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COMMENT

ABSTRACT This Comment reflects upon the relationship between gender and technology, and how it has been theorized in recent decades. I argue that while feminist approaches have had considerable influence on mainstream social studies of science and technology, tensions remain. I go on to explore the proliferation of feminist research which conceptualizes technology as culture. I suggest that the contemporary focus on cultural representation and consumption, exciting and productive as it is in many respects, has contributed to the neglect of design studies. These are necessary to fully elucidate how gender relations figure in the construction of technology.

Keywords consumption, culture, design, feminism, science

Reflections on Gender and Technology Studies:

In What State is the Art?

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John Glenn's return visit to outer space on 7 November 1998 served as a reminder that the conquest of space through technology has remained a predominantly male enterprise. Yet, in 1960, 13 women pilots were judged to be NASA's top astronauts – better than the Mercury Seven male astronauts who were later immortalized in print and on film. The women pilots, who stayed on the ground, were judged as more suitable than the men for space travel: for example, they required less oxygen per minute and had a much higher tolerance to sensory deprivation. However, within a few months of passing all the medical and scientific tests, the women were told they would not be part of the space race. They were the right stuff, but the wrong sex.[1]

This story of the forgotten women astronauts may be seen as part of the feminist project to uncover and recover women 'hidden from history'. It also graphically illustrates that there is nothing natural or inevitable about the ways in which technology is identified as masculine, and masculinity is defined in terms of technical competence. History might have been otherwise. If a woman, rather than a man, had been the first American in

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space, the masculine culture of technology might have been disrupted, or at least destabilized.

This event prompted me to reflect on how the relationship between gender and technology has been theorized over the last 20 years or so. In 1987, Sara Delamont commented on the gender-blindness of science studies at that time.[2] Since then, a whole new field of social studies of technology has been developed. As we enter the 21st century it is important to subject this field to similar questioning, and see if it has replicated the *lacunae* identified in science studies.

Looking back over contributions to this journal during the last decade, it is clear that there is a growing awareness of feminist issues. However, a rather small proportion of the main substantive papers (excluding shorter communications, reviews, and the like) systematically incorporate a gender analysis. Taking a broad definition that also includes papers sensitive to gender issues or about women, there were 9 (6.6%) such papers out of 136. This excludes editions of the journal devoted to symposia, none of which problematized gender as a central concern. What is it about social studies of technology that might account for this imbalance?

In this paper I want to look at how gender and technology studies emerged, the extent to which this theme has been taken up within mainstream technology studies and, in the final section, I will indicate the breadth of recent feminist literature on technology. I hope to show that there is more scope for cross-fertilization between feminist studies of technology and the mainstream S&TS tradition. During the 1990s there has been a lively debate between various strands of feminism and other social studies of technology.[3] Many of the issues that I raise here have now been taken on board.[4] However, I will argue that there are limitations in influential approaches in the field which remain obstacles to a fruitful dialogue.

Technology and the Sexual Division of Labour

Like many of my feminist contemporaries, I came to gender and technology studies from having been immersed (in the 1970s) in Marxist labour process debates about production. The argument here was that class conflict shapes technology in the workplace.[5] Capitalism continuously applies new technology designed to fragment and de-skill labour, so that labour becomes cheaper and subject to greater control. Technological revolution was understood to be a trait of capital accumulation processes. Although this theoretical approach had been reasonably sophisticated in its analysis of the capital–labour relation, feminists questioned the notion that control over the labour process operates independently of the gender of the workers who are being controlled.

This, for me, was where the feminist sociological project began, as a critique of the gender-blindness of Marxism. Feminist sociological work pointed out that the division of labour characterizing paid occupations was a sexual hierarchy, and that its gendered nature was not incidental.[6] Both

employers as employers, and men as men, were shown to have an interest in creating and sustaining occupational sex-segregation. Time and time again, gender was shown to be an important factor in shaping the organization of work that resulted from technological change. In sum, we argued that the relations of production are constructed as much out of gender divisions as out of class divisions.

And if the workplace is patriarchal, then what about the domestic sphere? Feminists pointed out that the labour process, as defined in mainstream work, ignored a significant part of all labour – the unpaid labour done by women in the home. Feminist interest in domestic technology can be traced back to the debate about housework as a key element of women's oppression. By the 1970s, housework was recognized as 'work' and had become the object of serious academic study by historians and sociologists.[7] We argued that paid work could not be understood without reference to women's unpaid work in the home, and that the sexual division of labour separated women from control over the technologies they used, both at the workplace and at home. Much of the early work came from feminist historians of technology working in North America, and it was the journal *Technology and Culture* that contained the first pieces on the history of domestic technology.[8] Dominating the debates was the apparent paradox that mechanization of the home had not substantially decreased the amount of time women spend on household tasks.

Looking back over the literature of this period, I see that it clearly reflects the major preoccupations of feminist scholars of the time. New cross-disciplinary research areas were charted so as to counter the masculine bias in various academic subjects and the invisibility of women's lives.[9] Feminism was concerned to show what being a woman might imply, and how women's lives were shaped by various social forces. Feminist sociologists' work was mainly focused on explanations at the level of social structure – so arguments in terms of the sexual division of labour, both in the labour market and in domestic work, figured strongly in these writings. In line with this, feminist technology studies were mainly concerned with the impacts of technology on women's lives.[10] So how technological change would impact on gender relations at work and at home were obvious questions.

The concern with the 'effects' of technology on society reflected the naïve technological determinism that prevailed in the social sciences at the time.[11] Beyond this, some contributors were prone to adopt a naïve version of the social shaping perspective. As Anne-Jorunn Berg notes:

> The somehow taken for granted character of technology rendered technology in theoretical terms a more or less vague extension of various patriarchal and/or capitalist structures.[12]

As a result, feminist approaches mainly dismissed technoscience as inherently patriarchal and malignant. Traces of this inheritance are evident in my own work.[13] While clearly critical of a radical or ecofeminist position which rejects technology in favour of a return to a mythical natural state,

the general tone of this feminist approach is rather pessimistic about the possibilities of redesigning technologies for gender equality: its emphasis is perhaps too heavily on how technological developments will reproduce gender hierarchies, rather than on the possibility that gender relations may be transformed by new technologies. Also, while the intrinsic indeterminacy of technology is acknowledged, not enough attention is paid to women's agency. There has been much criticism of the all-too-common tendency to treat women as the passive victims of technology.[14] For all this, it is clear that we were asking the right questions and were influential in setting a very productive feminist research agenda. This intellectual project was an emanation of second-wave feminism, as was the associated political project of building women's technical knowledge and expertise.

By the late 1980s, attention in feminist technology studies was tending to shift away from the focus on women *and* technology. It was moving instead to examine the very processes by which technology is developed and used, and those by which gender is constituted. Both these themes were already established in studies of how technology is shaped by gender relations.[15] However, they received fresh impetus from two theoretical developments – the new sociology of technology, and the postmodern turn in feminist theory.

Social Studies of Technology

Over the last two decades, Science and Technology Studies (S&TS) has become an established discipline. Several schools of theory have emerged, but two approaches have been particularly influential in relation to feminist studies.

The first is the 'social construction of technology' (SCOT) perspective, developed by Trevor Pinch and Wiebe Bijker.[16] In common with the social shaping approach, the SCOT approach emphasizes that technological artefacts are open to sociological analysis, not just in their usage, but especially with respect to their design and technical content: it draws heavily upon earlier work applying a sociological perspective to scientific knowledge. Pinch and Bijker take up the notion of 'symmetry' of explanation, and argue that symmetry means avoiding explaining the success or failure of technologies by whether or not they work: and, for them, 'machines "work" because they have been accepted by relevant social groups'.[17] While this particular formulation may underplay the materiality of machines,[18] the concept of the 'interpretative flexibility' of technology is widely seen as SCOT's most useful addition to feminist debates.[19]

Interpretative flexibility refers to the way in which different groups of people involved with a technology can have very different understandings of that technology, including different understandings of its technical characteristics. Thus users can radically alter the meanings and deployment of technologies. How then can SCOT account for the stabilization or 'closure' mechanisms in the creation of a new technology? Pinch and Bijker's answer is in terms of 'relevant social groups' sharing the same set

of meanings, and attaching them to a specific artefact. Relevant social groups are typically identified empirically as the actors that participate in the negotiations or controversies around a specific technology. As women are usually absent from these groups, there was a tendency to overlook the need for a gender analysis of the technology – a point I will return to below.

The other main approach that has been taken up by feminists is 'actor-network theory' (ANT), developed variously by scholars such as Michel Callon, Bruno Latour and John Law.[20] ANT exposed the fallacy of construing technology and society as separate spheres, influencing each other. Rather, the metaphor of a 'heterogeneous network' conveys the view that technology and society are mutually constitutive: both are made of the same stuff – networks linking human beings and non-human entities. The technological, instead of being a sphere separate from society, is part of what makes large-scale society possible. Through describing the network, ANT considers how some actors become decision-makers while others do not. Their most controversial idea, that we cannot deny *a priori* that non-human actors or 'actants' can have agency, has helped us to understand the rôle of technology in producing social life.

The conception of the non-human as actant reinforces an action-orientation. ANT considers how users of technologies are configured by various agents in the process of development and design, production, marketing, distribution, sales, maintenance, and so on. Designers define the potential actors or users of their technologies in various ways, and inscribe this vision of the world in the technical content of the new object. As Michel Callon expresses it: 'Machines carry the word of those who invented, developed, perfected and produced them ... the machine is a spokesperson'.[21] This 'script' or 'scenario', in Madeleine Akrich's terms, is written, or 'inscribed', into technology.[22] But, as with the notion of 'interpretative flexibility', the 'script' or 'inscription' is open to various translations. The user interacts with the pre-inscribed artefact, and can challenge and renegotiate the meanings and uses of the artefact. This idea, that consumers are an integral part of the process of technological development, has been important for feminist research, as we shall see.

From Gender-Blind to Gender-Aware

Within these mainstream bodies of work, the ways in which technological objects may be shaped by the operation of gender interests or identities have not been a central focus. Despite the emphasis on the way innovations are socially shaped, it has been largely incumbent on feminists to demonstrate that this 'social' is also a matter of gender relations. So what is it about social studies of technology that has made it hard for us to think about gender issues? Several problems are involved, and I will outline them below.

To begin with, the marginalization of gender in both SCOT and ANT constructivist studies of technology is indicative of a general problem with

their methodology. This is related to the conception of power deployed by theorists in this genre. Using a conventional notion of technology, these writers were concerned to identify and study the social groups or networks that actively seek to influence the form and direction of technological design. Their focus on observable conflict led to a common assumption that gender interests were not being mobilized. What many have overlooked is the fact that the exclusion of some groups, while not empirically discernible, may nevertheless have an impact upon the processes of technological development.[23] To adopt the terminology of Steven Lukes, action-oriented approaches are insufficiently 'radical', restricting their analyses to the two observable dimensions of power and neglecting a third, structural dimension.[24]

While the effects of structural exclusion on technological development are not easy to analyse, they should not be overlooked. Feminists have stressed that women's absence from spheres of influence is a key feature of gender power relations. Few women feature among the principal actors in technological design, as the sexual division of labour has excluded them from entering science, engineering and management.[25] As several commentators have pointed out, the problem with a primary focus on 'relevant social groups' in the process of technological development is how to take account of those actors who are routinely marginalized or excluded from a network.[26]

Within the broad social shaping approach, feminists have found it relatively easy to discuss systematic male domination over women as a sex in terms parallel to class exploitation. Just as capitalists are deemed to have a relatively stable set of interests in maximizing profits, so we could talk of men's interests as a sex being institutionalized. The concept of patriarchy was often deployed as a shorthand for institutionalized power relations between men and women where gender is a property of institutions and historical processes, as well as of individuals. However, this was not meant to imply that men are a homogeneous group. For example, in *Feminism Confronts Technology*, I stressed that men's interests are not all identical, and that when it comes to influencing the design and development of a specific technology, some groups will have more power and resources than others. So, long before the so-called 'postmodern challenge', 'difference' within the category of men, and between women, was already widely recognized.

By contrast, ANT was more strongly influenced by a Foucauldian concept of power, where power is represented as capacity and effectiveness. Latour, for instance, suggests that power is not a possession – indeed it must be treated as 'a consequence rather than a cause of action'.[27] Elsewhere, Latour has argued that such constellations as classes, countries, kings or laboratories should not be treated as the cause of subsequent events, but rather as a set of effects.[28] In other words, they should be seen as the consequence of a set of heterogeneous operations, strategies and concatenations. The job of the investigator, then, is not to discover final causes, but to unearth these schemes and expose their contingency.

John Law agrees that power is indeed the product of a set of (strategy-dependent) relations but, he argues, this does not mean that it cannot be stored and used for certain purposes.[29]

In my view, an overemphasis on the enabling aspects of power can make it awkward to address the obduracy of the link between men and technology. Feminists' traditional concerns with women's access to technology, the differential impact of technology on women, and the patriarchal design of technologies, have all sat uneasily with this analysis of technology. While ANT perceives that artefacts embody the relations that went into their making, and that these relations prefigure relations implied in the use and non-use of artefacts, it is less alert to the inevitable gendering of this process. ANT does not always recognize that the stabilization and standardization of technological systems necessarily involve negating the experience of those who are not standard, 'a destruction of the world of the non-enrolled'.[30]

A central argument of much feminist theory has been that men are set up as the norm against which women are measured and found wanting. Indeed, this thesis is at the core of my recent book, *Managing Like a Man*, which is about the male definition of management.[31] An investigation into senior managers in multinational corporations, it shows how the hegemonic organizational culture incorporates a male standard which positions senior women managers as out of place. A parallel argument can be made that the standardization of networks implicitly places men's experiences and men's investments at the centre, without acknowledging their specificity. The corollary is the simultaneous denial of other realities, such as women's. So, while it is true that the imputation of social interests to social structures and institutions is always contestable and difficult to specify, there are nevertheless important contexts where feminist analysis has no choice but to invoke 'interests explanations'.[32]

The absence of women from view is also a function of the concentration on issues of design. Innovation studies have underplayed the importance of enrolling other groups in the alliance of forces that enables a technological innovation to succeed. Agents in ANT are most commonly male heroes, big projects and important organizations, in what Susan Leigh Star has described as a 'managerial or entrepreneurial' model of actor networks.[33] There is a striking parallel here with Sara Delamont's point about the bias in science studies 'towards exciting, high status men working in élite centres of "big science" excellence', rather than the routine science in which most women are involved.[34] Once the lens is widened to include manufacturing operatives, marketing and sales personnel, and the consumers and end-users of technologies, women's work immediately comes into view. More women are literally present, the further downstream you go from the design process. Women are the hidden cheap labour force that produces technologies, the secretaries, cleaners and cooks, they are part of the sales force, and the main users of domestic and reproductive technologies. The undervaluing of women's 'unskilled' and delegated work serves to make them invisible in mainstream technology studies.

Finally, constructivist studies have generally assumed that gender has little bearing on the development of technology because the masculinity of the actors involved was not made explicit.[35] It might be seen as ironic that the focus on agency has rarely sensitized these authors to issues of gendered subjectivity. However, most scholars are habituated to consider gender issues only when their subjects are women. So one strategy for incorporating a gender perspective into technology studies, as in other areas of social science, has been to study places where women are. This work has done much to compensate for past neglect, but it has also unfortunately reinforced the perception that gender is only an issue where the research subjects are female. Gender thus becomes a variable to explain women's difference – in this case, to explain why contemporary Western femininity involves being ill-suited to technological pursuits.

A full theoretical integration of the analysis of gender into technology studies requires an understanding that both men and women have gender identities which structure their experiences and their beliefs. Then we can begin to explore the significance of technology in the formation of subject identity for both sexes. Feminists have long argued that the symbolic representation of technology is sharply gendered. Men's affinity with technology is now seen as integral to the constitution of male gender identity and the culture of technology. Engineering is a particularly intriguing example of an archetypically masculine culture where mastery over technology is a source of both pleasure and power for the predominantly male profession.[36] This is not to say that there is one masculinity or one form of technology: rather, it is to note that in contemporary Western society, hegemonic masculinity, the culturally dominant form of masculinity, is still strongly associated with technical prowess and power.[37] To be in command of the very latest technology signifies being involved in directing the future, so it is a highly valued and mythologized activity. More research is needed that explores how technologies operate as a site for the production of gendered knowledge and knowledge of gender.

Feminist Research in the S&TS Tradition

Much empirical research on gender and technology is now engaging with these issues, and can partly be seen as a response to the problems outlined above. More attention has been given to the development and diffusion processes of specific technologies in an attempt to deconstruct the designer/user divide.[38] In the limited space available here, I will only briefly outline the approach taken in three of these projects.

One exemplary study that deliberately set out to combine an innovation study with a user study is that by Cynthia Cockburn and Susan Ormrod, who trace the trajectory of the microwave oven from its conception right through to its consumption. Well aware that the standard S&TS focus on invention underplays the role of women, the authors unravel the way that the sexual division of labour is mapped on to each stage in the journey of a domestic technology. Like other domestic technologies, the

microwave is designed by men in their capacity as engineers and managers, people remote from the domestic tasks involved, for use by women in their capacity as houseworkers. Where women do enter the picture (apart from on the production line), it is primarily as home economists. Cockburn and Ormrod observe that the cooking expertise of the home economists is crucial to the successful design of the artefact. The women see themselves as doing 'a kind of engineering or science',[39] but it is not acknowledged as such by the predominantly male culture of engineers. Their technical skills are undervalued because of the strong association of cooking with femininity. As a result, even at the one point when women enter the innovation process, they wield little influence over the development of new technologies. What is so original about Cockburn and Ormrod's microwave study is that it follows the gendering processes through the various stages of the artefact's life. It recognizes that gendering does not begin and end with design and manufacturing: domestic technologies are also encoded with gendered meanings during their marketing, retailing and appropriation by users. While the technology is made into a physical object during production, the symbolic meanings attaching to it are continually being negotiated and reinvented. In particular, Cockburn and Ormrod explore the extent to which interpretative flexibility exists once a given commodity reaches the hands of the consumer. Marketing and retailing play a key rôle in framing demand: 'there is an unclear dividing line between accurately *representing* the customer, *constructing* the customer and *controlling* the customer'.[40] Thus, for Cockburn and Ormrod, marketing and consumption are all part of the social shaping of technology.

While the microwave study set out to demonstrate how gendering processes affect every stage in the life of a technology, its analysis is stronger in relation to the gendered construction of the potential users than in relation to the machine's design. It does not fully succeed in showing, in any detailed sense, how the development of the microwave reflected designers' assumptions about the gendered characteristics of the prospective users. Much of what goes on inside the black box of innovation remains a mystery.

Studies on cervical cancer screening by Monica Casper and Adele Clarke, and by Vicky Singleton and Mike Michael, are similarly concerned with the processes whereby technologies are deployed and appropriated by users.[41] These studies, the latter explicitly informed by an ANT approach, share with the microwave study the choice of a routine, mundane technology as opposed to heroic technoscience. They eschew the 'executive approach' that would necessarily focus on male technoscientists, instead widening the lens to incorporate women 'downstream'. Casper and Clarke's study is about how a rather recalcitrant tool, the 'Pap smear', became the major cancer screening technology in the world. They argue that several sets of concrete practices or 'tinkering' have been used to make the Pap smear appear to be the right tool for the job. One such practice has been the gendering of the division of labour in cytological screening. It appears that the success of the Pap smear depended on the feminization of

the job of technician, with its accompanying low pay for difficult work. This makes clear the centrality of women's undervalued work in the standardization of a technology. The authors also explore the rôle of the women's health movement and public health activists, those outside the usual boundaries of the network, in successfully reshaping elements of the tool.

Their findings echo those of Singleton and Michael's earlier study, which analyzes the UK Cervical Screening Programme as a durable actor-network. This study focuses on the pivotal part played by general practitioners, who are themselves enrolled in the programme and enrol women to participate: it highlights the way ANT tends to overlook not only those who are at the margins of a given network, but also the fact that people can possess different attributes, and be operating in several different domains at once. Indeed, the durability of the network depends on the possibility that general practitioners can be both the harshest critics and the most ardent supporters of the network – that is, they can occupy the margins and the core at the same time. Rather than viewing a network as victorious once and for all, this approach suggests that ambivalence, marginality and the multiple identities of actors/actants actually reinforce and sustain the network.

In neither of these accounts of cervical screening programmes is the scientist or the executive given primacy. What is curious is the absence of any discussion of how this technology is part of a long history of medical procedures designed for use exclusively on women's bodies. The gendering of the technical innovation itself is somehow taken for granted. However, the way gender is theorized in these studies does represent an encouraging advance over previous work. Early feminist studies of gender and technology tended to theorize gender as a fixed and unitary phenomenon, which exists prior to and independently of technology, and then becomes embedded within it. We then explained the success of a technology in terms of the economic or political interests of powerful groups, typically regarding these interests as established, and in need of no further explanation. Against this, recent feminist scholars such as Judith Butler argue that men's and women's interests are not objectively given but are collectively created.[42] Influenced by poststructuralism, they conceive of 'gender as a performance', so as to stress that gender is not fixed in advance of social interaction, but is constructed *in* interaction. One acts or performs gender, and demonstrates one's gender identity. Gender is a social achievement.

This notion of 'gender as doing' fits well with ANT's view of society as a *doing* rather than a *being*. The construction of gender identities, like that of technologies, is a moving relational process achieved in daily social interactions. The question is now posed in terms of 'how interests are shaped together with the technology-in-the-making'.[43] It follows from this that gendered conceptions of users are fluid, and subject to a variety of interpretations. Therefore the relationship between particular gender power interests and their inscription in technological innovation is treated with much more subtlety and complexity. This model of technological

development enables us to understand technologies and interests as products of mutual alliances and dependencies among groups involved in the specific technology. Thus technologies and new forms of gender relations and gendered cultures are co-produced.

Technology as Culture

Over the last decade there has been an explosion of feminist writing on technology, much of it being carried out at some conceptual distance from the sociology of science and technology which developed during this same period. This writing is explicitly informed by a combination of cultural studies, anthropology and postmodern philosophy.[44] Reflecting the postmodern emphasis on discourse, technology is conceptualized as an object of consumption, as a text and as a communication medium. Indeed, this work refuses to allow any distinction between the material and the cultural, and instead treats technology as a seamless fusion of material and cultural. Its contribution to previous feminist analysis is the concern with how technology as culture is implicated in the construction of subjective gender identities.

The most influential feminist commentator writing in this vein is Donna Haraway.[45] She argues that we should embrace the positive potential of technoscience, and is sharply critical of those who reject technology. Famously, 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. Genetic engineering, reproductive technology and the advent of virtual reality are all seen as fundamentally affecting the basic categories of 'self' and 'gender'. 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.

Most of this recent feminist literature is about biomedical technologies and information technologies. The increasing preoccupation in sociological theory with the body and sexuality has been paralleled by research on biomedical technologies – technologies for the body. There are many studies of childbirth and contraception, *in vitro* fertilization, cosmetic surgery and genetic engineering.[46] While reproductive technologies have long been of central concern to feminist studies, there has been a major shift in the analysis employed. Earlier work on the impact of reproductive technologies on women assumed that the body is biologically given and fixed. Over the last decade or so, feminists have begun to argue that there is now no such thing as the natural, physiological body. One consequence of this work is that the conventional distinction between sex (natural) and gender (social) has been thoroughly contested and deconstructed. Technologies, like science, are now seen as contributing to the stabilization of the body. With the rise of modern science, bodies have become objects that can be transformed with an increasing number of tools and techniques.

Modern bodies are made and remade through science and technology; they too are technological artefacts.

The common focus of these studies is scientific theories and medical texts, and how these are implicated in the cultural production of images and meanings of sex and the body. On the whole, however, what is revealed is the effects of bio-technology, its impact on our bodies, our sense of self and our social relations.

Information and communication technologies comprise the other substantial research field in the sociology of technology. There is a profusion of studies on the Internet, cyberspace and virtual reality. Popular writers such as Nicholas Negroponte and Howard Rheingold proclaim that innovations in this area will result in either a utopian or dystopian transformation of society and the individual.[47] Much of the research has been concerned with the cultural consequences of the diffusion and consumption of information and communication technologies for the family, rather than gender *per se*. For example, Roger Silverstone and Eric Hirsch focus on the 'changing character of our own domesticity, both inside and outside the home, and on the changing character of the social groups – principally the family – that still define much of its character'.[48] Similarly, the latest British Economic and Social Research Council programme on technology, called 'Virtual Society?', is about whether 'there are fundamental shifts in how people behave, organise themselves and interact as a result of the new electronic technologies'. The programme appears to contain little in the way of a gender analysis.[49]

Once again we are more likely to see a feminist inflection in this work on information and communication technologies when the research is conducted by feminists. In the same way as biomedical technologies are seen as potentially emancipating women by transforming the relations between the self, the body and machines, so too is the Internet. In *Life on the Screen: Identity in the Age of the Internet*, Sherry Turkle enthuses about the potential for people 'to express multiple and often unexplored aspects of the self, to play with their identity and to try out new ones'.[50] It is the increasingly interactive and creative nature of computing technology that now enables millions of people to live a significant segment of their lives in virtual reality. Moreover, it is in this computer-mediated world that people experience a new sense of self that is decentred, multiple and fluid. In this respect, Turkle argues, the Internet is the material expression of the philosophy of postmodernism.

Interestingly, the gender of Internet users mainly features in Turkle's chapter about virtual sex. Cyberspace provides a risk-free environment where people can engage in the intimacy they both desire and fear. Turkle argues that people find it easier to establish relationships online and then pursue them off-line. Yet, for all the celebration of the interactive world of cyberspace, what emerges from her discussion is that people engaging in Internet relationships really want the full embodied relationship. Like many other authors, Turkle argues that gender-swapping, or virtual cross-dressing, encourages people to reflect on the social construction of gender,

to acquire 'a new sense of gender as a continuum'.[51] However, she does not consider the possibility that gender differences in the constitution of sexual desire and pleasure influence the manner in which cybersex is used.

Allucquere Rosanne Stone also celebrates the myriad ways modern technology is challenging traditional notions of gender identity: 'In cyberspace the transgendered body is the natural body'.[52] For example, her discussion of phone and virtual sex describes how female sex workers disguise crucial aspects of identity and can play at reinventing themselves. She takes seriously the notion that virtual people or selves can exist in cyberspace, with no necessary link to a physical body. As an illustration of this, Stone's narrative about the cross-dressing psychiatrist has become an apocryphal feminist tale. It is the story of Julie Graham, who described herself as a New York neuropsychologist who never saw anyone in person because of her disfigurement. She successfully projected her personality and had a flourishing social life on the Internet, giving advice to many women who confided in her.[53] When Julie was exposed years later as a middle-aged male psychiatrist, many women who had sought her advice felt deeply betrayed and violated.

Julie's case is generally taken to show that the subject and the body are no longer inseparable; that cyberspace provides us with novel free choices in selecting a gender identity irrespective of our material body. However, this story can be read in a radically different manner, one that questions the extent to which the cyborg can escape the biological body. Although Julie's electronic manifestation appears at first sight to subvert gender distinctions, Ruth Oldenziel points out that it ultimately reinforced and reproduced these differences.[54] For the women seeking Julie's advice, her gender was crucial. They wanted to know that there was a woman behind the name; this is what prompted their intimacies. Julie's gender guided their behaviour and their mode of expression: 'It rendered her existence, no matter how intangible and "unreal" Julie appeared at first, extremely physical and genuine'.[55]

Relationships on the Internet are not as free of corporeality as Stone suggests. There is evidence that many more men adopt a female persona than *vice versa*, and this may be another way for men to assert their domination over female bodies. After all, if technologies are inscribed with gender relations in their design, then the culture of computing is predominantly the culture of the white American male.[56] As Oldenziel explains:

> The electronic environment largely simulates the outside, physical world, for in the end technical processes and objects are all products of human labor that create a world that goes as far, or better still, no further than our own imagination.[57]

It is not surprising that the typical Internet user world-wide remains a young, white, educated male in Western societies,[58] and that a major use of the Internet is to access pornography, designed for a predominately male audience. It is, though, disappointing that these facts go largely unremarked in the literature.[59]

New communication technologies have certainly brought about new techniques for sociality and new ways of gender-bending. The latter does, of course, have a rich cultural history. For example, one thinks of the way some 19th-century women novelists were able to exploit new printing technologies to establish themselves as successful male writers. Similarly, the Internet can be a site for the creation of new feminist communities, and a new tool for political organizing. Authors such as Sadie Plant and Dale Spender are excited by the possibilities that the World Wide Web offers to women.[60] The message is that young women in particular are colonizing cyberspace where, like gravity, gender inequality is suspended. While there is a thrilling quality to these pioneering endeavours, we must not be hypnotized by the hype that is now ubiquitous. While it is deeply unfashionable to be critical, there is a risk that concentration on the Internet as the site of transformative feminist politics may exaggerate its significance.

Conclusion

As a result of the sociological and feminist research carried out in the last decades of the 20th century, we now have a much more complex understanding of gender, of technology and of the mutually constitutive relationship between them. Increasingly, we now work from the basis that neither masculinity, femininity nor technology are fixed, unitary categories, but that they contain multiple possibilities and are constructed in relation to each other. At the same time, there has been a rejection of the technophobia evident in earlier feminist writing in favour of a popular cyberfeminism that embraces new technology as a source of empowerment for women. While much contemporary academic feminist writing on technology is not connected to feminist political activism in the same way that it was in the 1970s and 1980s, it may foster a critical optimism about the prospects for changing women's relationship to machinery. Long denied the opportunity to conquer outer space, in cyberspace women can at least nourish the dream of a world free from gender hierarchies.

This is a good moment to reflect on where feminist sociological research might head in the future. We may be coming full circle. We began by criticizing the early concern with the impact of technology on society, much of it being implicitly about consumption. We then turned to look at the social relations of technical design and innovation. Now much feminist work is explicitly concerned with consumption or cultural representation. Certainly it is the case that the simple divide between consumption and production has been deconstructed, and we now accept that design, production and consumption are profoundly interactive. However, while, at a theoretical level, we all take for granted that gender and technology are mutually constitutive, I would still argue that the weight of empirical research is on how technology shapes gender relations, rather than on how gender relations are shaping the design of technologies. My hope is that a

fully rounded understanding of the relationship between gender and technology will strengthen feminist voices within sociology of technology debates, and so help fashion our future.

Notes

I would like to thank Wendy Faulkner, John Law, Donald MacKenzie, Sally Wyatt and the anonymous referees for commenting on an earlier version of this paper.

1. 'Right Stuff Wrong Sex', BBC Radio 4 Broadcast, 24 April 1997.
2. Sara Delamont, 'Three Blind Spots? A Comment on the Sociology of Science by a Puzzled Outsider', *Social Studies of Science*, Vol. 17, No. 1 (February 1987), 163–70.
3. See, for example, Keith Grint and Rosalind Gill (eds), *The Gender–Technology Relation* (London: Taylor & Francis, 1995), and Steve Woolgar (ed.), 'Feminist and Constructivist Perspectives on New Technology', Special Issue, *Science, Technology, & Human Values*, Vol. 20, No. 3 (Summer 1995), 283–385.
4. See, for example, Ronald Kline and Trevor Pinch, 'Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States', *Technology and Culture*, Vol. 37, No. 4 (October 1996), 763–95; John Law and John Hassard (eds), *Actor Network Theory and After* (Oxford: Blackwell, 1999).
5. Harry Braverman, *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1974); David Noble, *Forces of Production: A Social History of Industrial Automation* (New York: Knopf, 1984).
6. Veronica Beechey, *Unequal Work* (London: Verso, 1987); Cynthia Cockburn, *Brothers: Male Dominance and Technological Change* (London: Pluto Press, 1983); Heidi Hartmann, 'Capitalism, Patriarchy, and Job Segregation by Sex', *Signs: Journal of Women in Culture and Society*, Vol. 1, No. 3 (1976), 137–67.
7. See, for example, Christine Bose, Philip Bereano and Mary Malloy, 'Household Technology and the Social Construction of Housework', *Technology and Culture*, Vol. 25, No. 1 (January 1984), 53–82; Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York: Basic Books, 1983); Ann Oakley, *The Sociology of Housework* (London: Martin Robertson, 1974).
8. See, for example, Alison Ravetz, 'Modern Technology and an Ancient Occupation: Housework in Present-Day Society', *Technology and Culture*, Vol. 6, No. 2 (Spring 1965), 256–60.
9. For example, Cambridge Women's Studies Group (eds), *Women in Society* (London: Virago, 1981).
10. See, for example, Wendy Faulkner and Eric Arnold (eds), *Smothered by Invention: Technology in Women's Lives* (London: Pluto Press, 1985); Joan Rothschild (ed.), *Machina Ex Dea: Feminist Perspectives on Technology* (New York: Pergamon Press, 1983).
11. According to this standpoint, technology was a separate sphere, developing independently of society, following its own autonomous logic, and then having 'effects' on society: see Donald MacKenzie and Judy Wajcman, 'Introductory Essay', in MacKenzie and Wajcman (eds), *The Social Shaping of Technology* (Milton Keynes, Bucks.: Open University Press, 1985), 2–25, at 4–5.
12. Anne-Jorunn Berg, *Digital Feminism* (Trondheim: Centre for Technology and Society, Norwegian University of Science and Technology, Report no. 28, 1996), 20.
13. Judy Wajcman, *Feminism Confronts Technology* (Cambridge: Polity Press, 1991).
14. This was particularly evident in feminist writing in the 1980s on reproductive technology: see, for example, Gena Corea et al., *Man-Made Women: How New Reproductive Technologies Affect Women* (London: Hutchinson, 1985).
15. See the 1985 edition of MacKenzie & Wajcman (eds), op. cit. note 11, especially Cynthia Cockburn's contributions ('Caught in the Wheels: The High Cost of being a Female Cog in the Male Machinery of Engineering', 55–65; 'The Material of Male Power', 125–46), and her books *Brothers*, op. cit. note 6, and *Machinery of Dominance* (London: Pluto Press, 1985).

16. Trevor J. Pinch and Wiebe E. Bijker, 'The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other', *Social Studies of Science*, Vol. 14, No. 3 (August 1984), 399–441, reprinted in Bijker, Thomas P. Hughes and Pinch (eds), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MA: MIT Press, 1987), 17–50.
17. Wiebe Bijker, *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change* (Cambridge, MA: MIT Press, 1995), 270.
18. See the new 'Introduction' to the revised edition of Donald MacKenzie and Judy Wajcman (eds), *The Social Shaping of Technology* (Milton Keynes, Bucks.: Open University Press, 1999), 3–27, esp. 22.
19. See, for example, the Introduction to Cynthia Cockburn and Susan Ormrod, *Gender and Technology in the Making* (London: Sage, 1993), 1–15, at 8–9.
20. Michel Callon, 'Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fisherman of St Brieuc Bay', in John Law (ed.), *Power, Action and Belief: A New Sociology of Knowledge?* (London: Routledge & Kegan Paul, 1986), 196–229; Callon, 'The Sociology of an Actor-Network: The Case of the Electric Vehicle', in Callon, Law and Arie Rip (eds), *Mapping the Dynamics of Science and Technology* (Basingstoke, Hants.: Macmillan, 1986), 19–34; Bruno Latour, *Science in Action* (Milton Keynes, Bucks.: Open University Press, 1987); Latour, *The Pasteurization of France* (Cambridge, MA: Harvard University Press, 1988); Law, 'Technology and Heterogeneous Engineering: The Case of Portuguese Expansion', in Bijker, Hughes & Pinch (eds), op. cit. note 16, 111–34; Law & Hassard (eds), op. cit. note 4.
21. As quoted in Berg, op. cit. note 12, 39.
22. Madeleine Akrich, 'The De-Scription of Technical Objects', in Wiebe Bijker and John Law (eds), *Shaping Technology/Building Society: Studies in Sociotechnical Change* (Cambridge, MA: MIT Press, 1992), 205–24.
23. See Langdon Winner, 'Upon Opening the Black Box and Finding it Empty: Social Constructivism and the Philosophy of Technology', *Science, Technology, & Human Values*, Vol. 18, No. 3 (Summer 1993), 362–78; Stewart Russell, 'The Social Construction of Artefacts: A Response to Pinch and Bijker', *Social Studies of Science*, Vol. 16, No. 2 (May 1986), 331–46.
24. Steven Lukes, *Power: A Radical View* (London: Macmillan, 1974). Lukes is providing a formal analysis of the dimensions of power, and does not himself discuss gender issues. However, much feminist research has been concerned with gender structures, and approaches that fail to find a place for this level of analysis will fail to do justice to feminist critiques.
25. See Mary Frank Fox, 'Gender, Hierarchy, and Science', in Janet Chafetz (ed.), *Handbook of the Sociology of Gender* (New York: Kluwer Academic/Plenum Publishers, 1999), 441–57, and Fox, 'Women in Science and Engineering: Theory, Practice, and Policy in Programs', *Signs*, Vol. 24, No. 1 (1998), 201–23.
26. Sandra Harding, *Whose Science? Whose Knowledge?* (Milton Keynes, Bucks.: Open University Press, 1991), and Susan Leigh Star, 'Power, Technology and the Phenomenology of Conventions: On Being Allergic to Onions', in John Law (ed.), *A Sociology of Monsters: Essays on Power, Technology and Domination* (London: Routledge, 1991), 26–56.
27. Bruno Latour, 'The Powers of Association', in Law (ed.), op. cit. note 20, 264–80, at 264.
28. Latour (1988), op. cit. note 20.
29. John Law, 'Theory and Narrative in the History of Technology: Response', *Technology and Culture*, Vol. 32, No. 2, Pt 1 (April 1991), 377–84.
30. Star, op. cit. note 26, 49.
31. Judy Wajcman, *Managing Like a Man: Women and Men in Corporate Management* (Cambridge: Polity Press, 1998).

32. See Steven Shapin's discussion of such explanations in his 'Following Scientists Around', *Social Studies of Science*, Vol. 18, No. 3 (August 1988), 533–50. See also Wiebe Bijker and John Law's discussion of the problematic structure/agency distinction in their 'Postscript' to Bijker & Law (eds), op. cit. note 22.
33. Star, op. cit. note 25, 26.
34. Delamont, op. cit. note 2, 166. See also Margaret Rossiter, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, MD: Johns Hopkins University Press, 1982).
35. See, for example, Callon, 'Sociology of an Actor-Network', and Latour (1987, 1988), all opera cit. note 20.
36. Sally Hacker, *Pleasure, Power and Technology* (Boston, MA: Unwin Hyman, 1989); Wendy Faulkner, 'The Power *and* the Pleasure? A Research Agenda for "Making Gender Stick" to Engineers', *Science, Technology, & Human Values*, Vol. 25, No. 1 (Winter 2000), 87–119; Ruth Oldenziel, *Making Technology Masculine: Men, Women, and Modern Machines in America* (Amsterdam: Amsterdam University Press, 1999).
37. See Wajcman, op. cit. note 13, Chapter 6.
38. See authors such as Berg, op. cit. note 12; Danielle Chabaud-Rychter, 'Women Users in the Design Process of a Food Robot: Innovation in a French Domestic Appliance Company', in Cynthia Cockburn and Ruza Furst-Dilic (eds), *Bringing Technology Home: Gender and Technology in a Changing Europe* (Milton Keynes, Bucks.: Open University Press, 1994), 77–93; the contributors to Merete Lie and Knut Sørensen (eds), *Making Technology Our Own? Domesticating Technology into Everyday Life* (Oslo: Scandinavian University Press, 1996); Lucy Suchman, 'Working Relations of Technology Production and Use', in MacKenzie & Wajcman (eds), op. cit. note 18, 258–65; and Juliet Webster, *Shaping Women's Work* (Harlow, Essex: Longman, 1995).
39. Cockburn & Ormrod, op. cit. note 19, 94.
40. Ibid., 109 (emphasis in original).
41. Monica Casper and Adele Clarke, 'Making the Pap Smear into the "Right Tool" for the Job: Cervical Cancer Screening in the USA, circa 1940–95', *Social Studies of Science*, Vol. 28, No. 2 (April 1998), 255–90; Vicky Singleton and Mike Michael, 'Actor-Networks and Ambivalence: General Practitioners in the UK Cervical Screening Programme', *ibid.*, Vol. 23, No. 2 (May 1993), 227–64.
42. See, for example, Judith Butler, *Gender Trouble* (New York: Routledge, 1990). Her emphasis on performance can be traced back at least to Erving Goffman's dramaturgical model: E. Goffman, *Interaction Ritual* (New York: Anchor Books, 1967).
43. Nelly Oudshoorn, *Beyond the Natural Body: An Archaeology of Sex Hormones* (London: Routledge, 1994), 82.
44. See, for example, Linda L. Layne (ed.), 'Anthropological Approaches in Science and Technology Studies', Special Issue, *Science, Technology, & Human Values*, Vol. 23, No. 1 (Winter 1998), 4–128; also Sarah Franklin's review essay on anthropological writing, 'Science As Culture, Cultures Of Science', *Annual Review of Anthropology*, Vol. 24 (1995), 163–84. Interestingly, a recent successful anthropology journal entitled *Journal of Material Culture* (Sage) is 'concerned with the relationship between artefacts and social relations ... and explores the linkage between the construction of social identities and the production and use of material culture'. I am thinking here of authors such as Sadie Plant, 'On the Matrix: Cyberfeminist Simulations', in Rob Shields (ed.), *Cultures of the Internet* (London: Sage, 1996), 170–83; Allucquere Rosanne Stone, *The War of Desire and Technology at the Close of the Mechanical Age* (Cambridge, MA: MIT Press, 1995); and Sharon Traweek, *Beamtimes and Lifetimes: The World of High Energy Physics* (Cambridge, MA: Harvard University Press, 1988).
45. Donna Haraway, 'A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s', *Socialist Review*, Vol. 15, No. 2 (1985), 65–108, and Haraway, *Modest_Witness@Second_Millennium.FemaleMan@Meets_OncoMouse™: Feminism and Technoscience* (New York: Routledge, 1997).
46. See, for example, Marc Berg and Annemarie Mol (eds), *Differences in Medicine: Unraveling Practices, Techniques and Bodies* (Durham, NC: Duke University Press, 1998);

Adele Clarke and Joan Fujimura (eds), *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences* (Princeton, NJ: Princeton University Press, 1992); Sarah Franklin, *Embodied Progress: A Cultural Account of Assisted Conception* (London: Routledge, 1997); Singleton & Michael, op. cit. note 41; Casper & Clarke, op. cit. note 41; Oudshoorn, op. cit. note 43; and Barbara Katz Rothman, *Genetic Maps and Human Imagination: The Limits of Science in Understanding Who We Are* (New York: W.W. Norton, 1998).

47. Nicholas Negroponte, *Being Digital* (Sydney: Hodder & Stoughton, 1995); Howard Rheingold, *The Virtual Community* (New York: Harper, 1994).
48. Roger Silverstone and Eric Hirsch, 'Introduction', in Silverstone and Hirsch (eds), *Consuming Technologies: Media and Information in Domestic Spaces* (London: Routledge, 1992), 1–11, at 3.
49. This is particularly disappointing given that a feminist group did critique the last large ESRC technology project, the 'Programme on Information and Communication Technologies' (PICT), on precisely these grounds. See Sonia Liff's report: 'Stunted Growth or Slow Development? The Coverage of Gender Issues within ESRC-Funded Research on Information Technology' (Swindon, Wilts.: ESRC/PICT Archives, 1990).
50. Sherry Turkle, *Life on the Screen: Identity in the Age of the Internet* (New York: Simon & Schuster, 1995), 12.
51. Ibid., 314.
52. Stone, op. cit. note 44, 180.
53. Ibid., Chapter 3.
54. Ruth Oldenziel, 'Of Old and New Cyborgs: Feminist Narratives of Technology', *Letterature D'America*, Vol. 14, No. 55 (1994), 95–111.
55. Ibid., 103.
56. See the collection edited by Susan Leigh Star, *The Cultures of Computing* (Oxford: Blackwell, 1995).
57. Oldenziel, op. cit. note 54, 104.
58. UNDP, *Human Development Report* (New York: United Nations, 1999).
59. A notable exception is Graham Thomas and Sally Wyatt, 'Access is Not the Only Problem: Using and Controlling the Internet', in Wyatt et al. (eds), *Technology and In/equality: Questioning the Information Society* (London: Routledge, forthcoming 2000).
60. Sadie Plant, *Zeros and Ones: Digital Women and the New Technoculture* (London: Fourth Estate, 1997); Dale Spender, *Nattering on the Net: Women, Power and Cyberspace* (Melbourne: Spinifex, 1995).

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