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FROM WOMEN AND TECHNOLOGY TO GENDERED TECHNOSCIENCE

This paper situates current discussions of women's position in ICTs in the wider context of feminist debates on gender and technology. While a common trend among early feminist theorists was a profound pessimism about the inherent masculinity of technology, this was replaced during the 1990s by an unwarranted optimism about the liberating potential of technoscience for women. This article gives an account of both technophobia and technophilia, arguing that recent approaches drawing on the social studies of technology provide a more subtle analysis. Avoiding both technological determinism and gender essentialism, technofeminist approaches emphasize that the gender–technology relationship is fluid and flexible, and that feminist politics and not technology per se is the key to gender equality.

Keywords Feminism; gender; technology; mutual shaping

Introduction

Feminist theories of gender and technology have come a long way over the last two decades. While much early second-wave feminism generated a fatalism that emphasized the role of technology in reproducing patriarchy, during the 1990s cyberfeminist writers celebrated digital technologies as inherently liberatory for women. In recent years feminist scholars have produced an important body of work, bridging the gap between technophobia and technophilia. Much of it has developed in tandem with the burgeoning field of science and technology studies. The resulting literature is generally more critical of technoscience while at the same time aware of its potential to open up new gender dynamics. Current approaches focus on the mutual shaping of gender and technology, where neither gender nor technology is taken to be pre-existing, nor is the relationship between them immutable. Such a co-construction approach provides a compelling critique of popular arguments and social theories that were and still are characterized by

technological determinism. Rather than technology per se being credited as the main agent of change, feminist politics is recognized as the key to gender equality.

This article provides an overview of the various approaches to conceptualizing the link between gender and technology, both past and present. In turning to this task, I should emphasize that feminist discussions have always taken diverse and overlapping forms. While standard histories of feminist thought tend to present liberal, socialist and radical feminisms, for example, as distinct perspectives, in reality there were always interconnections and they certainly did not develop as independent strands or in a simple chronological order. For our purposes here, I present the different streams rather schematically in order to highlight their contrasting perspectives.

The early groundwork

A core concern of the women's movement since its inception has been women's limited access to scientific and technical institutions and professions. Many national and international studies have identified the structural barriers to women's participation, looking at sex discrimination in employment and the kind of socialization and education that girls receive which have channelled them away from studying mathematics and science (Rossiter 1982; Keller 1985; Harding 1996). Sex stereotyping in schools has been exposed, particularly the processes by which girls and boys are channelled into different subjects in secondary and tertiary education, and the link between education and the segregated labour market. Explaining the under-representation of women in science education, laboratories and scientific publications, research has highlighted the construction and character of femininity encouraged by our culture.

For liberal feminism in the 1970s and 1980s, the solution was posed in terms of getting more women to enter science and technology – seeing the issue as one of equal access to education and employment. Rather than questioning technoscience itself, it was generally assumed that science is intrinsically open, concerned with unbiased and objective research. The issue was framed in terms of the uses and abuses to which a fundamentally (gender) neutral science and technology has been put by men. Feminist writing in this vein focused on gender stereotypes and customary expectations, and denied the existence of sex differences between women and men. If girls were given the right opportunities and encouragement they could easily become scientists and engineers. Remedying the gender deficit was seen as a problem that could be overcome by a combination of different socialization processes and equal opportunity policies.

The strengths and limitations of equal employment opportunity policies have been much debated over the intervening decades (Bacchi 1996). What is beyond doubt, however, is the extent and intransigence of women's marginalization from scientific and technical pursuits. Feminists at that time pointed out that the liberal feminist tradition located the problem in women (their socialization, their aspirations and values) and did not ask the broader questions of whether and in what way technoscience and its institutions could be reshaped to accommodate women. Women were being asked to exchange major aspects of their gender identity for a masculine version without prescribing a similar 'degendering' process for men.

Such critiques emphasized that in addition to gender structures, the culture of technology is important in making it a male domain. Technologies have a masculine image, not only because they are dominated by men but because they incorporate symbols, metaphors and values that have masculine connotations. Women's reluctance 'to enter' is to do with the sex-stereotyped association of technology as an activity appropriate for men. As with science, the very language of technology, its symbolism, is masculine. It is not simply a question of acquiring skills, because these skills are embedded in a culture of masculinity that is largely conterminous with the culture of technology. Both at school and at the workplace this culture is incompatible with femininity. Therefore, to enter this world, to learn its language, women have first to forsake their femininity.

While liberal feminism conceived of the problem as one of equality of access and opportunity, socialist and radical feminisms analysed the gendered nature of technoscientific knowledge and culture, and put the spotlight on artefacts themselves. The social factors that shape different technologies came under scrutiny, especially the way technology reflects gender divisions and inequalities. The problem was not only men's monopoly of technology, but also the way gender is embedded in technology itself. In other words, feminist analyses of technology were shifting beyond the approach of 'women and technology' to examine the very processes whereby technology is developed and used, as well as those whereby gender is constituted. This approach took two broad directions: one influenced by radical feminism, the other identified with socialist feminism.

An important precept of radical and cultural feminism is that Western technology, like science, is deeply implicated in the masculine project of the domination and control of women and nature. These feminisms emphasize gender difference and celebrate what they see as specifically feminine, such as women's greater humanism, pacifism, nurturance and spiritual development. The idea that what was 'specifically feminine' was socially produced was abandoned and notions of ineradicable difference flourished. This approach has been particularly influential in relation to the technologies of human biological reproduction (Corea *et al.* 1985; Spallone & Steinberg 1987).

It is fuelled by the perception that the processes of pregnancy and childbirth were directed and controlled by ever more sophisticated and intrusive technologies. Radical feminists' strong opposition to the development of the new reproductive technologies such as IVF during the 1980s reflected fears of patriarchal exploitation of women's bodies. There was a call for new technology to be based on female rather than male values.

These approaches took the debate regarding gender and technology beyond the use/abuse model, focusing on the political qualities of technology. Where liberal feminism saw power in terms of relations between individual people, radical feminism emphasized the way in which gender power relations were embedded more deeply within science and technology. They were also a forceful assertion of women's interests and needs as being different from men's and highlighted the way in which women are not always well served by current technologies. However, in representing women as inherently nurturing and pacifist, they also perpetuated a tendency to gender essentialism. The historical and cultural specificity of our modern understanding of women as being radically other than men was overlooked. Too often the result was a pessimistic portrayal of women uniformly as victims of patriarchal technoscience.

While women's bodies and sexuality were the focus of radical feminism, socialist feminism concentrated on the machinery of production. It was widely believed that microelectronic technology would have a negative impact on women's work, and this led to a pronounced anti-technology stance. There were fears that computerization of office work, for example, would lead to deskilling, with jobs fragmented into routine and standardized tasks subject to the control of the machine. Influenced by Marxist analyses of technological change resulting from class conflict, feminist researchers revealed how the capitalist division of labour intersected with sexual divisions. A crucial historical perspective was brought to bear on the analysis of men's monopoly of technology. Extensive research on manufacturing and engineering demonstrated that women's exclusion from technology was as a consequence of the male domination of skilled trades that developed during the industrial revolution (Cockburn 1983; Milkman 1987; Bradley 1989). Craft workers, typically seen as the defenders of working-class interests in disputes over technical change, resisted the entry of women to skilled technical jobs in order to protect their own conditions. Industrial technology from its origins thus reflected men's designs, and is a defining feature of masculinity.

Socialist feminist frameworks, then, saw masculinity as embedded in the machinery itself, highlighting the role of technology as a key source of male power (Cockburn 1985; McNeil 1987; Webster 1989; Wajcman 1991). Instead of treating artefacts as neutral or value-free, social relations (including gender relations) are materialized in tools and techniques. Technology was seen as socially shaped, but shaped by men to the exclusion of women.

While this literature did reflect an understanding of the historical variability and plurality of the categories of ‘women’ and ‘technology’, it was nevertheless pessimistic about the possibilities of redesigning technologies for gender equality. The proclivity of technological developments to entrench gender hierarchies was emphasized rather than the prospects they afford for change. In short, not enough attention was paid to women’s agency. And it is precisely this rather negative register that provoked a reaction from a new generation of feminist scholars.

Contemporary approaches

Feminist approaches of the 1990s and today are much more positive about the possibilities of ICTs to empower women and transform gender relations (Kemp & Squires 1998; Green & Adam 1999; Kirkup *et al.* 2000). Indeed, early concerns about women being left out of the communications revolution, victims of the digital divide, now seem exaggerated. A proliferation of mobile phones, the Internet and cyber-café’s are providing new opportunities and outlets for women, particularly those in highly industrialized countries who are better placed to take advantage of these technologies. While the early adopters of the Internet and mobile phone were predominantly men, studies in recent years have found narrowing gender differences in adoption rates. For example, while male ownership of mobile telephony is still higher across Western Europe, the gaps are not very wide, and in the United States women now slightly exceed men in mobile phone ownership (Castells *et al.* 2007, pp. 41–44). Certainly in wealthier countries, where diffusion levels are high, the gender gap is disappearing.

Given the dramatic changes in the ownership and use of digital technologies, many postmodern cyberfeminists enthusiastically embrace Web-based technologies. A common argument in this literature is that the virtuality of cyberspace and the Internet spelt the end of the embodied basis for sex difference (Millar 1998; Plant 1998). According to Sadie Plant (1998), for example, digital technologies facilitate the blurring of boundaries between humans and machines, and between male and female, enabling their users to choose their disguises and assume alternative identities. Industrial technology may have had a patriarchal character but digital technologies, based on brain rather than brawn, on networks rather than hierarchy, herald a new relationship between women and machines. Writers such as Plant are interested in revalorizing the feminine, bringing woman’s radical alterity, her difference, into being. For them, the Internet and cyberspace are seen as feminine media, providing the technological basis for a new form of society that is potentially liberating for women. According to this view, women, rather than men, are uniquely suited to life in the digital age.

Perhaps the optimism of this postmodern literature is best summed up by Donna Haraway (1985, 1997), who urges us to embrace the positive potential of science and technology. She is sharply critical of those who reject technoscience in favour of a return to a mythical unpolluted natural state. Famously, and provocatively, she prefers to be a 'cyborg' – a hybrid of organism and machine parts – rather than an ecofeminist 'goddess'. She notes the great power of science and technology to create new meanings and new entities, to make new worlds. She positively revels in the very difficulty of predicting what technology's effects will be and warns against any purist rejection of the 'unnatural', hybrid entities produced by biotechnology. Genetic engineering, reproductive technology and the advent of virtual reality are all seen as fundamentally challenging traditional notions of gender identity. As such, they mark a transformation in the relationship between women and technology.

In looking forward to what ICTs and biotechnologies may make possible, such writers elaborate a new feminist 'imaginary' different from the 'material reality' of the existing technological order. Haraway's ground-breaking work has been particularly influential among feminist technoscience (STS) scholars and she epitomizes the challenge to second-wave feminism's tendency to portray women as victims. Instead, women's agency and capacity for empowerment are stressed. Young women in particular are orienting and experiencing themselves differently in relation to new media technologies, compared with previous generations. Developments in digital technologies do call for some radical rethinking both of the processes of technological innovation and of their impact on the culture and practices of everyday life.

However, uncritical enthusiasm for everything digital has exposed postmodern literature to charges of technological determinism – albeit of a celebratory rather than pessimistic bent. In common with other proponents of the progressive impact of information and biotechnologies, cyberfeminists insist on distinguishing new technologies from more established ones and downplay any continuities between them. While women have been actively engaged in constructing hybrid, transgendered identities through their consumption of new media (for example, diary writing on web logs is a popular activity among young women), the possibility and the fluidity of gender discourse in the virtual world is constrained by the material world.

Consider for a moment the hype about *Second Life*, an online virtual world with over one million registrations (<http://www.secondlife.com>). It is a sophisticated 3D space designed for adult 'residents' who can imaginatively create avatars, homes and entire lifestyles using in-world currency. It is widely seen as promoting anti-establishment values, yet it has become a major source of virtual pornography, apparently well suited to those with a taste for sadomasochistic forms of sex (Bardzell & Bardzell 2006). Such fantasy cyberworlds, then, are not necessarily comfortable cultural

environments for women to inhabit. To move forward, we need to continue to refine our understanding of the relationship between ICTs and gender, so that we do not treat technology as either inherently patriarchal or unambiguously liberating.

Technofeminism: combining feminist and technology studies

Over the last two decades, feminist writing within the field of science and technology studies (STS) has theorized the relationship between gender and technology as one of mutual shaping. A shared idea in this tradition is that technological innovation is itself shaped by the social circumstances within which it takes place. Crucially, the notion that technology is simply the product of rational technical imperatives has been dislodged. Objects and artefacts are no longer seen as separate from society, but as part of the social fabric that holds society together; they are never merely technical or social. Rather, the broad social shaping or constructivist approach treats technology as a sociotechnical product – a seamless web or network combining artefacts, people, organizations, cultural meanings and knowledge (Bijker *et al.* 1987; Law & Hassard 1999; MacKenzie & Wajcman 1999). It follows that technological change is a contingent and heterogeneous process in which technology and society are mutually constituted.

In terms of gender and ICTs, feminist STS scholarship has explored the effects of gender power relations on design and innovation, as well as the impact of technological change on the sexes. In common with European research, my own technofeminist approach conceives of technology as both a source and a consequence of gender relations (Berg 1996; Faulkner 2001; Oudshoorn *et al.* 2004; Wajcman 2004). In other words, gender relations can be thought of as materialized in technology, and gendered identities and discourses as produced simultaneously with technologies. Several empirical studies have demonstrated that the marginalization of women from the technological community has a profound influence on the design, technical content and use of artefacts (Lie 2003; Lerman *et al.* 2003; Oudshoorn 1994, 2003).

Importantly, this co-production of gender and technology does not end with the innovation and design process. Feminist research has been at the forefront of moves to deconstruct the designer/user divide, and that between production and consumption, emphasizing the connectedness of all phases of technological development (Cockburn & Ormrod 1993). This is an important move, as standard STS case studies focus on the groups or networks that actively seek to influence the direction of technological developments. Women's systematic absence from these sites of observable conflict is not often understood to indicate the mobilization of gender interests. For feminists, women's

absence from particular sociotechnical networks is as telling as the presence of other actors, and even a condition of that presence. This points to the need to examine the ways in which the gendering of technology affects the entire life trajectory of an artefact. Integrating detailed studies of design, manufacture, marketing, purchase and consumption allows a range of social and cultural factors, including gender, to become apparent. For this reason, technofeminist approaches stress that gendering involves several dimensions, involving material, discursive and social elements. It is precisely this intricate interweaving of artefacts, culture and gendered identities in technoscientific practice that helps to explain why this link has proved so durable.

So far, I have been stressing how embedded gender relations are in the design, meaning and use of ICTs. However, STS scholarship increasingly recognizes that the social meanings of technology are contingently stabilized and contestable, that the fate of a technology depends on many social factors that cannot simply be read off fixed sets of power arrangements. Introducing terms like 'interpretative flexibility' and 'domestication' helps to capture the idea that the particular affordances of a technology are not given and predictable (Pinch & Bijker 1987; Haddon 2004). The interpretation, reading and making sense of technologies are constant features of everyday life. Feminist theorists are now much more aware of both the contradictory effects of ICTs on women and the different meanings the same artefact might have for different groups of women. Indeed, the concept of gender itself is now understood as a performance or social achievement, constructed in interaction. It is the product of a moving relational process, emerging from collective and individual acts of interpretation. As a result, the twin pitfalls of technological determinism and gender essentialism are much less in evidence.

The relationship between gender and ICTs, then, is not immutably fixed. While the design process is decisive, technologies also yield unintended consequences and unanticipated possibilities. ICTs are sociotechnical or socio-material configurations that exhibit different degrees of determination and contingency at different moments in their relationship. The capacity of women users to produce new, advantageous readings of artefacts is dependent on their broader economic and social circumstances. For example, a young woman in the West experiences her silver cell phone as a liberating extension of her body. For her mother, it may primarily be a tool to keep track of her daughter. For women working as traders in Bangladesh, the mobile phone provides the means to run businesses selling communication services to other women. There is enormous variability in gendering by place, nationality, class, race, ethnicity, sexuality and generation and thus women's experience of ICTs will be diverse.

The recent development of postcolonial technoscience brings the global dynamics in and around science and technology to the fore (Anderson 2002; McNeil 2005). It highlights the fact that too often STS studies,

including feminist contributions, have lacked or marginalized global perspectives. The focus of the field has been predominantly Eurocentric and North American. By challenging the universalism of Western science and technology, this literature serves as a reminder of the wider context and conditions of living in the South. In doing so, it also reveals the social relations of production that underpin consumption of ICTs. To continue with the example above, as material objects mobile phones are mass-produced in factories. Like other electronic devices, such as laptops, they require the scarce mineral Coltan, the delivery of which feeds into military conflicts in Central Africa, and thus has very specific consequences for women. Feminist frameworks are increasingly attuned to these relations of production and consumption, and their implications for global inequalities.

Conclusion

The literature on gender and technology has grown to become a broad and diverse field. It foregrounds the need to investigate the ways in which women's identities, needs and priorities are being reconfigured together with digital technologies. This opens up fresh possibilities for studies that are more attuned to how different groups of women users creatively respond to and assimilate numerous ICTs in diverse real-world locations.

Despite women's massive consumption of new media, however, the reality of women working in the ICT industries is less changed than might have been expected (Gill 2002; Perrons 2003; Whitehouse 2006). For all the hyperbole about the network society, it has not led to women's full integration into its design. The Internet does not automatically transform every user into an active producer, and every worker into a creative subject. The potential for empowerment offered by ICTs will largely be realized by those groups with technical knowledge who understand the workings of the machine. Acquisition of this know-how will become ever more critical, and gender imbalance in technical expertise ever more telling.

The central premise of feminist technoscience is that people and artefacts co-evolve: the materiality of technology affords or inhibits the doing of particular gender power relations. Crucially, such a perspective redefines the problem of the exclusion of groups of people from technological domains and activities. Whereas policy-makers and researchers explain the problem in terms of the deficiency of users, such as women, technofeminism exposes how the concrete practices of design and innovation lead to the absence of specific users.

There is increasing recognition that the development of effective ICTs requires detailed knowledge of the sites and practices in and through which the new technologies will literally be made to work (Suchman

2007). While it is impossible to specify in advance the desirable design characteristics of artefacts and information systems that would guarantee more inclusiveness, it is imperative that women are involved throughout the processes and practices of shaping technological innovation. This may not necessarily result in technologies that are friendly to both women and men, as women programmers for example may adopt a 'gender script', but it is a starting point. Drawing more women into design – the configuration of artefacts – is not only an equal employment opportunities issue but is also crucially about how the world we live in is designed, and for whom.

There is ample scope for more empirical research on the gender relations of ICTs. Just as gender relations are transforming, so ICTs themselves are changing and evolving over time. This will be ever more so as computing becomes ubiquitous, with digital devices increasingly embedded into everyday things and objects, part of our taken-for-granted environment and even of ourselves. A focus on studying sociotechnical networks or systems, instead of singular technologies, will then be increasingly necessary. ICTs are much more complex and flexible than the technologies that preoccupied earlier generations of feminist scholars. We require more nuanced research that captures the increasingly complex intertwining of gender and technoscience as an ongoing process of mutual shaping over time and across multiple sites. It is important that, for all the diversity of feminist voices, this reflect our shared concern with the hierarchical divisions marking relations between men and women. We live in a technological culture, a society that is constituted by science and technology, and so the politics of technology is integral to the renegotiation of gender power relations.

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