# Smart technologies and gender. A never-ending story

*Knut H. Sørensen and Vivian Anette Lagesen*
Department of Interdisciplinary Studies of Culture, NTNU

Published in *The Routledge Handbook of Smart Technologies An Economic and Social Perspective*. Edited ByHeinz D. Kurz, Marlies Schütz, Rita Strohmaier, Stella S. Zilian. Chapter 11, p. 210-226. Check with the book for a final version of the text.

## Abstract

In this chapter, we explore gender issues in/of so-called smart technologies, drawing on analytical tools provided by the field of feminist technoscience. We begin by discussing some major approaches of this area of study, including the work of Cynthia Cockburn, Wendy Faulkner and Donna Haraway. Our review continues by addressing the issue of gendering of smart technologies and how the gendering has harmful consequences. The we investigate the sources of gender bias, exploring computer science and engineering as a world of and for men. We conclude by describing the gendering of smart technologies as the result of a co-production of the lack of women in the communities developing these technologies and the lack of concern of these communities with the interests and needs of women. This co-production appears to be stabilised to the extent that harmful gendering will continue to characterise smart technologies.

## A world without women

Many of the discourses related to smart technologies and the ideas of widespread digitalisation of human societies are promissory. They express attractive sociotechnical imaginaries where access to electronic resources of communication, problem solving, information and entertainment is ubiquitous; it should result in progress for everybody. However, the promises are ambiguous in the sense that the developments represent both opportunities and challenges, not the least with respect to artificial intelligence and robotics. At the core of these promissory performances is the issue of understanding a variety of human practices and how they may be supported or changed. Thus, it is important to ask who are engaged in such explorations of smart technologies and whose understandings count when decisions about design and deployment are made? This chapter engages with these questions with a focus on gender issues.

We can illustrate the importance of pursuing such issues by recalling the promissory discourses related to the slogan of 'the paperless office', which emerged in the late 1970s. Computers was claimed to facilitate office automation to the extent that around 40 per cent of the workforce consisting mainly of women would be redundant. However, the effects of the digitalisation of office work turned out to be much less dramatic, in part because the claim of severe cuts was based on a lack of knowledge about the work performed by women office workers and the skills needed to perform them. Their tasks were more comprehensive and complex than the men in the computer industry assumed and thus not so easy to automate (Webster 1996). What happened was a gross misjudgement based on gendered stereotypes – women's work requires little skills – and no effort had been made to investigate this assumption.

Today, the widespread belief is that the situation with respect to gender and equal opportunities for men and women has changed fundamentally since the 1980s. However, as we shall see when we delve into the issue of gender and smart technologies, the state of affairs is not fundamentally different from what it was 40 years ago. The computer industry is still numerically dominated by men, and the assumptions underlying the design of smart technologies seems to rely to a surprising degree singularly on the experiences and the tastes of men designers, with little interest in analysing women's needs and practices. The consequences of the lack of gender balance in the industry are palpable, and the unreflexive use of gender stereotypes in design is quite remarkable.

In an editorial on November 23, 2019, *The Economist* complains that "Silicon Valley is bad at making products that suit women. This is a missed opportunity".[1] What are at stake are the entrenched practices of design, in line with the observation of Greek philosopher Protagoras that "man is the measure of all things". Thus, the complaint is that smart technologies are constructed with inherent gendered biases, such as virtual-reality headsets that do not fit women whose pupils are close together than men's and smartphones that are too big to fit comfortably in the hands of the average woman.

The editorial sees the problem as emerging from the dominant position of men in the IT industry as a entanglements of gender biases in design and the gender imbalance among those constructing smart technologies. The problem is even framed as a business case: "Women are

[1] https://www.economist.com/leaders/2019/11/21/silicon-valley-is-bad-at-making-products-that-suit-women-that-is-a-missed-opportunity

50% of the population and make 70-80% of the world's consumer-spending decisions. That means they control the deployment of more than $40trn a year". In line with this observation, the editorial rhetorically asks about the industry "What is holding them back?"

Unfortunately, there are some rather obvious answers. Liza Mundy's (2017) aptly titled article "Why is Silicon Valley so awful to women?" suggests that the gender balance problem of the industry is deeply entrenched and difficult to change. She and other analysts (e.g., Emily Chang, 2018) describe the culture of Silicon Valley as deeply alienating to and harassing of women, as a "Brotopia" to use Chang's expression. Even if the companies offer attractive wages and interesting work, the work environment is sexist and even more so than in most other industries. The perseverance of the subtle micro-aggression directed at women is particularly a problem because it is hard to recognise and even harder to complain about. As we will show, there are discursive practices that render women invisible and unwanted with respect to smart technologies. The high level of aggression occasionally expressed (and which is hard to believe) is evident from the discourses articulated by men engaged with computer games in the incident known as 'gamergate'.[2]

Thus, in this chapter, we will discuss the issue of smart technologies and gender with a view both to the position of women in IT and the gender biases inherent in the designs of the IT industry, including some of the consequences of such biases. However, it seems pertinent to start by inquiring into the concept of smart technologies; what happens when we try to unpack it? Rommetveit et al. (2017) show that there are many uses of 'smart' that includes reference to characteristics of the technology, processes of modernising, and professional achievement. Oxford English Dictionary offers among several other definitions that 'smart' may be said: "Of a device or machine: appearing to have a degree of intelligence; able to react or respond to differing requirements, varying situations, or past events; programmed so as to be capable of some independent action".[3] The Wikipedia article on 'smart devices' mention the following examples: smartphones, smart cars, smart thermostats, smart doorbells, smart locks, smart refrigerators, phablets and tablets, smartwatches, smart bands, smart key chains, and smart speakers.[4]

---

[2] See https://www.theguardian.com/commentisfree/2019/aug/20/the-guardian-view-on-gamergate-when-hatred-escaped
[3] https://www.oed.com/view/Entry/182448#eid22356150
[4] https://en.wikipedia.org/wiki/Smart_device

These references do not address gender issues directly as they use terms that we at face value consider to be gender neutral. However, Rommetveit et al. (2017: 8-9) suggest the importance of addressing "the gendered and elitist imaginaries of technology use, who the 'citizen' is and the ways in which citizens are seen as actively engaged, empowered, rational, calculating, and so on. This we foreground […] as issues of inclusion/exclusion, especially in scenarios and other depictions of lifeworlds that appear to be populated for the most part by able-bodied Western males and over-simplified stereotyping of groups such as the family and the elderly." The Wikipedia list of smart devices seemingly connotes more to the lifeworlds of men than that of women, but this needs further inquiry.

In the following, we first present some prominent approaches that are helpful in analysing the issues of this chapter, often labelled as feminist technoscience. We continue by addressing the gender imbalance problems related to computer science and engineering, presenting some of the relevant research in this area. Then, we discuss some features of gender biases in the construction and design of smart technologies, with a focus on what we consider as the mismeasure of women. Finally, we provide some suggestions about how to deal with gender biases and the lack of women in computer science and engineering.

## Backdrop: some important feminist technoscience approaches

As a social science concern, the gender and technology issue is basically a post-1980 phenomenon. The early feminist critique of technoscience emerged from observations that new technology was not a neutral force of production, but rather a tool that could be employed to undermine women's position in the labour force or as a basis for differential treatment of men and women (Cockburn 1983, 1985). This tradition of research developed a topical interest in how the introduction of computers would shape and be shaped by the gender division of labour in workplaces (for an overview, see Webster 1996). Later, there came a growing concern about the comparatively low and declining numbers of women in computer science and engineering (e.g., Cohoon and Aspray 2006, Lagesen 2007, Fox et al. 2009).

Further, the image of computers was transformed from highlighting computing machines to identifying them as the core of information and communication technologies (ICT). This reflected that the technologies became common household goods as well as standard workplace tools. Accordingly, and in line with the observations made in the introduction, feminist technoscience put two distinct problem areas on the agenda (see Faulkner 2001). First, the initial concern about women *in* ICT: why so few? Second, the issue of women *and* ICTs: women's situation as users and non-users of the new technologies. Women seemed to be on the wrong side of a digital divide between those with and without access to and competence in using and making the new ICTs.

Thus, the dominant concern of early feminist technoscience work was the exclusion of women as users as well as professionals with respect to ICTs. While some scholars studied the relations between men and technology and the role of technology as constituent of modern masculinity (see, e.g., Hacker 1989, 1990, Mellström 1995, 2003, Turkle 1984), the exclusion of women remained the major focus (see, e.g., Abbate 2012, Ahuja 2002, Archibald et al. 2005, Barker and Aspray 2006, Cronin and Roger 1999). Two main exclusion accounts relevant to women and/in ICT emerged in the feminist technoscience literature (Sørensen et al. 2011). The first may be called *'A world without women',* focusing on absolute exclusion and the ICT arenas as men's worlds. A second account, *'A chilly culture'*, told about the problems of retaining women when they are a minority as users or designers of ICT.

The account of exclusion as a mechanism upholding 'a world without women' is based on the argument that throughout history men scientists and engineers have made explicit efforts to keep women out of technoscientific arenas (e.g., Noble 1992; Merchant 1980). Ruth Oldenziel (1999) shows that the modern profession of engineering in the USA was established through conscious efforts to exclude women (as well as lower class and ethnic minority men), including the making of masculine symbolic representations of 'technology' and defining the emerging field of engineering as belonging to white middleclass men. Thus, technoscience as 'a world without women' is described as a culture of science and technology where women and femininity appear as matter out of place. Seemingly, this legitimises sexism and harassment of women (Chang 2018).

What is produced and re-produced, according to this first account of exclusion, is an outspoken gender-based division of labour in relation to science and technology, combined with a gendered construction and appreciation of skills that renders women as less competent and less relevant than men. Gender-related divisions and differences have also been observed with respect to use, from children's toys to men's and women's different relationship to artefacts and activities in everyday life (Horowitz 2001, Lie and Sørensen 1996, Kleif and Faulkner 2003). Some scholars have pointed to (some) men's fascination with technology as an outcome of erotic relationships imbued with pleasures of exercising power (Hacker 1989, 1990); as a flight from the challenges of social relations especially with women (Turkle 1984); and as a way of reproducing a kind of brotherhood around technology (Mellström 1995).

The second account of exclusion that describes the ICT culture that women experience as chilly, came from widespread observations of women choosing not to study computer science and engineering as well as the phenomenon metaphorically described as 'the leaking pipeline'. Such metaphors are widely used to explain the lack of women in science and engineering (Blickenstaff 2005; Husu 2001; Moratti 2020). The underlying idea of 'the leaking pipeline' is to consider educational or career paths as pipelines. The argument is that when the share of women is reduced, for example from the PhD to the full professor stage, this is due to women opting or being coerced out of the academic career path; thus, the career pipeline is leaking. Overall, proportionately more women than men were seen to have left specialist ICT work throughout their career trajectory (Millar and Jagger 2001). Accordingly, the chilliness account was invoked in two ways. It was employed to capture how women often experience ICT education and workplaces as unwelcoming and to describe the problem of recruitment: why many women appear reluctant to become involved with ICT. In this latter context, the chilly ICT culture account emphasised the symbolic meaning of this technology as a domain for men as well as the alienating aspect of the privileging of hacker or geek practices that many women experienced.

The making of computer science and engineering as a domain for men was a result of historical circumstances. Early on, computers seemed to be interpreted as a fairly gender-neutral technology (Sørensen and Berg 1987), possibly due to the important role of women as programmers in the pioneering period of computers (Ensmenger 2010, Misa 2010). During the 1990s, however, the initial promise of gender neutrality was seen to be corrupted because, increasingly, the use of computers appeared to be dominated by young men, while young women felt alienated (Rasmussen and Håpnes 2003; Misa 2010, Abbate 2012). A centrepiece of this argument was the figure of the hackers/nerds/geeks, first identified by Joseph Weizenbaum (1976). They were predominantly young men pre-occupied with computers, seen to be the embodiment of the chilling or excluding aspects of the culture of computing (Gansmo et al. 2003a; 2003b). Sherry Turkle (1984) in her study of hackers at MIT added a gender dimension, describing the ambivalent attitudes towards them. The young men were admired by other students for their enthusiasm and skills but pitied because of their lack of social competence and their social seclusion. Turkle (1988) also found evidence of capable women opting out of computing because they saw the asocial aspect of the hackers as rendering computing, in Faulkner's terminology (2009), a 'gender inauthentic' option for them. Even women computer enthusiasts appeared to diminish their own abilities compared to men co-enthusiasts (Nordli 2003).

In the feminist technoscience literature, we also find a counter storyline that Sørensen et al. (2011) name 'the woman communicator'. It represents a more optimistic focus on what might make computers attractive to women, emphasising the coming of the Internet as a positive turn for women's relationship with ICT. This belief – also called cyberfeminism (Bell and Kennedy 2000, Hawthorne and Klein 1999) – maintained that the Internet signified increased emphasis on communication compared to programming and calculation. For example, Sadie Plant (1997) argues that women, computers, virtual reality, and cyberspace are linked together in dispersed and distributed connections with an inherently feminine character. More commonly, scholars highlighted how ICT came to represent a transgression of the idea that computers are made mainly for calculation and management of information; this area of technology is not the least interwoven with communication. The latter quality was assumed to be beneficial for women' careers. They were expected to profit from their comparatively better communication skills (Rasmussen and Håpnes 2003, Spender 1995). More generally, cyberfeminism celebrated digital technologies, above all the internet, as potentially liberating for women and contesting men's dominance with respect to computers (Everett 2004).

However, the optimism was challenged. Van Zoonen (2002) claims that the Internet has been shaped by men, and that even women's everyday use of the Internet frequently was embedded in constructions made by men-dominated communities of designers. A crucial weakness was the tendency to reproduce an essentialist belief in 'woman, the great communicator' (Sørensen et al. 2011). Thus, such an argument based on a discourse on 'cyberfeminism' (Plant 1997) invoked a traditional dichotomous thinking about gender but based on a reversal of the usual status hierarchy; women knowing communication were more important than men knowing programming.

We may still observe all the three accounts present in technofeminism in action, also with respect to smart technologies. However, the observations presented in the introduction suggest a diagnosis of a continued predominance of the chilly culture, not the least with respect to the experiences of women working in the ICT industry. Regarding women as users of ICT, a lot of previous research was concerned about women being on the wrong side of the digital divide (Sørensen et al. 2011). The digital divide – the split between those who could or could not use ICT was mainly considered as a matter of access to computers and the internet and of having the skills needed. Policy initiatives aimed to fix the situation by providing training and affordable online connections. Still, such problems remain because, as Pippa Norris (2001: 91-92) puts it: "(T)he heart of the problem lies in broader patterns of social stratification that shape not just access to the virtual world, but also full participation in other common forms of information and communication technologies".

As indicated in the introduction, we also see an emerging narrative of what Caroline Criado Perez (2019) calls 'invisible women'. This account of mismeasures and neglect of women's characteristics and needs in the design of smart technologies adds to the previous ones by emphasising the need to be concerned with the shape and the performance of these technologies. Cynthia Cockburn (1983) made an early observation of the phenomenon in her study of the design of typesetting machines; they were constructed to keep women skilled in typewriting out of the printing industry. However, for a long time, the focus was on the symbolic rather than the practical aspects of computers and the internet, emphasising the perception that these were masculine technologies. What Perez and others show is not so much explicit efforts to keep women from using smart technologies as a long-standing tradition of not actively considering women as users and investigating their needs and preferences, but just using (white) men as 'the measure of all things' and not pursuing diversity as input to design efforts.

These accounts are useful as tools to diagnose problems. What more can feminist technoscience offer to explore the issues related to gender and smart technologies?

## Beyond exclusion and neglect: the cyborg, the co-production and the assemblage optics as feminist technoscience analytics

The idea that gender and technology interact and reciprocally interfere is basic to feminist technoscience. In principle, this framework embraces and combines non-essentialist and non-binary understandings of gender with constructivist understandings of technology, to provide an inherently dynamic perspective on both objects of inquiry (Cockburn and Ormrod 1993; Cockburn and Fürst-Dilic 1994, Faulkner 2001, Wacjman 2004). This idea may be developed in different ways. Here, we draw on Sheila Jasanoff's (2004) proposed idiom of co-production, noticing that when somebody does gender s/he also does technology. Thus, we need to study actors. At the heart of invoking the idiom in to study gender technology issues is the understanding that stability with respect to performing gender or smart technologies should be analysed as achievements and not be taken as a given. If, for example, the gendering of smart technologies appears to be stable in a given context, it is because it is made stable. Jasanoff's framework helps us to observe how actors help to produce stability through (1) the making and re-making of identities of people designing or using technology (as for example competent and authentic), (2) the making of institutions, for example R&D units, that reproduce ways of designing technologies, (3) the making of discourses that upholds certain views on gender and technology (in for example consumer tests or textbooks), and (4) the making of representations such as use metrics, that uphold stable practices because metrics may make practices seem 'natural'. A key advantage of adopting a co-production framework is that, when we investigate the production of stability and repetition with respect to gender and smart technologies, we may at the same time observe sources of instability and change.

The latter point is rooted in the cyborg metaphor, introduced by Donna Haraway (1991). She argues that the cyborg figure represents an implosion of human and machine, which seems a pertinent perspective given the invasive character of smart technologies into bodies and human life. Haraway is particularly interested in disruptions and ambiguities in the relation between gender and technoscience. She advocates the exploration of the relationships between men, women and technology and the need to pay attention to the complexities and contradictions of these relationships. A significant point is that cyborgs are infused what Haraway calls trickster qualities, a mix of seductive features and surprising outcomes. This seems a highly relevant perspective on smart technologies, given how they are entrenched in promissory discourses about progress.

Some have also advocated that a version of actor-network theory (ANT) is useful to study gender and technology (Lagesen 2012; Singleton 1995). These efforts share some features with the cyborg approach, not the least the focus on the interactions between human and non-human elements of an object of study, but ANT emphasises the process of assembling the elements that constitute the object. A main tenet of ANT is that society is an achievement of actors (human and nonhuman) engaged in producing a variety of associations among human and nonhuman elements. Researchers should trace these associations by following the actors engaged in making them (Latour 2005). Hence, we should see the hybrids of gender and smart technologies discussed in this chapter as outcomes of processes of reassembling associations among human and nonhuman elements. From this perspective, when a woman engages with a smartphone or a smartwatch, she might end up doing gender as well organising her everyday life in a different way than before, with potentially variable outcomes.

The Economist editorial we quoted in the introduction should serve as a reminder that the making of smart technologies means business; that the endgame is profit. This is of course an important aspect of the processes of assembling for example a smartphone. The many instances listed by Perez (2019) suggest that often women are not included in the assembling efforts; they are not part of the equation. This does not mean that women never are in focus. For example, as Cassidy (2001) shows, during the 1990s, the US computer industry tried to advertise the personal computer with a kind of feminine identity. These advertisements promoted the idea that personal computers were an important work tool as well as an instrument of developing family life. One of the most highly profiled initiatives to include women as users of ICT – in this case girls and computer games – was the development of the 'Barbie Fashion Designer', a video game that has been described as 'a beachhead in the dynamic dialogue between girls and computers'. This interpretation offers a glimpse into what Sherry Turkle (2011) calls 'the mirror of the machine', the ability of computers to highlight the possibilities in using ICT to foreground different and possibly evolving images of femininity to be experienced.

The Barbie fashion designer game has also been heralded as an example of what Cassell and Jenkins (1998: 14f) calls entrepreneurial feminism, an assembly strategy that includes feminist ideas in the targeting of new markets consisting of women. Hendrik Spilker and Knut H.

Sørensen (2000, 2002) analysed two other examples of entrepreneurial feminism. The first was the design and marketing of a CD-ROM meant to help young women discover the world of personal computers and the Internet. They labelled this kind of inclusion effort women-in-particular because the design sought to attract young women specifically by guiding the assembly efforts to include elements thought to be particularly interesting to this group. The second example was found in one media consortium's effort to make their web page attractive to all 'normal' users, women as well as men. This women-and-everybody-else strategy was based on efforts to make women part of the hybrid of web technology and active users of the Internet. The web design was guided by the idea that there existed a standardised, unisex mode for utilising the web page. Making the web page accordingly was assumed to make it particularly attractive to women.

In the following, we return to the topical issues identified in the introduction. First, we discuss the argument of women's invisibility in the making of smart technologies and some of the consequences of this. Then we move 'upstream' to review some of the more recent literature on women in computer science and engineering, reflecting on what the continued underrepresentation of women convey about the sociotechnical imaginaries related to smart technologies. In the conclusion, we discuss the possible co-production of using men as the measure of most (all?) smart technologies and the lack of women engaged in the design of these technologies.

## In the image of men

The argument of women's invisibility implies a particular gendering of smart technologies, where women's needs and tastes are not considered. By gendering we mean a process of assembling human and non-human elements where gender biases influence the process, intentionally or not. Often, biases are unconscious reflections, but they may also result from ideological conviction or explicit endorsement of gender stereotypes. Importantly, the gendering of objects may not be stable. For example, in 2004 Epson launched a printer for women, designed by an all-women team. The Epson E-100 printer was shaped like a beauty-box and came out of an 'All Women, For Women' programme through an effort to make a printer that was 'easy for women to use'. The printer was designed and marketed in Japan. Interestingly, the same printer was marketed in the United States. The only noticeable difference was the colour, which was changed to grey metallic. In the US, this printer was advertised as a printer for both men and women (Sørensen and Lagesen 2005).

The example of the printer for women illustrates the difficulty with translating gender unambiguously into physical form. As Sørensen (1992) points out, it is generally hard to explicitly implement masculine (or feminine) values in the design of technologies. The problem partly stems from the non-linearity of design processes, but also in assigning gender to physical form. When engineering students in Sørensen and Berg's (1987) study aligned big, noisy and dirty technologies to men and small, silent and clean technologies to women, this reflected stereotypical perceptions of men and women's work. The students' gendering of technologies was based on gendered interpretations of different kinds of work.

Still, technologies may be seen as gendered in a more literal sense, with reference to physiological differences. Perez (2019: 159f) points to the size of smartphones as an example of the gendering of smart technologies, arguing that the relatively large screens of the most advanced mobiles on the average fit men's hands better than those of women. Voice recognition is another example. Such features play an increasing role in the design of smart technologies. However, such systems tend to recognize men's voices better than women's, even if women have higher speech intelligibility. Yet another of Perez's examples is the implicit gender bias in the algorithms of many artificial intelligence systems, such as those used to assess CVs of job applicants in some companies. These biases may not be intended but just a result of unreflected application of gender stereotypes.

There is a deep irony in that a society where it is commonly believed that the differences between men and women have a biological origin, technoscientists do biomedical and psychological research and design technologies as if there were no such dissimilarities. The idea seems to be that it is sufficient to study men or depart from men's practices, even if the outcomes are supposed to serve everybody. This contrasts even design strategies where the aim is to serve 'women and everybody else' (Spilker and Sørensen 2002). As we read Perez, gender bias with respect to smart technologies refers to at least three different practices:

- Unreflexively adapting technologies to men's anatomy, such as the size of hands or the sound of voices.
- Generalising from studies of men.
- Neglecting behavioural differences.

An example of the third kind of bias is the design of health apps for mobiles based on the assumption that the phone always is carried on the body. While men tend to have their mobiles in their pockets, which produces somewhat reliable data of movements, women tend to have their mobiles in their handbags. Arguably, smartphones contribute to the cyborg features of today's people, but from a gender equality perspective, their trickster features are evident.

To a considerable extent, such gender biases are the result of sloppy and unreflexive design where user involvement is, at best, weak and limited. This is aptly illustrated by the development of so-called smart homes. Smart homes are heterogeneous assemblages of a variety of smart technologies, buildings, appliances, work, consumption, entertainment, emotions, aesthetics, etc. (Maalsen 2020; Wilson et al. 2015). The phenomenon also referred to as home automation dates back to at least the 1960s, promising protection, productivity and pleasure (Strengers et al. 2019). When Anne-Jorunn Berg (1994) studied efforts of constructing smart homes in the US, she found that the underlying ideas reflected the interests and fascinations of the men involved in the design. Housework, however, received little attention and was something of which the designers knew little. The gender bias was evident but not in a binary fashion. The smart home was not designed to cater to the interests of all men but to men with an outspoken fascination for technology, probably also with considerable technical competence.

Yolande Strengers (2013, 2014) uses the label 'the Resource Man' to signify such men as those implicitly or explicitly targeted by the smart home designers. She developed this concept from studies of one aspect of smart homes – energy consumption. The Resource Man is a person, usually a man, who "embodies a unified vision for the smart energy consumer […]. In his ultimate state, the Resource Man is interested in his own energy data, understands it, and wants to use it to change the way he uses energy" (Strengers 2014: 26). The Resource Man is an assemblage of gender, competence, interest and probably also income, since many smart home technologies are quite expensive. He may also be considered a digital housekeeper (Kennedy et al. 2015), the person who manage the digital technologies of a household, such as broadband connections, routers, computers and digital media. This is a concept that highlights the gendered distribution of expertise and engagement with smart technologies.

From a feminist perspective, it is interesting to note a trickster quality of smart home technologies that affect men. The enactment of the role of the Resource Man or the digital housekeeper is time consuming. Thus, as Strengers and Nicholls (2018) note, it means ‘more work for father’, playing with Ruth Schwartz Cowan’s (1989) classic book title ‘More work for mother’. It aptly summarises Cowan’s findings from her analysis of the consequences of the development of household technologies for white, middle-class women in the US. Thus, the gendering of smart home technologies may be experienced as ambiguous. ‘More work for father’ probably also means than the Resource Man exercises greater influence regarding the acquisition and the domestication of these technologies but otherwise and that smart homes mainly retain the gendered division of labour well known from ‘normal’ households.

Robots developed for domestic use, such as vacuum cleaners, lawnmower and window cleaners, may also involve ‘more work for father’. However, Fortunati (2018) argues that the domestic sphere now is replacing the workplace as the most important area for innovation in robotics, which should lead to the design of robots that can take part in other kinds of housework and care. How this will affect the gendered division of labour in households is still an open issue. It is reasonable to believe that housework and care work will be transformed, but it is too early to speculate if this will lead to less work for both men and women or if Cowan’s history will be repeated, that more tasks with higher demands on quality will be performed in the household of the future.

Even if some developers claim that their robots are gender-neutral, robots are easily gendered (Søraa 2017). Not the least, the shape and the sound of the voice of a robot tend to be interpreted as either masculine or feminine. This perception may affect the interaction between humans and robots, but the gendering of such interactions appears to be shifting and complex (Nomura 2017). Moreover, gendering of robots may happen because “Much of what roboticists take for granted in their own gendered socialization and quotidian lives is reproduced and reified in the robots they design (…). How robot-makers gender their humanoids is a tangible manifestation of their tacit understanding of femininity in relation to masculinity, and vice versa” (Robertson 2010: 4). However, the gendering of robots may also be quite explicit, for example in the design of sex robots (Strengers and Kennedy 2020).

Thus, there is a considerable risk that robots will be gendered because their design departs from established practices and entrenched gender bias. A similar phenomenon has been observed with respect to artificial intelligence and machine learning. To train machines, huge amounts of data are accessed from existing datasets, and these datasets tend to reflect existing, gendered practices (Zou and Schiebinger 2018; Schiebinger and Ogawa 2018). To avoid such tacit gendering will require concerted action.

This argument is augmented by Strengers and Kennedy (2000). They argue that main parts of the present development in robotics and AI may be interpreted as the making of what they call 'smart wives' – digital assistants that are feminised to appear as friendly and sometimes flirty, docile and efficient. The aim of the development, Strengers and Kennedy claim, is to design smart technologies by digitally reproducing the stereotypical housewife of the 1950s: a white, middle class and heteronormative housekeeper with high standards for cleanliness and personal services. In this way, there is considerable risk that developments in robotics and AI contribute to uphold outdated stereotypes, even reversing progress with respect to gender, sexual, and ethnic equality. Consequently, Strengers and Kennedy ask for a reboot of 'the smart wife'.

The critical observations made above are also relevant with respect to 'smart cities', which represent another sociotechnical imaginary that is based on smart technologies, above all the so-called Internet of Things (Talari et al. 2017, Silva et al 2018). The European Union present its version of the imaginary as:

> A smart city is a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business. A smart city goes beyond the use of information and communication technologies (ICT) for better resource use and less emissions. It means smarter urban transport networks, upgraded water supply and waste disposal facilities and more efficient ways to light and heat buildings. It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population.[5]

The smart city imaginaries such as the one quoted above tend to be without any concern for gender (or ethnicity for that matter); the underlying idea is progress for everybody. Such assemblages of technologies are implicitly assumed to be able to cater flexibly to all sorts of needs, without any outspoken consideration of priorities, differences and conflicts among the public. Thus, arguably, smart cities are gendered through the neglect of gender issues. An example is mobility, where needs and travel patterns definitively are gendered (Uteng 2019). The neglect may be due to the fact that smart city technologies largely are tools of governance,

[5] https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en (accessed 2020-05-14).

particularly through various forms of surveillance – sensors, cameras, etc. – and the use of models and algorithms to analyse and make sense of the large amount of data that is produced. The number crunching allows for indicators of pollution, traffic, energy use, water supply and so on. Maybe the Resource Man will find these indicators useful, but who else besides city bureaucrats? On the other hand, digital surveillance has potentially harmful consequences for women and people of colour emanating from the employment of stereotypes in designs and calculations rather than neglect (Dubrofsky and Magnet 2015).

Oudshoorn et al. (2016) take these arguments further by suggesting that diversity gets lost in the design of smart technologies. It is not just gender that is neglected. Age, class and ethnicity also tend to be overlooked. This is a bit surprising, given an increasing concern for diversity in many societies. However, the communities engaging in the development of smart technologies may have been oblivious to such concerns, maybe because of the widespread tradition of considering *the* user in singular in design discourses (Woolgar 1990, Akrich 1995). Another issue may be the lack of diversity within these communities, such as their gender imbalance. Thus, we need to look further at why the ICT professions are so resilient with respect to improving the gender diversity of the industry.

## A world of and for men

For 25 years, researchers have engaged with the issue of why there are so few women studying and working with computer science and engineering, finding many explanations as shown above. The state of affairs has remained the same, despite numerous attempts to make amendments. Thus, the field of computer science seems to be and to remain gendered to the effect that women continue to be a minority in the field. This situation could be interpreted as the outcome of a co-production of gender and technology (Vitores and Gil-Juárez 2016). However, some care should be exercised. Women are not a minority in computer science everywhere (Johnson et al. 2019). One such example is Malaysia, where women constitute a majority of computer science students and computer science is considered 'suitable' for women (Lagesen 2008). Clearly, the gendering of computer science depends on cultural context. Similarly, in the US, women dominated as programmers in the 1940s, because programming was interpreted as secretarial work (Ensmenger 2010).

Still, in countries such as the US, which has been in the forefront of the development of smart technology, men dominate the industry. The situation seems similar in China and in countries in Western Europe. The gender balance was considerably better until the late 1980s, as Nathan Ensmenger observes in his book (2010) "The computer boys take over". He explains the gendering process as related to the recruitment practices of the computer industry

> The primary selection mechanism used by the industry selected for antisocial, mathematically inclined males, and therefore antisocial, mathematically inclined males were overrepresented in the programmer population; this in turn reinforced the popular perception that programmers ought to be antisocial and mathematically inclined (and therefore male), and so on ad infinitum. Combined with the often-explicit association of programming personnel with beards, sandals, and scruffiness, it is no wonder that women felt increasingly excluded from the center of the computing community (Ensmenger 2010: 78-79).

Thus, the gendering process provided for a subgroup of men with special qualities, qualities that were reflected in recruitment tests, etc. The outcome seems to follow Phelp's (1972) statistical theory of racism and sexism. The computer industry did not search for women but not for all kinds of men either. As Ensmenger shows, programming was made into something mysterious that required special skills and attitudes. In turn, this contributed to an image of the computer industry that reinforced the limited recruitment, providing for a rather homogeneous set of employees with a homogeneous culture. The result has been the development of what Chang (2018) calls a 'Brotopia', a technology-focused, promissory culture of men that features aggressiveness, misogyny and workaholism. The few women that succeed clearly struggle.[6]

Chang's information stems from Silicon Valley companies. They may not be representative of the industry more generally, but there is little doubt that companies such as Google and Facebook are at the front of developing smart technologies. This makes the 'Brotopia' culture an important context of smart technologies. Moreover, the Silicon Valley companies may represent an extreme version of an exclusive, homogeneous culture of men computer specialists, but even more moderate versions seem just as dominated by men. The mechanisms of exclusion may be different but no less effective in keeping women (and many men) out. Only a subset of men with special interests and personal qualities is engaged in the making of smart technologies. The culture seems akin

[6] https://fortune.com/2020/10/09/sheryl-sandberg-lean-in-rachel-thomas-women-leaving-workforce/ (accessed February 3, 2021).

to the hacker cultures, described as dominated by men, androcentric, stuck in discourses of meritocracy that mask inequity and lack of diversity and allowing for sexual harassment and exclusion of women (Steinmetz et al. 2020).

It is worrisome that the culture underpinning the development of smart technologies has proved to be so resilient to improve the diversity of the workforce. Numerous attempts have been made to recruit women students to computer science and engineering. Some of these have been successful (Frieze and Quesenberry 2019, Lagesen 2007, Margolis and Fisher 2002) but less so in the long run. This contrasts remarkably to the substantial changes in the gender balance that have taken place in formerly men dominated professions such as medicine and law. As we observed previously, explanations of the lack of women in computer science and engineering is abound. However, we know much less about the mechanisms that also seem to keep many men out of the making of smart technologies, even though Ensmenger's research provide useful indications. His observations of the industry's emphasis on antisocial and mathematical inclination when they recruit, is also a sign of warning regarding the gendering of smart technologies. The resulting culture seems a problematic point of departure for design of inclusive smart technologies as well as technologies that address a wider range of needs than those of the small subgroup of men employed in the industry.

Thus, we suspect that smart technologies may be gendered, often intentionally, to serve a subset of men such as 'the Resource Man' (Strengers 2013; 2014), although 'the smart wife' may attract wider popularity (Strengers and Kennedy 2020). We know that women use a lot of the technologies we call smart and that women encounter many such technologies that supervise or control them as well as men, such as we find in 'smart cities'. Despite the striking examples highlighted in Perez (2019), the most important problem is not the exclusion of women but the feeble efforts to include them (Sørensen et al. 2011).

## Conclusion: the gendering of smart technologies through the co-production of the lack of women and the lack of interest in women

We argue that the dual gendering of designers of smart technologies as well as the content/shape of these technology remain stable and resilient to change. Sheila Jasanoff's idiom of co-production offers some important clues about why this dual gendering seems so entrenched, also in the case of a rather dynamic development of technology. As previously mentioned, she invites us to consider the following four ordering instruments: making identities, making institutions, making discourses, and making representations. These ordering instruments have helped to stabilise the gender and computer technologies as we have demonstrated above. For example, the identity of ICT professionals has been gendered in a quite stable way. The predominant elements include being a man with little social interest, a competitive orientation, and good mathematical skills. According to Ensmenger (2010), this identity is reproduced through the recruitment policy of the ICT industry and it provides for boundary work to keep the industry – at least the technology professionals – employing only an exclusive group of people (Lagesen and Sørensen 2009). Thus, the ICT industry works as an institution that is a stable repository of knowledge and power, despite the discourse of disruptive innovations that has been prevalent for quite some time. Moreover, there is no disruption in the gendered discourse of expertise, which place women on the outside of the world of designing smart technologies. This discourse has mobilised and continues to mobilise a representation of the profession of computer science and engineering as gender inauthentic to women (Faulkner 2009). In addition, the ICT industry is – as we have shown – experienced by women as a chilly and sometimes also as a hostile environment that is not particularly attractive as a place of work.

In turn, we have identified a co-production of the exclusion of women from the design of smart technologies and the lack of concern for gender diversity when engaging with such design. The invisibility of women in this context (Perez 2019) is largely due to the unreflected masculine identity of the design experts, the institutionalised tradition of the ICT industry for preferring men employees, the gender-blind promissory discourses of this industry, and the long-term tradition for using (some) men as representative of humanity. This does not mean that in general, smart technologies do not fit women and their needs, but rather that such fit is accidental. The unreflected application of the so-called I-methodology of design means that too many artefacts and system primarily are made to be attractive and useful to the Resource Man and the digital housekeeper. The I-methodology refers to a design practice in which designers consider themselves as representative of the users (Oudshoorn et al. 2004). Akrich (1995: 173) describes it as the "reliance on personal experience, whereby the designer replaces his professional hat by that of the layman".

How may more women be included in the design of smart technologies, as experts as well as potential users? Clearly, this is not achieved through quick fixes. The ICT industry does little to attract women and to make them feel welcome once they are there. Rather, the frequent display of 'brotopia' cultures alienates many women and make women into outsiders – thus excluding women from the making of smart technologies. The many initiatives to recruit more women as students of computer science and engineering provides evidence of this pessimistic conclusion, since it appears that only very long-term, long lasting inclusion efforts have any sizeable effect (Lagesen 2011). Still, they may not lead to an improved gender balance in ICT companies (Simonsen and Corneliussen 2019). The industry claims to initiate actions to recruit more women, but the results are disappointing. Londa Schiebinger directs the EU/US Gendered Innovations in Science, Health & Medicine, Engineering, and Environment Project, which aims to improve gender equality in innovations.[7] This represents an effort to produce an alternative discourse about gender, science and technology, which also asks the designers of smart technologies to actively change their tacit use of gender bias (Zou and Schiebinger 2018; Schiebinger and Ogawa 2018). The impact of this project will at best be long-term.

The concern for gender equity is also integrated in the policy for Responsible Research and Innovation (RRI), which the European Union has adopted together with several other countries.[8] Considerable efforts have been put into the development of tools to do RRI, which includes quite a few initiatives to address gender issues.[9] Bührer and Wroblewski (2019) show, using a survey conducted among European researchers, that two items dominate in the gender equality activities reported: encouragement of gender-balanced teams and provision of specific support for women within teams. However, few respondents said that they explicitly dealt with gender issues in their research.

[7] http://genderedinnovations.stanford.edu/
[8] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation
[9] See, e.g., Fit4RRI (https ://fit4rri.eu/), RRI Tools (https ://www.rri-tools.eu/), and FOSTER (https :// www.fosteropenscience.eu/).

The editorial in The Economists that we quoted in the introduction, identifies a lack of concern for women's needs and preferences as a missed business opportunity. Maybe this will be more widely recognised by the industry and initiate the comprehensive reforms that are called for to ensure a healthier and more including tech industry. Governments could also be mobilised, but as Palmén et al. (2019) argue, based on a study of seven European countries, the "countries surveyed are currently reluctant to impose bureaucratic gender equality obligations on the business sector" (162). Thus, unfortunately, we may have to expect that the problem of harmful gendering of smart technologies will remain with us for quite some time unless both industry and government seize to take serious action. The temptation to use femininity just as a superfluous design and advertising move may be too great (Sørensen and Lagesen 2005).

**Acknowledgements**

We have received no funding for this research. We are grateful to the editors and an anonymous reviewer for very useful comments.

# References


Abbate, J. (2012): *Recoding gender: Women's changing participation in computing*. Cambridge, MA: The MIT Press.

Ahuja, M. K. (2002): Women in the information technology profession: A literature review, synthesis and research agenda. *European Journal of Information Systems* 11, 20-34.

Akrich, M. (1995): User representations: Practices, methods and sociology, in Rip et al (eds.): *Managing Technology in Society: The Approach of Constructive Technology Assessment*. London, UK: Pinter Publishers, 167-184.

Archibald, J., J. Emms, F. Grundy, J. Pane and Turner, E. (eds.) (2005): *The Gender Politics of ICT*. London: Middlesex University Press.

Barker, J. L. and Aspray, W. (2006): The state of research on girls and IT, in Cohoon, J.M. and Aspray, W. (eds): *Women and Information Technology: Research on Underrepresentation*. Cambridge, MA: The MIT Press, 3-54.

Bell, D. and Kennedy, B. M. (eds.) (2000): *The Cybercultures Reader*. London, UK: Routledge.

Berg, A.-J. (1994): A gendered socio-technical construction: the smart house, in C. Cockburn and Fürst-Dilić, R. (eds): *Bringing Technology Home: Gender and Technology in a Changing Europe*. Open University Press, Milton Keynes, 165-180.

Blickenstaff, C. J. (2005): Women and science careers: leaky pipeline or gender filter? *Gender and education* 174, 369-386.

Bührer, S. and Wroblewski, A. (2019): The practice and perceptions of RRI—A gender perspective. *Evaluation and Program Planning* 77, 101717

Cassell, J. and Jenkins, H. (1998): Chess for girls? Feminism and computer games, in Cassel, J. and Jenkins, H. (eds.): *From Barbie to Mortal Kombat, Gender and Computer Games*. Cambridge, MA: The MIT Press, 2-45.

Cassidy, M. F. (2001): Cyberspace meets domestic space: Personal computers, women's work, and the gendered territories of the family home. *Critical Studies in Media Communication* 18 (1), 44-65.

Chang, E. (2018): *Brotopia. Breaking up the boys' club of Silicon Valley*. New York: Penguin

Cockburn, C. (1983): *Brothers. Male Dominance and Technological Change*. London: Pluto Press.

Cockburn, C. (1985): *Machinery of Dominance*. London, UK: Pluto Press.

Cockburn, C. and Fürst-Dilic, R. (eds.) (1994): *Bringing Technology Home: Gender and Technology in a Changing Europe*. Maidenhead, Berkshire, UK: Open University Press.

Cockburn, C. and Ormrod, S. (1993): *Gender & Technology in the Making*. Thousand Oaks, CA: Sage.

Cohoon, J. M. and Aspray, W. (2006): A critical review of the research on women's participation in postsecondary computing education, in Cohoon, J. M. and Aspray, W. (eds.): *Women and Information Technology: Research on Underrepresentation*. Cambridge, MA: MIT Press, 137-180.

Cowan, R. S. (1983): *More work for mother*. New York: Basic books.

Cronin, C. and Roger, A. (1999): Theorizing progress: Women in science, engineering, and technology in higher education. *Journal of Research in Science Teaching* 36 (6), 636-661

Dubrofsky, R. E. and Magnet, S. A. (eds.) (2015): *Feminist surveillance studies*. Durham, NC: Duke University Press.

Ensmenger, N. (2010): T*he Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise*. Cambridge, MA: The MIT Press.

Everett, A. (2004): On cyberfeminism and cyberwomanism: High-tech mediations of feminism's discontents. *Signs: Journal of Women in Culture and Society* 30(1), 1278-1286.

Faulkner, W. (2001): The technology question in feminism: A view from feminist technology studies. *Women's Studies International Forum* 24 (1), 79-95.

Faulkner, W. (2009): Doing gender in engineering workplace cultures: Part II—The in/visibility paradox. *Engineering Studies* 1 (3), 169-189.

Fortunati, L. (2018): Robotization and the domestic sphere. *New Media & Society* 20(8), 2673-2690

Fox, M. F., G. Sonnert and Nikiforova, I. (2009): Successful programs for undergraduate women in science and engineering: Adapting versus adopting the institutional environment. *Research in Higher Education* 50, 333-353.

Frieze, C. and Quesenberry, J. L. (eds.) (2019): *Cracking the Digital Ceiling: Women in Computing Around the World*. Cambridge, UK: Cambridge University Press.

Gansmo, H. J., V. A. Lagesen and Sørensen, K. H. (2003a): Forget the hacker? A critical re-appraisal of Norwegian studies of gender and ICT, in Lie, M.(ed.): *He, She and IT Revisited: New Perspectives on Gender in the Information Society*. Oslo, Norway: Gyldendal Akademisk, 34-68.

Gansmo, H. J., V. A. Lagesen and Sørensen, K. H. (2003b): Out of the boy's room? A critical analysis of the understanding of gender and ICT in Norway. *Nora Nordic Journal of Women's Studies.* 11 (3), 130-139.

Hacker, S. (1989): *Pleasure, Power, and Technology: Some Tales of Gender, Engineering and the Cooperative Workplace*. Boston, MA: Unwin Hyman.

Hacker, S. (1990): *Doing It the Hard Way: Investigations of Gender and Technology*, eds. D. E. Smith and S. M. Turner. Boston. MA: Unwin Hyman.

Haraway, D. (1991): A cyborg manifesto: Science, technology and socialist-feminism in the late twentieth century, in Haraway, D. (ed.): *Simians, Cyborgs and Woman: The Reinvention of Nature.* London, UK: Routledge, 149-181.

Hawthorne, S. and Klein, R. Eds. (1999). *Cyberfeminism.* North Melbourne: Spiniflex

Horowitz, R. Ed. (2013). *Boys and their toys: Masculinity, class and technology in America*. New York: Routledge.

Husu, L. (2001): On metaphors on the position of women in academia and science. *NORA: Nordic Journal of Women's Studies*, 93: 172-181.

Jasanoff, S. (2004): Ordering knowledge, ordering society, in Jasanoff, S. (ed.): *States of Knowledge: The Co-Production of Science and Social Order*. London, UK: Routledge, 13-45.

Johnson, N., Garcia, J. and Seppi, K. (2019): Women in cs: changing the women or changing the world?, in 2019 IEEE Frontiers in Education Conference (FIE) IEEE, 1-8.

Kafai, Y. B., C. Heeter, J. Denner and Sun, J. Y. (eds.) 2008: *Beyond Barbie and Mortal Kombat. New Perspectives on Gender and Gaming*. Cambridge, MA: The MIT Press.

Kennedy, J., Nansen, B., Arnold, M., Wilken, R. and Gibbs, M. (2015): Digital housekeepers and domestic expertise in the networked home. *Convergence* 21(4), 408-422.

Kleif, T. and Faulkner, W. (2003): "I'm no athlete [but] I can make this thing dance!"—Men's pleasures in technology. *Science, Technology, & Human Values* 28 (2), 296-325.

Lagesen, V. A. (2007): The strength of numbers: Strategies to include women into computer science. *Social Studies of Science* 37 (1), 67-92.

Lagesen, V. A. (2008): A cyberfeminist utopia? Perceptions of gender and computer science among Malaysian computer science students. *Science, Technology, & Human Values* 33 (1), 5-27.

Lagesen, V. A. (2011): Getting women into computer science, in Sørensen, K. H., Faulkner, W. and Rommes, E.: *Technologies of Inclusion. Gender in the Information Society*. Trondheim: Tapir Academic Press, 147-169.

Lagesen, V. A. (2012). Reassembling gender: Actor-network theory (ANT) and the making of the technology in gender. *Social Studies of Science*, 42(3): 442-448.

Lagesen, V. A. and Sørensen, K. H. (2009): Walking the line? The enactment of the social/technical binary in software engineering. *Engineering Studies* 1 (2), 129-149.

Latour, B. (2005): *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford, UK: Oxford University Press.

Lie, M. and Sørensen, K. H. Eds. (1996). *Making technology our own? Domesticating technology into everyday life.* Oslo: Scandinavian University Press

Maalsen, S. (2020): Revising the smart home as assemblage. *Housing Studies*, 35(9), 1534-1549.

Margolis, J. and Fisher, A. (2002): *Unlocking the clubhouse: Women in computing.* Cambridge, MA: The MIT press.

Mellström, U. (1995): *Engineering Lives: Technology, Time and Space in a Male-Centred World*. Linköping, Sweden: Linköping studies in arts and sciences.

Mellström, U. (2003): *Masculinity, Power and Technology: A Malaysian Ethnography*. Aldershot, Hampshire, UK: Ashgate.

Merchant, C. (1980): *The Death of Nature: Women, ecology and the scientific revolution*. San Francisco, CA: Harper & Row.

Millar, J. and N. Jagger. (2001). *Women in ITEC Courses and Careers*. UK, Department of Trade and Industry

Misa, T. J. (ed.) (2010): *Gender codes. Why women are leaving computing*. New Jersey: Wiley

Moratti, S. (2020): What's in a word? On the use of metaphors to describe the careers of women academics. *Gender and Education* 327, 862-872.

Mundy, L. (2017): Why is Silicon Valley so awful to Women? *The Atlantic* 319, 60-73.

Nomura, T. (2017): Robots and gender. *Gender and the Genome* 1(1), 18-25.

Noble, D. F. (1992): *A World Without Women: The Christian Clerical Culture of Western Science.* New York: Alfred A. Knoph.

Nordli, H. (2003): *The net is not enough. Searching for the female hacker*, Ph.D. thesis, STS report 61/2003. Trondheim, Norway: Centre for Technology and Society, NTNU.

Norris, P. (2001): *Digital Divide. Civic Engagement, Information Poverty, and the Internet Worldwide*. West Nyack, New York: Cambridge University Press.

Oldenziel, R. (1999): *Making Technology Masculine: Men, Women and Modern Machines in America 1870-1945.* Amsterdam, the Netherlands: Amsterdam University Press.

Oudshoorn, N., Neven, L. and Stienstra, M. (2016): How diversity gets lost: Age and gender in design practices of information and communication technologies. *Journal of women & aging* 28(2), 170-185.

Oudshoorn, N., Rommes, E. and Stienstra, M. (2004): Configuring the user as everybody: Gender and design cultures in information and communication technologies. *Science, Technology, & Human Values* 29(1), 30-63.

Palmén, R., Schmidt, E. K., Striebing, C., Reidl, S., Bührer, S. and Groó, D. (2019): Measuring gender in R&I–theories, methods, and experience. *Interdisciplinary Science Reviews*, 44(2), 154-165.

Perez, C. C. (2019): *Invisible women. Exposing data bias in a world designed for men*. London: Chattoo & Windus

Phelps, E. S. (1972): The statistical theory of racism and sexism. *The American Economic Review* 62(4), 659-661.

Plant, S. (1997): Zeroes and Ones: Digital Women and the New Technoculture. London, UK: Doubleday and Forth Estate.

Rasmussen, B. and Håpnes, T. (2003): Gendering technology; Young girls negotiating ICT and gender, in Lie, M. (ed.): *He, She and IT Revisited; New Perspectives on Gender in the Information Society.* Oslo, Norway: Gyldendal Akademisk, 173-197.

Robertson, J. (2010): Gendering humanoid robots: Robo-sexism in Japan. *Body & Society,* 16(2), 1-36.

Rommetveit, K, Dunajcsik, M. Tanas, A. Silvast, A. and Gunnarsdóttir, K. (2017): The CANDID Primer: Including Social Sciences and Humanities scholarship in the making and use of smart ICT technologies (edited by K Gunnarsdóttir). CANDID (H2020-ICT-35-2016) D5.4. Available at: http://candid.no/progress [25.05.2020]

Schiebinger, L. and Ogawa, M. (2018): Gendered Innovations in Medicine, Machine Learning, and Robotics. *Trends in the sciences* 23(12), 12_8-12_19.

Silva, B. N., Khan, M. and Han, K. (2018): Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities. *Sustainable Cities and Society* 38, 697-713.

Simonsen, M. and Corneliussen, H. G. (2020): Can Statistics Tell Stories about Women in ICT? Tracing men and women's participation in fields of ICT through statistics for Norway, Nordic countries and Europe. Available at: https://www.vestforsk.no/sites/default/files/2020-02/Simonsen_Corneliussen_2019_Can_Statistics_Tell_Stories_about_Women_in_ICT_1.pdf [25.05.2020]

Singleton, V. (1995): Networking constructions of gender and constructing gender networks. In: Grint, K. and Gill, R. (eds.); *The Gender/Technology Relation*. London: Taylor & Francis, 146-173.

Sørensen, K. H. (1992): Towards a feminized technology? Gendered values in the construction of technology. *Social Studies of Science* 22(1), 5-31.

Sørensen, K. H. and Berg, A.-J. (1987): Genderization of technology among Norwegian engineering students. *Acta Sociologica* 2, 151-171.

Sørensen, K. H., W. Faulkner and Rommes, E. (2011): *Technologies of inclusion. Gender in the information society*. Trondheim: Tapir Academic Press

Sørensen, K. H. and Lagesen, V.A. (2005): Cyberfeminism revisited: is ICT either feminine or masculine? STS working paper 1/2005. Trondheim: NTNU. http://dx.doi.org/10.13140/RG.2.2.28487.83367

Søraa, R. A. (2017): Mechanical genders: how do humans gender robots? *Gender, Technology and Development* 21(1-2), 99-115.

Spender, D. (1995): Nattering on the Net: Women, Power and Cyberspace. North Melbourne, Victoria, Australia: Spinifex Press.

Spilker, H. and Sørensen, K.H. (2000): A ROM of one's own or a home for sharing? Designing inclusion of women in multimedia. *New Media & Society* 2 (3), 268-285.

Spilker, H. and Sørensen, K. H. (2002). Feminism for profit? Public and private gender politics in multimedia, in Sørensen, K. H and Williams, R. (eds.): *Shaping Technology/Guiding Policy: Concepts, Spaces and Tools*. Cheltenham, UK: Edward Elgar, 243-263.

Steinmetz, K. F., Holt, T. J. and Holt, K. M. (2020): Decoding the Binary: Reconsidering the Hacker Subculture through a Gendered Lens. *Deviant Behavior*, 41:8, 936-948 .

Strengers, Y. (2013): *Smart energy technologies in everyday life: Smart Utopia*? Springer.

Strengers, Y. (2014): Smart energy in everyday life: are you designing for resource man? *Interactions* 21(4), 24-31.

Strengers, Y. and Kennedy, J. (2020): *The Smart Wife: Why Siri, Alexa, and Other Smart Home Devices Need a Feminist Reboot*. Cambridge, MA: The MIT Press.

Strengers, Y., Kennedy, J., Arcari, P., Nicholls, L. and Gregg, M. (2019): Protection, productivity and pleasure in the smart home: Emerging expectations and gendered insights from Australian early adopters, *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1-13.

Strengers, Y. and Nicholls, L. (2018): Aesthetic pleasures and gendered tech-work in the 21st-century smart home, *Media International Australia* 166(1), 70-80.

Talari, S., Shafie-Khah, M., Siano, P., Loia, V., Tommasetti, A. and Catalão, J. P. (2017): A review of smart cities based on the internet of things concept. *Energie 1*0(4), 421.

Turkle, S. (1984): *The Second Self: Computers and the Human Spirit*. New York: Simon and Schuster.

Turkle, S. (1988): Computational reticence; why women fear the intimate machine, in Kramarae, C. (ed.): *Technology and Women's Voices: Keeping in Touch*. London: Routledge and Kegan Paul, 41-61.

Turkle, S. (2011): *Alone Together. Why We Expect More from Technology and Less from Each Other*. New York: Basic Books.

Uteng, T. P. (2019): Smart Mobilities: A Gendered Perspective. *Kart og Plan* 112(04), 258-281.

van Zoonen, L. (2002): Gendering the internet. Claims, controversies and cultures*, European Journal of Communication* 17 (1), 5-23.

Vitores, A. and Gil-Juárez, A. (2016). The trouble with 'women in computing': a critical examination of the deployment of research on the gender gap in computer science. *Journal of Gender Studies,* 25(6): 666-680.

Wajcman, J. (2004): *Technofeminism*. Cambridge, UK: Polity Press.

Webster, J. (1996): *Shaping Women's Work: Gender, Information Technology and Employment*. London: Longman

Weizenbaum, J. (1976): *Computer Power and Human Reason: From Judgment to Calculation*. San Francisco, CA: W. H. Freeman.

Wilson, C., Hargreaves, T., and Hauxwell-Baldwin, R. (2015): Smart homes and their users: a systematic analysis and key challenges. *Personal and Ubiquitous Computing* 19(2), 463-476.

Woolgar, S. (1990): Configuring the user: the case of usability trials. *The Sociological Review* 38(1_suppl), 58-99.

Zou, J. and Schiebinger, L. (2018): AI can be sexist and racist — it's time to make it fair. *Nature* 559, 324-326.