8. Feminist Perspectives on Technology

JUDY WAJCMAN

The study of the relationship between gender and technology has received increasing attention in recent years as feminists (both scholars and activists) have become concerned with the impact of new technology on women's lives and work, while "social constructivist" researchers on technology (see Chapter 2) have begun to examine how women's roles (and, in some cases, their absence) have influenced the evolution of technologies. This selection, "Feminist Perspectives on Technology," by Judy Wajcman, provides an overview of this area of study.

In order to understand the relationship between women and technology, it is important, first of all, to distinguish between science and technology and to be sensitive to the different layers of meaning of "technology." Women have contributed to the development of technology not just in terms of their conventional inventive activity but in terms of other kinds of activities in which they have engaged, but which may not have been recognized as "technological" in a gender-stereotyped view of technology. The emerging sociology of technology lacks a gender dimension, which Wajcman aims to provide both by the conceptual analysis presented here (and in her book, Feminism Confronts Technology, *from which this essay is taken), and by her own sociological research.*

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FROM SCIENCE TO TECHNOLOGY

While there has been a growing interest in the relationship of science to society over the last decade, there has been an even greater preoccupation with the relationship between technology and social change. Debate has raged over whether the "white heat of technology" is radically transforming society and delivering

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us into a postindustrial age. A major concern of feminists has been the impact of new technology on women's lives, particularly on women's work. The introduction of word processors into the office provided the focus for much early research.

The recognition that housework was also work, albeit unpaid, led to studies on how the increasing use of domestic technology in the home affected the time spent on housework. The exploitation of Third World women as a source of cheap labor for the manufacture of computer components has also been scrutinized. Most recently there has been a vigorous debate over developments in reproductive technology and the implications for women's control over their fertility.

Throughout these debates there has been a tension between the view that technology would liberate women — from unwanted pregnancy, from housework, and from routine paid work — and the obverse view that most new technologies are destructive and oppressive to women. For example, in the early seventies, Shulamith Firestone (1970) elaborated the view that developments in birth technology held the key to women's liberation through removing from them the burden of biological motherhood. Nowadays, there is much more concern with the negative implications of the new technologies, ironically most clearly reflected in the highly charged debate over the new reproductive technologies.

A key issue here is whether the problem lies in men's domination of technology or whether the technology is in some sense inherently patriarchal. If women were in control, would they apply technology to more benign ends? In the following discussion on gender and technology, I will explore these and related questions.

An initial difficulty in considering the feminist commentary on technology arises from its failure to distinguish between science and technology. Feminist writing on science has often construed science purely as a form of knowledge, and this assumption has been carried over into much of the feminist writing on technology. However, just as science includes practices and institutions, as well as knowledge, so too does technology. Indeed, it is even more clearly the case with technology, because technology is primarily about the creation of artifacts. This points to the need for a different theoretical approach to the analysis of the gender relations of technology from that being developed around science.

Perhaps this conflation of technology with science is not surprising given that the sociology of scientific knowledge over the last ten years has contested the idea of a noncontroversial distinction between science and technology. John Staudenmaier (1985, pp. 83–120) comments that although the relationship between science and technology has been a major theme in science and technology studies, the discussion has been plagued by a welter of conflicting definitions of the two basic terms. The only consensus to have emerged is that the way in which the boundaries between science and technology are demarcated, and how they are related to each other, change from one historical period to another.

In recent years, however, there has been a major reorientation of thinking about the form of the relationship between science and technology. The model of the science–technology relationship that enjoyed widespread acceptance over a long period was the traditional hierarchical model, which treats technology as

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applied science. This view that science discovers and technology applies this knowledge in a routine, uncreative way is now in steep decline. "One thing which practically any modern study of technological innovation suffices to show is that far from applying, and hence depending upon, the culture of natural science, technologists possess their own distinct cultural resources, which provide the principal basis for their innovative activity" (Barnes and Edge, 1982, p. 149). Technologists build on, modify, and extend existing technology, but they do this by a creative and imaginative process. And part of the received culture technologists inherit in the course of solving their practical problems is nonverbal; nor can it be conveyed adequately by the written word. Instead, it is the individual practitioner who transfers practical knowledge and competence to another. In short, the current model of the science–technology relationship characterizes science and technology as distinguishable subcultures in an interactive, symmetrical relationship.

Leaving aside the relationship between technology and science, it is most important to recognize that the word *technology* has at least three different layers of meaning. Firstly, "technology" is a form of knowledge, as Staudenmaier emphasizes.[1] Technological "things" are meaningless without the "know-how" to use them, repair them, design them, and make them. That know-how often cannot be captured in words. It is visual, even tactile, rather than simply verbal or mathematical. But it can also be systematized and taught, as in the various disciplines of engineering.

Few authors, however, would be content with this definition of technology as a form of knowledge. "Technology" also refers to what people do as well as what they know. An object such as a car or a vacuum cleaner is a technology, rather than an arbitrary lump of matter, because it forms part of a set of human activities. A computer without programs and programmers is simply a useless collection of bits of metal, plastic, and silicon. "Steelmaking," say, is a technology, but this implies that the technology includes what steelworkers do, as well as the furnaces they use. So "technology" refers to human activities and practices. And, finally, at the most basic level, there is the "hardware" definition of technology, in which it refers to sets of physical objects, for example, cars, lathes, vacuum cleaners, and computers.

In practice, the technologies dealt with here cover all three aspects, and often it is not useful to separate them further. My purpose is not to attempt to refine a definition. These different layers of meaning of "technology" are worth bearing in mind in what follows.

The rest of this [essay] will review the theoretical literature on gender and technology, which in many cases mirrors the debates about science outlined above. However, feminist perspectives on technology are more recent and much less theoretically developed than those that have been articulated in relation to science. One clear indication of this is the preponderance of edited collections that have been published in this area.[2] As with many such collections, the articles do not share a consistent approach or cover the field in a comprehensive fashion. Therefore, I will be drawing out strands of argument from this literature rather than presenting the material as coherent positions in a debate.

HIDDEN FROM HISTORY

To start with, feminists have pointed out the dearth of material on women and technology, especially given the burgeoning scholarship in the field of technology studies. Even the most perceptive and humanistic works on the relationship between technology, culture, and society rarely mention gender. Women's contributions have by and large been left out of technological history. Contributions to *Technology and Culture,* the leading journal of the history of technology, provide one accurate barometer of this. Joan Rothschild's (1983, pp. xii–xiv) survey of the journal for articles on the subject of women found only four in twenty-four years of publishing. In a more recent book about the journal, Staudenmaier (1985, p. 180) also notes the extraordinary bias in the journal toward male figures and the striking absence of a woman's perspective. The history of technology represents the prototype inventor as male. So, as in the history of science, an initial task of feminists has been to uncover and recover the women hidden from history who have contributed to technological developments.

There is now evidence that during the Industrial Era, women invented or contributed to the invention of such crucial machines as the cotton gin, the sewing machine, the small electric motor, the McCormick reaper, and the Jacquard loom (Stanley, 1992). This sort of historical scholarship often relies heavily on patent records to recover women's forgotten inventions. It has been noted that many women's inventions have been credited to their husbands, because they actually appear in patent records in their husbands' names. This is explained in terms of women's limited property rights, as well as the general ridicule afforded women inventors at that time (Pursell, 1981; Amram, 1984; Griffiths, 1985). Interestingly, it may be that even the recovery of women inventors from patent records seriously underestimates their contribution to technological development. In a recent article on the role of patents, Christine MacLeod (1987) observes that, prior to 1700, patents were not primarily about the recording of the actual inventor, but were instead sought in the name of financial backers.[3] Given this, it is even less surprising that so few women's names are to be found in patent records.

For all but a few exceptional women, creativity alone was not sufficient. In order to participate in the inventive activity of the Industrial Revolution, capital as well as ideas were necessary. It was only in 1882 that the Married Women's Property Act gave English women legal possession and control of any personal property independently of their husbands. Dot Griffiths (1985) argues that the effect of this was to virtually exclude women from participation in the world of the inventor–entrepreneur. At the same time, women were being denied access to education and specifically to the theoretical grounding in mathematics and mechanics upon which so many of the inventions and innovations of the period were based. As business activities expanded and were moved out of the home, middle-class women were increasingly left to a life of enforced leisure. Soon, the appropriate education for girls became "accomplishments" such as embroidery and music — accomplishments hardly conducive to participation in the world of the inventor–entrepreneur. In the current period, there has been considerable interest in the possible contributions that Ada Lady Lovelace, Grace Hopper,

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and other women may have made to the development of computing. Recent histories of computer programming provide substantial evidence for the view that women played a major part.[4]

To fully comprehend women's contributions to technological development, however, a more radical approach may be necessary. For a start, the traditional conception of technology too readily defines technology in terms of male activities. As I have pointed out above, the concept of technology is itself subject to historical change, and different epochs and cultures had different names for what we now think of as technology. A greater emphasis on women's activities immediately suggests that females, and in particular black women, were among the first technologists. After all, women were the main gatherers, processors, and storers of plant food from earliest human times onward. It was therefore logical that they should be the ones to have invented the tools and methods involved in this work, such as the digging stick, the carrying sling, the reaping knife and sickle, pestles, and pounders. In this vein, Autumn Stanley (1992) illustrates women's early achievements in horticulture and agriculture, such as the hoe, the scratch plow, grafting, hand pollination, and early irrigation.

If it were not for the male bias in most technology research, the significance of these inventions would be acknowledged. As Ruth Schwartz Cowan notes:

> The indices to the standard histories of technology . . . do not contain a single reference, for example, to such a significant cultural artifact as the baby bottle. Here is a simple implement . . . which has transformed a fundamental human experience for vast numbers of infants and mothers, and been one of the more controversial exports of Western technology to underdeveloped countries — yet it finds no place in our histories of technology. (1979, p. 52)

There is important work to be done not only in identifying women inventors, but also in discovering the origins and paths of development of "women's sphere" technologies that seem often to have been considered beneath notice.

A TECHNOLOGY BASED ON WOMEN'S VALUES?

During the eighties, feminists began to focus on the gendered character of technology itself. Rather than asking how women could be more equitably treated within and by a neutral technology, many feminists now argue that Western technology itself embodies patriarchal values. This parallels the way in which the feminist critique of science evolved from asking the "woman question" in science to asking the more radical "science question" in feminism. Technology, like science, is seen as deeply implicated in the masculine project of the domination and control of women and nature.[5] Just as many feminists have argued for a science based on women's values, so too has there been a call for a technology based on women's values. In Joan Rothschild's (1983) preface to a collection on feminist perspectives on technology, she says that "Feminist analysis has sought to show how the subjective, intuitive, and irrational can and do play a key role in our science and technology." Interestingly, she cites an important male figure in

the field, Lewis Mumford, to support her case. Mumford's linking of subjective impulses, life-generating forces, and a female principle is consistent with such a feminist analysis, as is his endorsement of a more holistic view of culture and technological developments.

Other male authors have also advocated a technology based on women's values. Mike Cooley is a well-known critic of the current design of technological systems, and he has done much to popularize the idea of human-centered technologies. In *Architect or Bee?* (1980, p. 43) he argues that technological change has "male values" built into it: "the values of the White Male Warrior, admired for his strength and speed in eliminating the weak, conquering competitors and ruling over vast armies of men who obey his every instruction. . . . Technological change is starved of the so-called female values, such as intuition, subjectivity, tenacity, and compassion." Cooley sees it as imperative that more women become involved in science and technology to challenge and counteract the built-in male values: that we cease placing the objective above the subjective, the rational above the tacit, and the digital above analogical representation. In *The Culture of Technology*, Arnold Pacey (1983) devotes an entire chapter to "Women and Wider Values." He outlines three contrasting sets of values involved in the practice of technology — first, those stressing virtuosity, second, economic values, and third, user or need-oriented values. Women exemplify this third "responsible" orientation, according to Pacey, as they work with nature in contrast to the male interest in construction and the conquest of nature.

Ironically, the approach of these male authors is in some respects rather similar to the eco-feminism that became popular among feminists in the eighties. This marriage of ecology and feminism rests on the "female principle," the notion that women are closer to nature than men and that the technologies men have created are based on the domination of nature in the same way that they seek to dominate women. Eco-feminists concentrated on military technology and the ecological effects of other modern technologies. According to them, these technologies are products of a patriarchal culture that "speaks violence at every level" (Rothschild, 1983, p. 126). An early slogan of the feminist antimilitarist movement, "Take the Toys from the Boys," drew attention to the phallic symbolism in the shape of missiles. However, an inevitable corollary of this stance seemed to be the representation of women as inherently nurturing and pacifist. The problems with this position have been outlined [here] in relation to science based on women's essential values. We need to ask how women became associated with these values. The answer involves examining the way in which the traditional division of labor between women and men has generally restricted women to a narrow range of experience concerned primarily with the private world of the home and family.

Nevertheless, the strength of these arguments is that they go beyond the usual conception of the problem as being women's exclusion from the processes of innovation and from the acquisition of technical skills. Feminists have pointed to all sorts of barriers — in social attitudes, girls' education, and the employment policies of firms — to account for the imbalance in the number of women in engineering. But rarely has the problem been identified as the way engineering has been conceived and taught. In particular, the failure of liberal and equal opportunity

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policies has led authors such as Cynthia Cockburn (1985) to ask whether women actively resist entering technology. Why have the women's training initiatives designed to break men's monopoly of the building trades, engineering, and information technology not been more successful? Although schemes to channel women into technical trades have been small scale, it is hard to escape the conclusion that women's response has been tentative and perhaps ambivalent.

I share Cockburn's view that this reluctance "to enter" is to do with the sex-stereotyped definition 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 coterminous with the culture of technology. Both at school and in the workplace, this culture is incompatible with femininity. Therefore, to enter this world, to learn its language, women have first to forsake their femininity.

TECHNOLOGY AND THE DIVISION OF LABOR

I will now turn to a more historical and sociological approach to the analysis of gender and technology. This approach has built on some theoretical foundations provided by contributors to the labor process debate of the 1970s. Just as the radical science movement had sought to expose the class character of science, these writers attempted to extend the class analysis to technology. In doing so, they were countering the theory of "technological determinism" that remains so widespread.

According to this account, changes in technology are the most important cause of social change. Technologies themselves are neutral and impinge on society from the outside; the scientists and technicians who produce new technologies are seen to be independent of their social location and above sectional interests. Labor-process analysts were especially critical of a technicist version of Marxism in which the development of technology and productivity is seen as the motor force of history. This interpretation represented technology itself as beyond class struggle.

With the publication of Harry Braverman's *Labor and Monopoly Capital* (1974), there was a revival of interest in Marx's contribution to the study of technology, particularly in relation to work. Braverman restored Marx's critique of technology and the division of labor to the center of his analysis of the process of capitalist development. The basic argument of the labor-process literature that developed was that capitalist–worker relations are a major factor affecting the technology of production within capitalism. Historical case studies of the evolution and introduction of particular technologies documented the way in which they were deliberately designed to deskill and eliminate human labor.[6] Rather than technical inventions developing inexorably, machinery was used by the owners and managers of capital as an important weapon in the battle for control over production. So, like science, technology was understood to be the result of capitalist social relations.

This analysis provided a timely challenge to the notion of technological determinism and, in its focus on the capitalist division of labor, it paved the way for development of a more sophisticated analysis of gender relations and technology. However, the labor process approach was gender blind, because it interpreted the social relations of technology in exclusively class terms. Yet, as has been well established by the socialist feminist current in this debate, the relations of production are constructed as much out of gender divisions as class divisions. Recent writings (Cockburn, 1983, 1985; Faulkner and Arnold, 1985; McNeil, 1987) in this historical vein see women's exclusion from technology as a consequence of the gender division of labor and the male domination of skilled trades that developed under capitalism. In fact, some argue that, prior to the Industrial Revolution, women had more opportunities to acquire technical skills and that capitalist technology has become more masculine than previous technologies.

I have already described how, in the early phases of industrialization, women were denied access to ownership of capital and access to education. Shifting the focus, these authors show that the rigid pattern of gender divisions that developed within the working class in the context of the new industries laid the foundation for the male dominance of technology. It was during this period that manufacturing moved into factories and home became separated from paid work. The advent of powered machinery fundamentally challenged traditional craft skills, because tools were literally taken out of the hands of workers and combined into machines. But, as it had been men who on the whole had technical skills in the period before the Industrial Revolution, they were in a unique position to maintain a monopoly over the new skills created by the introduction of machines.

Male craft workers could not prevent employers from drawing women into the new spheres of production. So instead they organized to retain certain rights over technology by actively resisting the entry of women to their trades. Women who became industrial laborers found themselves working in what were considered to be unskilled jobs for the lowest pay. "It is the most damning indictment of skilled working-class men and their unions that they excluded women from membership and prevented them gaining competences that could have secured them a decent living" (Cockburn, 1985, p. 39). This gender division of labor within the factory meant that the machinery was designed by men with men in mind, either by the capitalist inventor or by skilled craftsmen. Industrial technology from its origins thus reflects male power as well as capitalist domination.

The masculine culture of technology is fundamental to the way in which the gender division of labor is still being reproduced today. By securing control of key technologies, men are denying women the practical experience upon which inventiveness depends. I noted earlier the degree to which technical knowledge involves tacit, intuitive knowledge and "learning by doing." New technology typically emerges not from sudden flashes of inspiration but from existing technology, by a process of gradual modification to, and new combinations of, that existing technology. Innovation is, to some extent, an imaginative process, but that imagination lies largely in seeing ways in which existing devices can be improved and in extending the scope of techniques successful in one area into

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The nature of women's inventions, like that of men's, is a function of time, place, and resources. Segregated at work and primarily confined to the private sphere of household, women's experience has been severely restricted and therefore so too has their inventiveness. An interesting illustration of this point lies in the fact that women who were employed in the munitions factories during the First World War are on record as having redesigned the weaponry they were making.[7] Thus, given the opportunity, women have demonstrated their inventive capacity in what now seems the most unlikely of contexts.

MISSING: THE GENDER DIMENSION IN THE SOCIOLOGY OF TECHNOLOGY

The historical approach is an advance over essentialist positions that seek to base a new technology on women's innate values. Women's profound alienation from technology is accounted for in terms of the historical and cultural construction of technology as masculine. I believe that women's exclusion from, and rejection of, technology is made more explicable by an analysis of technology as a culture that expresses and consolidates relations among men. If technical competence is an integral part of masculine gender identity, why should women be expected to aspire to it?

Such an account of technology and gender relations, however, is still at a general level.[8] There are few cases where feminists have really got inside the "black box" of technology to do detailed empirical research, as some of the most recent sociological literature has attempted. Over the last few years, a new sociology of technology has emerged, which is studying the invention, development, stabilization, and diffusion of specific artifacts.[9] It is evident from this research that technology is not simply the product of rational technical imperatives. Rather, political choices are embedded in the very design and selection of technology.

Technologies result from a series of specific decisions made by particular groups of people in particular places at particular times for their own purposes. As such, technologies bear the imprint of the people and social context in which they developed. David Noble (1984, p. xiii) expresses this point succinctly as follows: "Because of its very concreteness, people tend to confront technology as an irreducible brute fact, a given, a first cause, rather than as hardened history, frozen fragments of human and social endeavor." Technological change is a process subject to struggles for control by different groups. As such, the outcomes depend primarily on the distribution of power and resources within society.

There is now an extensive literature on the history of technology and the economics of technological innovation. Labor historians and sociologists have investigated the relationship between social change and the shaping of production processes in great detail and have also been concerned with the influence of technological form upon social relations. The sociological approach has moved away

from studying the individual inventor and from the notion that technological innovation is a result of some inner technical logic. Rather, it attempts to show the effects of social relations on technology that range from fostering or inhibiting particular technologies, through influencing the choice between competing paths of technical development, to affecting the precise design characteristics of particular artifacts. Technological innovation now requires major investment and has become a collective, institutionalized process. The evolution of a technology is thus the function of a complex set of technical, social, economic, and political factors. An artifact may be looked on as the "congealed outcome of a set of negotiations, compromises, conflicts, controversies, and deals that were put together between opponents in rooms filled with smoke, lathes, or computer terminals" (Law, 1987, p. 406).

Because social groups have different interests and resources, the development process brings out conflicts between different views of the technical requirements of the device. Accordingly, the stability and form of artifacts depend on the capacity and resources that the salient social groups can mobilize in the course of the development process. Thus, in the technology of production, economic and social class interests often lie behind the development and adoption of devices. In the case of military technology, the operation of bureaucratic and organizational interests of state decision making will be identifiable. Growing attention is now being given to the extent to which the state sponsorship of military technology shapes civilian technology.

So far, however, little attention has been paid to the way in which technological objects may be shaped by the operation of gender interests. This blindness to gender issues is also indicative of a general problem with the methodology adopted by the new sociology of technology. Using a conventional notion of technology, these writers study the social groups that actively seek to influence the form and direction of technological design. What they overlook is the fact that the absence of influence from certain groups may also be significant. For them, women's absence from observable conflict does not indicate that gender interests are being mobilized. For a social theory of gender, however, the almost complete exclusion of women from the technological community points to the need to take account of the underlying structure of gender relations. Preferences for different technologies are shaped by a set of social arrangements that reflect men's power in the wider society. The process of technological development is socially structured and culturally patterned by various social interests that lie outside the immediate context of technological innovation.

More than ever before, technological change impinges on every aspect of our public and private lives, from the artificially cultivated food that we eat to the increasingly sophisticated forms of communication we use. Yet, in common with the labor process debate, the sociology of technology has concentrated almost exclusively on the relations of paid production, focusing in particular on the early stages of product development. In doing so [it has] ignored the spheres of reproduction, consumption, and the unpaid production that takes place in the home.

By contrast, feminist analysis points us beyond the factory gates to see that technology is just as centrally involved in these spheres.

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Inevitably perhaps, feminist work in this area has so far raised as many questions as it has answered. Is technology valued because it is associated with masculinity or is masculinity valued because of the association with technology? How do we avoid the tautology that "technology is masculine because men do it"? Why is women's work undervalued? Is there such a thing as women's knowledge? Is it different from "feminine intuition"? Can technology be reconstructed around women's interests? These are the questions that abstract analysis has so far failed to answer. The character of salient interests and social groups will differ depending on the particular empirical sites of technology being considered. Thus, we need to look in more concrete and historical detail at how, in specific areas of work and personal life, gender relations influence the technological enterprise. . . . [In the book from which this chapter is drawn I stress] that a gendered approach to technology cannot be reduced to a view which treats technology as a set of neutral artifacts manipulated by men in their own interests. While it is the case that men dominate the scientific and technical institutions, it is perfectly plausible that there will come a time when women are more fully represented in these institutions without transforming the direction of technological development. To cite just one instance, women are increasingly being recruited into the American space-defense program, but we do not hear their voices protesting about its preoccupations. Nevertheless, gender relations are an integral constituent of the social organization of these institutions and their projects. It is impossible to divorce the gender relations that are expressed in, and shape technologies from, the wider social structures that create and maintain them. In developing a theory of the gendered character of technology, we are inevitably in danger of either adopting an essentialist position that sees technology as inherently patriarchal or losing sight of the structure of gender relations through an overemphasis on the historical variability of the categories of "women" and "technology." [My work seeks] to chart another course.

NOTES

1. Staudenmaier (1985, pp. 103–20) outlines four characteristics of technological knowledge — scientific concepts, problematic data, engineering theory, and technological skill.
2. A good cross-section of this material can be found in Trescott (1979), Rothschild (1983), Faulkner and Arnold (1985), McNeil (1987) and Kramarae (1988). McNeil's book is particularly useful as it contains a comprehensive bibliography, which is organized thematically.
3. MacLeod (1987) suggests that although George Ravenscroft is credited in the patent records with being the "heroic" inventor of lead-crystal glass, he was rather the purchaser or financier of another's invention. This study alerts us to the danger of assuming that patent records have always represented the same thing.
4. For a biography of Lady Lovelace, which takes issue with the view of her as a major contributor to computer programming, see Stein (1985). However, both Kraft (1977) and, more recently, Giordano (1988) have documented the extensive participation of women in the development of computer programming.
5. Technology as the domination of nature is also a central theme in the work of critical theorists, such as Marcuse, for whom it is capitalist relations (rather than patriarchal relations) that are built into the very structure of technology. "Not only the application of technology but technology itself is domination (of nature and men) — methodical, scientific, calculated,

calculating control. Specific purposes and interests of domination are not foisted upon technology 'subsequently' and from the outside; they enter the very construction of the technical apparatus" (Marcuse, 1968, pp. 223–4).

6. This point is elaborated in Chapter 2 of *Feminism Confronts Technology*. See also Part Two of MacKenzie and Wajcman (1985) for a collection of these case studies.
7. Amram (1984) provides a selection of the patents granted to women during the First World War.
8. Cockburn's (1983, 1985) work is one important exception discussed at greater length in Chapter 2 of *Feminism Confronts Technology*.
9. For an introduction to this literature, see MacKenzie and Wajcman (1985) and Bijker, Hughes, and Pinch (1987).

REFERENCES

Amram, F. 1984. "The Innovative Woman." *New Scientist* 24 May 1984, 10–12.

Barnes, Barry, and David Edge, eds. 1982. *Science in Context: Readings in the Sociology of Science*. Milton Keynes, England: Open University Press/Cambridge, MA: MIT Press.

Bijker, Wiebe E., Thomas P. Hughes, and Trevor J. Pinch, eds. 1987. *The Social Construction of Technological Systems*. Cambridge, MA: MIT Press.

Braverman, Harry. 1974. *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century*. New York: Monthly Review Press.

Cockburn, Cynthia. 1985. *Machinery of Dominance: Women, Men, and Technical Know-How*. London: Pluto Press.

Cockburn, Cynthia. 1983. *Brothers: Male Dominance and Technical Change*. London: Pluto Press.

Cooley, Mike. 1980. *Architect or Bee? The Human/Technology Relationship*. Slough, England: Langley Technical Services.

Cowan, Ruth S. 1979. "From Virginia Dare to Virginia Slims: Women and Technology in American Life." *Technology and Culture* 20; 51–63.

Faulkner, Wendy, and Erik Arnold, eds. 1985. *Smothered by Invention: Technology in Women's Lives*. London: Pluto Press.

Firestone, Shulamith. 1970. *The Dialectic of Sex*. New York: William Morrow & Co.

Giordano, R. 1988. *The Social Context of Innovation: A Case History of the Development of COBOL Programming Language*. Columbia University Department of History.

Griffiths, Dot. 1985. "The Exclusion of Women from Technology." In Faulkner and Arnold, op. cit.

Kraft, P. 1977. *Programmers and Managers: The Routinization of Computer Programming in the United States*. New York: Springer Verlag.

Kramarae, Chris, ed. 1988. *Technology and Women's Voices*. New York: Routledge & Kegan Paul.

Law, John. 1987. Review Article: "The Structure of Sociotechnical Engineering — A Review of the New Sociology of Technology." *Sociological Review* 35; 404–25.

MacKenzie, Donald, and Judy Wajcman, eds. 1985. *The Social Shaping of Technology: How the Refrigerator Got Its Hum*. Milton Keynes, England: Open University Press.

MacLeod, Christine. 1987. "Accident or Design? George Ravenscroft's Patent and the Invention of Lead-Crystal Glass." *Technology and Culture* 28, 4:776–803.

Marcuse, H. 1968. *Negations*. London: Allen Lane.

McNeil, Maureen, ed. 1987. *Gender and Expertise*. London: Free Association Books.

Noble, David. 1984. *Forces of Production: A Social History of Industrial Automation*. New York: Knopf.

Pacey, Arnold. 1983. *The Culture of Technology*. Oxford, England: Basil Blackwell/Cambridge, MA: MIT Press.

Pursell, C. 1981. "Women Inventors in America." *Technology and Culture* 22, 3:545–9.

Rothschild, Joan, ed. 198
Pergamon Press.

Stanley, Autumn. 1992. *N*
Technology. Metuchen, N

Staudenmaier, John M. 19
MA: MIT Press.

Stein, D. 1985. *Ada: A Life*

Trescott, Martha M., ed. 1
in History. Metuchen, N