According to Benjamin it is important ‘*to have a big ass*’, referring to a Hebrew proverb underlining the ability to sit down for long hours maintaining concentration and enjoy it at the same time. Indeed, programming is so immersive that it’s difficult to sustain any other relationship than that with the computer and the code. Andri has a big family and this sometimes makes it hard for him to reach a state of flow. He therefore prefers to work in the nighttime. Similarly, Ted describes the nuisance of having a family to attend to when in flow:

You don’t want to go home, but you have to. So, on a day like that I go home, cook dinner, fix things with the kids, and then I’m back in front of the computer another five to six hours. (...) Everybody gets annoyed. Anyone who tries to seek contact with me will get irritated. (Ted)

This has an impact on career paths, as we will return to later.

4.2. Pervasive stereotypes

Stereotypes, prejudices and bias do not stop at the door of a tech company. In fact, many of our interviewees, male and female alike, resorted to stereotypes about genetic predisposition (e.g., men are more rational thinkers), early socialization (e.g., boys build things,

girls play with dolls) or ideas about gendered behavior patterns (e.g., women give each other fewer promotions) when trying to explain why there are only few women in their teams. One of the very pervasive stereotypes is the combination of women having (a) other professional preferences and goals in life and (b) fewer technical skills. As a result, so the story goes, women chose not to study computer science – and when they do and enter the job market, this lowers the skill levels in the profession. From this perspective, the diversity problem in the industry results from individual choices and genetic talent distribution rather than structural inequalities.

Stereotypes may play out on a subconscious, latent level, but they can become manifest in situations when behavior is formally judged, such as feedback talks and performance reviews:

Is it sad sometimes? Yeah. For example, at the end of a job or a certain period, you get your review. As a woman, you are too loud, you are too aggressive. A friend of mine just got her review (which said): 'You know very well what you want about your career and you are very aggressive in going to get it.' What's wrong with that? What's wrong with being assertive? With saying: I want to go there, I want you as a manager to prepare me for there? A good manager understands that a person's role in that job is temporary and they will grow out of it. (Gaby)

Adam refers to women as better in seeing the big picture and not getting '*snowed-in*' and thus better at foreseeing unintended consequences. Stereotypes are also reinforced by *where* you find women in tech. Anna, who refers to herself as non-binary, remembers when she first set foot in a bio-tech company in the early 1990s:

Almost all the administrative personnel were women, they almost all worked for men, and their status and level in the organization was based in the position of the man they worked for, not the job itself (...). It was absurd. (Anna)

This is reinforced by Lasse. At his former company all programmers were men between 26 and 43. There were women in the company, but only in administration. He himself thus concluded that the profession is homogenous and reinforces stereotypes of women in positions serving the male programmers, and this even in the 2000s.

Interestingly, interviewees point to various places with (presumably) fewer bias against women in tech, such as India, Eastern Europe or the Middle East. While working women have been idealized in former Communist countries in Eastern Europe, in more patriarchal societies programming was seen as an ideal profession for a woman, not involving any hard, physical work, a job that can be done from home, with a high social reputation. This sustains the observations by Lagesen (2008) in Malaysia, where programming is not perceived as 'masculine', but as women-friendly office work. Another reason, they explain, is that computer science has different disciplinary roots in Eastern Europe and the Middle East. In Western Europe, computer science developed from engineering, whereas in Eastern Europe from mathematics and physics, a field that traditionally attracts more female students than engineering.

In the beginning, it was all about jobs with screwdrivers, you really had to install components – the physical part, which probably had a deterrent effect on women. That's why we have the situation that many people think: when I work on computers, I have nothing to do with people. They find it boring. Unfortunately, that is not true. This is an ideal job for men and women. It has a lot to do with communication. (Pascal)

4.3. Lack of role models

The fact that women are twice as likely as men to leave the tech industry has far-reaching consequences. One of them is that women who are freshly hired hardly find any role models, and even fewer the farther they move up, as our interviewees have repeatedly underlined:

It's been a growing point of frustration. It would take me a long time to think of someone who does what I do, who is female; let alone someone who has gone to the next level. So there are no more role models left. (...) There are no mentors left. (...) And I get left with the very depressing sense that there's no way to win. The best that I can do is to make it less crappy for whoever comes after me. (Gaby)

Anna points a finger at venture capital here, that women entrepreneurs are not as likely to be funded as men, hence a lack of women innovators in startups.

We have seen the data, women tend to get filtered out and then they don't get funding when they are in growth. Some really innovating things get lost. (Anna)

So even if there were more diversity on the engineering level, it is also important to look at the senior positions according to Anna.

Even though there were some diversity on the engineering level, but as soon as you got out of that level, the people who were doing and creating the products and services you would get white, straight, cis-gendered men for the most part. (Anna)

Another aspect here is the important role of reputation for advancing to senior positions, or to have followers, as Lance, a senior programmer and entrepreneur in the Silicon Valley with higher positions in tech giants, put it:

(Y)ou need to have followers. If you look at what differentiates a successful senior engineer (...) from a junior, it is that they have followers. (...) An engineer's reputation is the power they have. (..) If we have a meeting or we discuss how we're going to design the next generation X, and we're eight people in a room, and someone says 'Hey, wait a minute, where is Jessica?', then I know Jessica has followers, that Jessica has influence. And that's how I spot people that get promoted to very important technical roles. Because people don't want to make decisions without them. So reputation is the thing. That's the currency. (Lance)

As attended to previously, women were all over the programming profession until the 1980s. Grace Hopper, who later was promoted to the rank of an admiral, and the ENIAC girls, could become a role model for women wanting to enter programming. But for this to happen again, programming needs to be demystified. And things seem to start moving. What Ensmenger (2015) calls *rugged individualism* is starting to give way thanks to a normalization of the industry, as well as some tech giants becoming the corporate giants which the eccentric, anti-social boys that started them had challenged (most notably IBM, see Levy, 1984).

4.4. Typical career paths

There is widespread agreement among interviewees that it is fairly easy for women to be hired by a tech company, as many companies seek to enlarge their female workforce, to become more diverse. Diversity reports of larger companies show that the number of

women in tech (not in HR or management positions) is growing, albeit very slowly (as presented in [Table 1](#)). Thus, entering the profession does not seem to be a problem – for those with a computer science degree, that is.

In the past decade, the tech industry has changed regarding professional biographies, how you move up within a company and the profession itself. The pace is extremely fast, as the technological development picked up speed. As a result, programmers struggle with keeping up. Adam reported learning 14 different programming languages before his mid-30s. There are hardly any ‘old’ programmers still working entirely in tech positions, but they move up into a management track, leading smaller, then larger teams, doing code review, in many cases quitting coding altogether for team management tasks (see also Rosales & Svensson, 2021). This is particularly the case in larger companies, tech giants that are especially attractive as employers.

I wanted to become a manager, because I thought I would have more influence on the software that I am developing.(...) But when the team grew to around 80 people it became a nightmare. I had to spend most of my time on writing reports, conducting performance praises for my team and trying to motivate them to stay on the project that was already running for five years. It was a challenge, but not a technical challenge anymore. (Sebastian)

The industry is moving fast, employees are expected to working long hours, work fast, keep up with new developments and technologies, to handle a lot of stress, high expectations of performance (thus the recurrent references to grit mentioned earlier), accept a work life that is often at odds with having a family or children, household chores which most often fall on women in heterosexual relationships. But our interviews also confirm Cooper’s (2000) finding that this particular masculine work ethic exerts normative control and also clashes with fatherhood.

Programmer was a very nice job 20 years ago but today it is like being the slave (laughs) that nobody wants to be. (Thao)

After the age of 35, interviewees report, it is difficult to find a job as a programmer. Kristina is trying to change her career and pursue her dream of becoming a programmer. But in her late 30s, she felt she was old:

I need more time to learn, to spend time at home. Sometimes I’m there until 2 am [...] I just feel the breath of my younger colleagues behind me, so [...] it is not easy. (Kristina)

The age gap is also reflected in different backgrounds that older and younger programmers come from – older ones often being lateral entrants from other fields with high intrinsic motivation, younger ones with computer science degrees and the external motivation of high salaries.

Computer science has not been around for that long. Most people who work in it are young. In our company there are many people between 20 and 30. But if you want to stay with it (programming), it often means: ‘Oh, he is still here’. That is a cultural dilemma. If you are still a programmer at 60, then it is a problem. (George)

Against this background, moving into management positions mid-career is a common practice, but a particularly challenging one for women with a tech background. When women move up into management positions, performing leadership tasks, they tend

to encounter more challenging situations than in junior positions that were more on the tech side as, for instance, in the two excerpts below:

It actually got a lot harder as I've become more senior. (...) One of the reasons is as a senior engineer my job is in part to tell people that they're wrong. And that creates conflict. (Gaby)

I was in a big conference room and it was just guys (...) I was flying into the boardroom in Chicago from Russia and one guy was like "hi can you make me some coffee"? Then the guy next to him said „listen, you report to her”. (Olga)

Female programmers who move up into management positions encounter younger, male colleagues who challenge their authority, while at the same time there are fewer resources (like mentoring programs) for mid-level engineers. There are so few women that it is difficult for them to network or form a community with other women, but there is a sense of loneliness, of not being able to connect with someone like oneself in the profession:

I looked at the 'people similar to you' on LinkedIn, month after month. I go down 50 profiles – and I'm the only woman. And that is weird. (...) That manifests itself in everything from a junior engineer literally being speechless like: 'Wow, I've never seen a girl do that'. It was not intended as an insult. It was just ... he had really never met a female engineer before (laughs). And certainly not somebody senior. (Gaby)

For the few women who stay in the industry, management positions can become easier to handle with experience and age – or only the more resilient and persistent women remain in management positions and in the tech industry.

5. Discussion

This gender gap or lack of diversity cannot be solved by tech companies simply hiring more women, by becoming more inclusive and diverse in their recruiting practices. Norms and workplace cultures also need to change, and they won't by themselves. The history of programming matters, how it was made masculine, complex and mystified as programming went from rather clerical to high-skilled work. This has a bearing on the profession today. Entrepreneurial values, a cheerful optimism/belief in yourself and your programming skills (i.e., grit), can be understood as male-coded as well as being in flow which makes it hard to sustain a family outside of work. This underlines that the (media) logic of programming favors male norms of work and behavior, working long hours, keeping up with new developments and technologies, handling a lot of stress and high expectations of performance. This results in a lack of clear career paths and in stereotypes that women for example have other goals in life (family) and less interest in tech in general.

Network media logic (Klinger & Svensson, 2018), the inherent *modus operandi* of digital platforms, impacts not only public communication in general, but also political communication, e.g., how parties run campaigns and citizens find information. We argue here that analyzing the potentials and perils of digital platforms for public and political communication falls short when it focuses only on the user side of platforms. It is the actors and structures *behind* the user interfaces, the underlying technologies and their creation and creators that have a major impact on all three dimensions of network media

logic and the agency of algorithms. Indeed, biases do not only emerge in front of the screens, but biases are already built into digital technologies (see also Oudshoorn et al., 2002), formed by the norms and ideas (logics) that guide the norms and work culture of programming. By interviewing programmers behind the screen, we have been able to highlight some of the more pervasive norms and logics that continue to restrict women from the industry, and as a consequence, also impacts their use of and representation in digital media.

This is important because representation matters, behind and in front of the screens. Diverse teams yield better results, better revenue and provide the necessary feedback structures to avoid bias, sexism or racism to be built into technologies, as one interviewee illustrated in a telling anecdote:

(W)e actually made a dating app that was not a success, but that was engineered by two middle-aged men asking their male colleagues if they thought it was a good idea. And they thought it was a great idea, but all the girls thought it was sickly disgusting. (Ted)

In a digital world that increasingly relies on digital infrastructure, on tools, platforms, devices and automated decision-making systems built and maintained by programmers, the making of this infrastructure is highly important. Those who create the technologies that everyone else uses in all aspects and corners of life – from finding love to shopping, forming political opinions or managing financial assets – have power. Thus, our argument is that gender and programming is not just a topic for feminist studies, and it goes beyond studying the history of computing. It is important for public, even political communication, because programming digital platforms and communication technologies ultimately revolves around power. While citizens may decide to ‘like’ something on social media or not, it is programmers who decide if there is an option to like (or dislike) something in the first place, how and when algorithms amplify content, and how to rank likes or comments in algorithmic platform curation. These programming decisions have impact, particularly because in hybrid media systems digital platforms have become major players in political communication. This is where political communication takes place, where ideas are expressed and negotiated, where mobilization and de-mobilization of societal groups and movements occurs. While previous research shows again and again that e.g., women are less willing to discuss politics online (Koc-Michalska et al., 2019) and women do not have access to the same leadership and decision-making positions or entrepreneurial opportunities as men (Kreiss et al., 2020), one cannot fully understand and explain these disparities and inequalities by studying what is happening in-front of the screens.

Hence, we can approach the relation between programmers and users (citizens) as a (massive) power asymmetry. Moreover, most people do not understand how algorithms work,⁶ and they do not have the means to change or adapt them. In most cases algorithms are opaque, back-boxes for citizens and those affected by their automated decision-making. Yet these technologies decide what citizens see on Facebook or Google during, for example, an election campaign. Citizens do not know how algorithms on social media or search engines filter and select information for them, whether they are shown cute cat videos or political information about animal rights. To make technology better suited to promote (or at least not to damage) the common good means to make them more

diverse and inclusive by design, i.e., make sure they recognize diversity, are created by a diverse group of programmers.

In other words, there need to be more women in tech, more people of color and other social groups. In order to level the playing field, technology needs to reflect the diversity of digital societies not only in using technologies but by inclusion in making them. As our study has shown, for this to happen, the culture and social norms need to change, stereotypes need to be challenged. The tech industry needs a greater effort to actively make room for women in their different walks of life, make sure women-led startups get proper funding, in order to make sure that there will be female role models, again, in the future.

Notes

1. <https://www.nytimes.com/2020/12/03/technology/google-researcher-timnit-gebru.html>
2. <https://www.techrepublic.com/article/why-more-than-half-of-women-leave-the-tech-industry/>, <https://www.europeanwomenintech.com/blog/why-are-women-leaving-technology-jobs>, <https://www.cnet.com/news/half-of-young-women-will-leave-their-tech-job-by-age-35-study-finds/>
3. <https://www.fastcompany.com/90596608/why-so-many-companies-diversity-numbers-fall-flat>
4. <https://www.nationalgeographic.org/thisday/sep9/worlds-first-computer-bug/>
5. Interviewees have been anonymized (fictive names) here.
6. <https://www.bertelsmann-stiftung.de/fileadmin/files/BSSt/Publikationen/GrauePublikationen/WhatEuropeKnowsAndThinkAboutAlgorithm.pdf>

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Notes on contributors

Dr. Ulrike Klinger is Professor for Digital Democracy at the European New School of Digital Studies at European University Viadrina in Frankfurt (Oder) and associated researcher at the Weizenbaum Institute for the Networked Society in Berlin, Germany. She has worked extensively on the transformation of digital public spheres, the role of digital media in election campaigns, and the impact of technologies on public communication.

Dr. Jakob Svensson is Professor for Media and Communication Studies at Malmö University, Sweden. His research revolves around socio-cultural processes behind online experiences, political participation online, which media logics prevail, and mobile phones and empowerment in the global south.

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