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Feminist Theories of Technology

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Chapter 9: Feminist Theories of Technology

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OVER the last 15 years, an exciting new field of study has emerged, concerned to develop a feminist perspective on technology. The development of this perspective is more recent and consequently less theoretically developed than that which has been articulated in relation to science (see Keller, Chapter 4 in this volume). To date, however, most contributions to the debate on gender and technology have been of a somewhat specialist character, focused on a particular type of technology. Thus the area is characterized by many edited collections such as Martha Moore Trescott (1979a), Joan Rothschild (1983), Jan Zimmerman (1983), Wendy Faulkner and Erik Arnold (1985), Maureen McNeil (1987), Chris Kramarae (1988), and Gill Kirkup and Laurie Keller (1992), which do not necessarily share a theoretical approach.

While some feminists have been primarily concerned with women's limited access to scientific and technical institutions (see Fox, Chapter 10), others have begun to explore the gendered character of technology itself. This latter, more radical, approach has broadly taken two directions. There are those feminists who argue that Western technology itself embodies patriarchal values and that its project is the domination and control of women and nature (Corea et al., 1985; Griffin, 1978; Merchant, 1980; Mies, 1987). This approach finds political expression in the cultural feminism and eco-feminism of the 1980s, which calls for a new feminist technology based on women's [p. 190 ↓] values. Taking a different tack, there are a group of writers who adopt the methods of the social studies of technology, which is more historical and sociological in orientation (Cockburn, 1983, 1985; Cowan, 1976, 1979, 1983; Faulkner & Arnold, 1985; Hartmann, Kraut, & Tilly, 1986–1987; McGaw, 1982; McNeil, 1987). Much of their work has been concerned with the gender division of labor in both paid and unpaid work.

What I have attempted here, and developed more fully elsewhere (Wajcman, 1991), is to construct a framework that brings together these various perspectives. Instead

of imposing an artificial uniformity, I will argue that different kinds of technology are shaped by specific constellations of interests, so that the male interests shaping reproductive technologies, for example, are different than those that form technologies in the workplace. In this chapter I have chosen to concentrate on the three most heavily researched areas—production, reproduction, and domestic technologies. In the final section I present a more general analysis of women's marginality, one that focuses on technology as a masculine culture.

The Technology of Production

The study of technologies in the context of paid work has been and still is the main subject of research on technological change. Since the mid-1970s, feminist researchers and activists have addressed the effects of automation on women's employment. The introduction of computer-based technologies into offices is a prime site of this research, mainly because the majority of clerical and secretarial workers almost everywhere are women. Office automation forms the basis for many of the generalizations about women's work experience. This research examines the effects of technological change both on women's employment opportunities and on their experience of work (Crompton & Jones, 1984; Feldberg & Glenn, 1983; Hartmann et al., 1986, 1987; Webster, 1989; Wright, 1987).

Although word processors were initially seen as a threat to typists' skills and as leading to the fragmentation and standardization of work, a more complex picture is now emerging. With respect to skill levels required for given jobs, detailed empirical studies show that opposing tendencies of increased complexity and of greater simplification and routinization may coexist. Rather than the impact of automation being uniform across a range of office jobs, the effects of new technology operate within and reinforce preexisting differences in the patterns of work. It has been found, for example, that technological change tends to further advantage those who already have recognized skills and a degree of control over their work tasks (Baran, 1987).

[p. 191 ↓] Another strand of research has taken up the issue of divisions between men and women in the workplace and the implications of this for the sex typing of occupations. Of particular concern here is the remarkable persistence of the gender

stereotyping of jobs, even when the nature of the work and the skills required to perform it have been radically transformed by technological change.

Much of this feminist research has been influenced by a theoretical perspective, mainly Marxist in orientation, that identified the connections between technologies of production and control over labor (Braverman, 1974; Noble, 1984). The basic argument of this literature is that, within capitalism, a major factor affecting the development and use of machinery is the antagonistic class relations of production. To control the labor force and maximize profitability, capitalism continuously applies new technology designed to fragment and deskill labor, so that labor becomes cheaper and subject to greater control (MacKenzie & Wajcman, 1985).

Although this theoretical approach has been sophisticated in its analysis of the capital-labor relation, feminists questioned the notion that control over the labor process operates independently of the gender of the workers who are being controlled. They pointed out that the relations of production are constructed as much out of gender divisions as class divisions (Beechey, 1988; Cockburn, 1983; Hartmann, 1976). Both employers as employers, and men as men, were shown to have an interest in creating and sustaining occupational sex segregation.

The Sex Typing of Technical Skills

Standard historical accounts of craft unionism have examined the role of technical skills in securing job control, that is, as a weapon in class conflict. Its role as a weapon in patriarchal struggles at work has been ignored. It is now well established in the feminist literature that, as exclusively male preserves, craft unions have played an active part in creating and sustaining women's subordinate position in the workforce. The identification of men with skill has been central to male dominance in the workplace.

Some authors have focused on the male domination of the skilled trades created with the introduction of machines during the industrial revolution (Cockburn, 1983, 1985; Faulkner & Arnold, 1985; McNeil, 1987). Male craft workers could not prevent employers from drawing women into the new spheres of production. Instead, they organized to retain certain rights over technology by actively resisting the entry of

women into their trades. Women who became industrial laborers found themselves working in what were considered to be unskilled jobs for the lowest pay. Even when they did manage to enter technical/skilled industrial work, as in the two world wars, **[p. 192 ↓]** this was followed by a deliberate process of expulsion from that work once the immediate crisis had passed. Most women workers wanted to retain their jobs and were only removed through the combined efforts of management and unions (Milkman, 1987).

Thus male dominance of technology has largely been secured by the active exclusion of women from areas of technological work and it is fundamental to the way in which the gender division of labor is still being reproduced today. Let us now turn the focus around and look at how these gender divisions may themselves shape particular technological developments in the first place. If technology is designed by men, with job stereotypes in mind, then it is hardly surprising that sex segregation is being further incorporated into the workplace. Gender divisions in the workplace profoundly affect the direction and pace of technological innovation.

The Gendered Relations of Workplace Technology

One of the most important ways that gender divisions interact with technological change is through the price of labor, in that women's wage labor generally costs considerably less than men's. This may affect technological change in at least two ways. Because a new machine has to pay for itself in labor costs saved, technological change may be slower in industries where there is an abundant supply of women's cheap labor. For example, the clothing industry has remained technologically static since the nineteenth century with little change in the sewing process. While there are no doubt purely technical obstacles to the mechanization of clothing production, there will be less incentive to invest in automation if skilled and cheap labor power is available to do the job. Thus there is an important link between women's status as unskilled and low-paid workers, and the uneven pace of technological development.

SAGE knowledge

There is a more direct sense, however, in which gender inequality leaves its imprint on technology. Employers may seek *forms* of technological change that enable them to replace expensive skilled male workers with low-paid, less unionized female workers. A good example of this comes from Cynthia Cockburn's (1983) account of an archetypal group of skilled workers being radically undermined by technological innovation. It is the story of the rise and fall of London's Fleet Street compositors, an exclusively male trade with strong craft traditions of control over the labor process. A detailed description of the technological evolution from the Linotype system to electronic photocomposition shows how the design of the new typesetting technology reflected gender issues.

The new computerized system was designed using the keyboard of a conventional typewriter rather than the compositor's traditional, and very different, **[p. 193 ↓]** keyboard. There was nothing inevitable about this. Electronic circuitry is in fact perfectly capable of producing a Linotype lay on the new-style board. So what politics lie behind the design and selection of this keyboard? In choosing to dispense with the Linotype layout, management were choosing a system that would undermine the skill and power basis of the compositors, and reduce them at a stroke to "mere" typists. This would render typists (mainly women) and compositors (men) equal competitors for the new machines; indeed, it would advantage the women typists. The keyboard on the new printing technology was designed with an eye to using the relatively cheap and abundant labor of female typists.

Although machine design is overwhelmingly a male province, it does not always coincide with the interests of men as a sex. As we have seen, some technologies are designed for use by women to break the craft control of men. Thus gender divisions are commonly exploited in the power struggles between capital and labor. In this way, the social relations that shape industrial technology include those of gender as well as class.

Reproductive Technology

The area most vigorously contested at the moment by feminists, both politically and intellectually, is in the sphere of human biological reproduction. Much feminist scholarship has been devoted to uncovering women's struggle throughout history

against the appropriation of medical knowledge and practice by men. Contemporary debates are fueled by the perception that the processes of pregnancy and childbirth are directed and controlled by ever-more sophisticated and intrusive technologies.

Reproductive Technology as Patriarchal Domination

Most vocal in their opposition to the development of the new reproductive technologies are a group of radical feminists who see these technologies as a form of patriarchal exploitation of women's bodies (Corea et al., 1985; Hanmer, 1985; Klein, 1985; Mies, 1987; Rowland, 1985). According to these writers, techniques such as in vitro fertilization, egg donation, sex predetermination, and embryo evaluation represent another attempt to control women's bodies. The technological potential for the complete separation of reproduction from sexuality is seen as a move to appropriate the reproductive capacities that have been, in the past, women's unique source of power.

Central to the radical feminist analysis is a concept of reproduction as a natural process, inherent in women alone, and a theory of technology as **[p. 194 ↓]** intrinsically patriarchal. In a similar vein to the work on reproductive technologies, eco-feminists have analyzed military technology and the ecological effects of other modern technologies as products of patriarchal culture that "speak violence at every level" (Caldecott & Leland, 1983; Griffin, 1978). These theories argue that women are more in tune with nature because of their biological capacity for motherhood. Conversely, men's inability to give birth has made them disrespectful of human and natural life, resulting in wars and ecological disasters.

Technology, like science, is seen as an instrument of male domination of women and nature. And, just as many feminists have argued for a science based on women's values, so too there has been a call for a technology based on women's values. From this perspective, a new feminist technology would be based on "a nonexploitative relationship between nature and ourselves" and would embrace feminine intuition and subjectivity.

This trend in feminism has been gathering force in recent years, and resonates with some feminist postmodernism that is largely concerned with an analysis of technology as a cultural phenomenon. It has been positive in taking the debate about gender and technology beyond the use/abuse model of technology and focusing on the political qualities of technology itself. It has also been a forceful assertion of women's interests, needs, and values as being different than men's as well as of the way women are not well served by current technologies.

However, there are clearly some fundamental problems with this idea of a technology based on women's values, including the representation of women as inherently nurturing and pacifist. The assertion of fixed, unified, and opposed female and male natures has been subjected to a variety of thorough critiques (Eisenstein, 1984; Segal, 1987). There is only space here to observe that the values being ascribed to women originate in the historical subordination of women. The belief in the unchanging nature of women, and their association with procreation, nurturance, warmth, and creativity, lies at the very heart of traditional and oppressive conceptions of womanhood. Rather than asserting some inner essence of womanhood as an ahistorical category, we need to recognize the ways in which both "masculinity" and "femininity" are socially constructed and are in fact constantly under reconstruction. The pursuit of a technology based on women's inherent values is therefore misguided.

The literature referred to above has surveyed the range of reproductive technologies and was important because it identified the sexual politics in which these technologies were embedded. Recently, there has been some attempt to make distinctions within the field of reproductive technologies by emphasizing the specific nature of each technology and the differing positions of women in relation to them. Edited collections such as those by Michelle **[p. 195 ↓]** Stanworth (1987) and Maureen McNeil, Ian Varcoe, and Steven Yearley (1990) represent notable contributions to the social studies of technology. While maintaining that male interests have profoundly structured the form of reproductive technologies that have become available, this literature treats neither men nor the technologies as a homogeneous group. It also recognizes that women are not necessarily hostile to increased technical intervention. Indeed, many women, as patients, favor high-technology deliveries and want access to in vitro fertilization (Morgall, 1992).

While it is evident that all the stages in the career of a medical technology, from its inception and development, through to consolidation as part of routine practice, are a series of interlocking male activities, the male interests involved are specifically those of white middle-class professionals. The division of labor that produces and deploys the reproductive technologies is both sexual and professional: Women are the patients, while the obstetricians, gynecologists, molecular biologists, and embryologists are overwhelmingly men.

Technology and Professionalization

One of the key themes to emerge from these studies is that the "technological imperative" within reproductive medicine is intrinsic to the defense of doctors' claims of professionalism. The unequal power relations between medical practitioners and their female patients are based on a combination of factors, predominantly those of professional qualification and gender. The professional hierarchy means that doctors are regarded as experts who possess technical knowledge and skill that laypeople don't have. Technology is particularly attractive in the case of obstetricians because techniques such as the stethoscope and foetal monitoring enable male doctors to claim to know more about women's bodies than the women themselves (Oakley, 1987).

High-technology activities are not only the key to power at the level of doctor-patient relations but also to power within the profession. Status, money, and professional acclaim within the medical profession are distributed according to the technological sophistication of the specialty, and the new techniques of in vitro fertilization and embryo transfer are no exception. Before the introduction of these techniques, the investigation and treatment of infertility had long been afforded low status in the medical hierarchy. The new techniques of in vitro fertilization and embryo transfer provide gynecologists with an exciting, high-status area of research as well as a technically complex practice that only they can use (Pfeffer, 1987). Clearly, professional interests play a central role in determining the type and tempo of technological innovation in this area.

[p. 196 ↓] There are also wider economic forces at work. The commercial interests of the vast biotechnology industry are particularly influential. Much has been written about

the "new medical-industrial complex" and the way in which resources are systematically channeled into profitable areas that often have no connection with satisfying human needs (Yoxen, 1986). However, there is as yet little detailed information about the financial interests of medical biotechnology corporations in the development of the new reproductive technologies.

The gender perspective presented in these studies has in some ways built on the earlier analysis of gender relations of production technologies. However, while the conflictual relations of the workplace provide the context for the analysis of technologies of production, reproductive technologies can only be understood in the wider context of the growing supremacy of technology in Western medicine. Although women are prime targets of medical experimentation, reproductive technology cannot be analyzed in terms of a patriarchal conspiracy. Instead, a complex web of interests has been woven here—those of professional and capitalist interests overlaid with gender.

Domestic Technology

Just as women are the primary consumers of reproductive technologies, so are domestic technologies destined for use by women. In this case, considerable optimism has attached to the possibility that technology may provide the solution to women's oppression in the home. Since the 1970s, with the recognition of housework as work, feminist scholars have produced excellent material on the history of housework and domestic technology (Bose, Bereano, & Malloy, 1984; Cowan, 1983; Hayden, 1982; Ravetz, 1965; Strasser, 1982). Another body of writing on domestic technology has concentrated on the recent dramatic expansion of information and communication technologies in the home. It has been concerned with the cultural consequences for the family of their diffusion and consumption (Silverstone & Hirsch, 1992).

Such research has challenged the main orientation within the sociology of technology toward paid, productive labor in the public domain. Issues that have been central here are the relationship between domestic technologies and time spent on household labor, whether technology has affected the degree of gender specialization of housework, and gender bias in the use of new technologies. Dominating the debates is the knowledge

that the amount of time women spend on household tasks has not decreased with "mechanization of the home."

"Labor-Saving" Appliances

In her study of household technology, Ruth Schwartz Cowan (1983) provides the following explanations for the failure of the "industrial revolution in the home" to ease or eliminate household tasks. Mechanization gave rise to a whole range of new tasks, which, although not as physically demanding, were as time consuming as the jobs they had replaced. The loss of servants in the early decades of this century meant that even middle-class housewives had to do all the housework themselves. Further, although domestic technology did raise the productivity in housework, it was accompanied by rising expectations of the housewife's role, which generated more domestic work for women. With a major change in the importance attached to child rearing and the mother's role, the home and housework acquired heightened emotional significance. The split between public and private spheres meant that the home was expected to provide a haven from the alienated, stressful technological order of the workplace as well as entertainment, emotional support, and sexual gratification. The burden of satisfying these needs fell on the housewife.

Much of the feminist literature has pointed to the contradictions inherent in attempts to mechanize the home and standardize domestic production. Such attempts have foundered on the nature of housework—privatized, decentralized, and labor intensive. The result is a completely "irrational" use of technology and labor within the home, because of the dominance of single-family residences and the private ownership of correspondingly small-scale amenities. "Several million American women cook supper each night in several million separate homes over several million stoves" (Cowan, 1979, p. 59). Domestic technology has thus been designed for use in single-family households by a lone and loving housewife. Far from liberating women from the home, it has further ensnared them within the social organization of gender.

Alternatives

There is a tendency to see the technologies we have as the only possible ones. This obscures the way particular social and economic interests have influenced their development. It is useful to ask how a particular technology or set of technologies might be redesigned with alternative priorities in mind. History provides us with examples of alternative technologies that have been developed but that have not flourished. In particular, studying paths not taken can illuminate the way in which ideologies of gender shape technology.

In the case of domestic technologies, this can be illustrated in a number of ways. For example, it is worth remembering that during the first few decades **[p. 198 ↓]** of this century a range of alternative approaches to housework were being considered and experimented with. These included the development of commercial services, the establishment of alternative communities and cooperatives, and the invention of different types of machinery (Hayden, 1982). Seeing that the exploitation of women's labor by men was embodied in the actual design of houses, a group of Victorian feminists believed that the only way to free women from domestic drudgery was to change the entire physical framework of houses and neighborhoods. The continued dominance of the single-family residence and the private ownership of household tools has obscured the significance of these alternative approaches.

Thus, when women have designed technological alternatives to time-consuming housework, little is heard of them. A contemporary example is Gabe's innovative self-cleaning house (Zimmerman, 1983). Although still premised on the single-family home, her design focuses on the need to relieve women of the burden of housework it generates. An artist and inventor from Oregon, Frances Gabe spent 27 years building and perfecting the self-cleaning house. In effect, a warm water mist does the basic cleaning and the floors (with rugs removed) serve as the drains. Every detail has been considered. "Clothes freshener cupboards" and "dish washer cupboards" that wash and dry relieve the tedium of stacking, hanging, folding, ironing, and putting away. The costs of her system are no more than average because it is not designed as a luxury item. Although ridiculed at the time, architects and builders now admit that Gabe's house

is functional and attractive. One cannot help speculating that the development of an effective self-cleaning house has not been high on the agenda of male engineers.

Domestic Technology: A Commercial Afterthought

The fact is that much domestic technology has not anyway been specifically designed for household use but has its origins in very different spheres. Many domestic technologies were initially developed for commercial, industrial, and even military purposes and only later, as manufacturers sought to expand their markets, were they adapted for home use. For this reason new domestic appliances are not always appropriate to the household work that they are supposed to perform. Nor are they necessarily the implements that would have been developed if the housewife had been considered first or indeed if she had had control of the processes of innovation.

An industrial designer I interviewed put it thus: "Why invest heavily in the design of domestic technology when there is no measure of productivity for housework as there is for industrial work?" Given that women's labor in the home is unpaid, different economic considerations operate. When producing for the household market, manufacturers concentrate on cutting the **[p. 199 ↓]** costs of manufacturing techniques to enable them to sell reasonably cheap products. Much of the design effort is put into making appliances look attractive or impressively high tech in the showroom—for example, giving them an unnecessary array of buttons and flashing lights. Far from being designed to accomplish a specific task, some appliances are designed expressly for sale as moderately priced gifts from husband to wife and in fact are rarely used. In these ways the inequalities between women and men, and the subordination of the private to the public sphere, are reflected in the very design processes of domestic technology. Men design domestic technology with female users in mind and against the background of a particular ideology of the family.

SAGE knowledge

The Indeterminacy of Technology

Throughout this chapter I have been examining the way in which the gender division of our society has affected technological change. As I have argued that technology is imprinted with patriarchal designs, it may appear that the politics implicit in my account are profoundly pessimistic. A crucial point is that the relationship between technological and social change is fundamentally indeterminate. The designers and promoters of a technology cannot completely predict or control its final uses. There are always unintended consequences and unanticipated possibilities. For example, when, as a result of the organized movement of people with physical disabilities in the United States, buildings and pavements were redesigned to improve mobility, it was not envisaged that these reforms would help women manoeuvering prams around cities. It is important not to underestimate women's capacity to subvert the intended purposes of technology and turn it to their collective advantage.

A good illustration of how a technology can yield unintended consequences, and how women can disrupt the original purposes of a technology, is provided by the diffusion of the telephone. In a study of the American history of the telephone, Claude Fischer (1988) shows that there was a generation-long mismatch between how the consumers used the telephone and how the industry men thought it should be used. Although sociability (phoning relatives and friends) was and still is the main use of the residential telephone, the telephone industry resisted such uses until the 1920s, condemning this use of the technology for "trivial gossip." Until that time the telephone was sold as a practical business and household tool.

The people who developed, built, and marketed telephone systems were predominantly telegraph men. They therefore assumed that the telephone's function would be to replicate that of the parent technology, the telegraph. Telephone "visiting" was considered to be an abuse or trivialization of the **[p. 200 ↓]** service. The issue of sociability was also tied up with gender. It was women in particular who were attracted to the telephone to reduce their loneliness and isolation and to free their time from unnecessary travel. A 1930s survey found that, whereas men mainly wanted a telephone for business reasons, women ranked talking to kin and friends first (Fischer, 1988, p. 51).

A fuller feminist analysis of these processes is provided by Michele Martin's book (1991) on telephone development in Canada. She shows that women's access to the telephone came from their husband's phone connection between home and office and that they gained this access for functional purposes. Again, the author demonstrates that women consumers were quick to resist these limitations and to adapt and appropriate the telephone to their own needs.

Women's relationship to the telephone is still different than men's in that women use the telephone more because of their confinement at home with small children, because they have the responsibility for maintaining family and social relations, and possibly because of their fear of crime in the streets (Rakow, 1988, 1992). Although designed with working men in mind, the telephone has increased women's access to each other and the outside world. Thus, far from relating passively to male-designed technologies, this example shows that women can and do actively participate in defining the meaning and purpose of technologies.

Of course, the unintended consequences of a technology are by no means always positive for women. To take the same example, the diffusion of the telephone has facilitated the electronic intrusion of pornography and sexual harassment into the home. Not only are abusive and harassing telephone calls made largely by men to women, but new sexual services are being made available to men in this way. The point is that a technology can contain contradictory possibilities; its meaning will depend on the economic, cultural, and political context in which it is embedded.

Technology as Masculine Culture

The ways in which technology is constructed as masculine, and masculinity is defined in terms of technical competence, have been alluded to frequently in this chapter. This is a good point at which to explore in more depth the interplay between the culture of technology and masculinity.

Hidden from History

To start with, women's contributions to technological innovation have by and large been left out of the history books, which generally still represent the prototype inventor as male. So, as in the history of science, an initial task **[p. 201 ↓]** of feminists has been to uncover and recover the women technologists who have been hidden from history. Some of this historical scholarship examines patent records to rediscover women's forgotten inventions (Stanley, 1992). In the current period, there has been considerable interest in the involvement of women such as Ada Lady Lovelace and Grace Hopper in the development of computer programming (Stein, 1985).

However, reassessing women's role in this way is limited by our understanding of what technology is. We tend to think about technology in terms of industrial machinery and cars, for example, ignoring other technologies that affect most aspects of everyday life. The very definition of technology, in other words, too readily defines technology in terms of male activities. It is important to recognize that 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 women, 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. If it were not for the male orientation of most technological research, the significance of these inventions would be acknowledged.

Thus 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. By diminishing the significance of women's technologies, the cultural stereotype of technology as an activity appropriate for men is reproduced. We need to try and sever this link between what technology is and what men do. The enduring force of the identification between technology and manliness is not an inherent biological sex difference. It is instead the result of the historical and cultural construction of gender.

Masculinity and Machines

There are now a range of feminist analyses that focus on the symbolic dimension of technology and the way technology enters into our gender identity (Hacker, 1989; Kramarae, 1988; Turkle, 1984). Technology in this sense is more than a set of artifacts; it includes the physical and mental know-how to make use of those things. Appropriating these sorts of knowledge and practices is integral to the constitution of male gender identity. Men affirm their masculinity through technical competence and posit women, by contrast, as technologically ignorant and incompetent. That our present technical culture expresses and consolidates relations among men is an important **[p. 202 ↓]** factor in explaining the continuing exclusion of women. Indeed, as a result of these social practices, women may attach very different meanings and values to technology. To emphasize the ways in which the symbolic representation of technology is sharply gendered is not to deny that real differences do exist between women and men in relation to technology. Nor is it to imply that all men are technologically skilled or knowledgeable. Rather, it is the dominant cultural ideal of masculinity that has this intimate bond with technology.

In modern societies it is the education system, in conjunction with other social institutions, that plays a key role in the formation of gender identity. Schooling, in conjunction with youth cultures, the family, and mass media all transmit meanings and values that identify masculinity with machines and technical competence. There is now an extensive literature on sex stereotyping in general in schools, particularly on the processes by which girls and boys are channeled into different subjects in secondary and tertiary education, and the link between education and the extreme gender segregation of the labor market. This work has shown that discrimination against female students is compounded by exclusionary masculinist cultures within the scientific and technical classroom (Barton & Walker, 1983; Deem, 1980).

The durability of these cultures in the workplace has been the focus of another strand of feminist research. From school to workplaces, feminists have been frustrated by the limited success of equal opportunity policies and schemes to channel women into technical trades. This has prompted some writers to home in on men's workplace

cultures so as to understand how it is that women experience them as alien territory (Cockburn, 1983; Hacker, 1981).

Engineering culture, with its fascination with computers and the most automated techniques, is archetypically masculine. Of all the major professions, engineering contains the smallest proportion of females and projects a heavily masculine image hostile to women. It is a particularly intriguing example of masculine culture because it cuts across the boundaries between physical and intellectual work and yet maintains strong elements of mind-body dualism.

Central to the social construction of the engineer is the polarity between science and sensuality, the hard and the soft, things and people. This draws on the wider system of symbols and metaphors in Western culture that identify women with nature and men with culture. These sexual stereotypes contain various elements such as that women are more emotional, less analytical, and weaker than men. Sally Hacker (1981) found that engineers attach most value to scientific abstraction and technical competence and least to feminine properties of nurturance, sensuality, and the body. The posing of such **[p. 203 ↓]** categories as "hard/soft" and "reason/emotion" as opposites is used to legitimate female exclusion from the world of engineering.

Engineering epitomizes another form of the masculinity of technology as well—that involving physical toughness and mechanical skills. All the features that are associated with manual labor and machinery—dirt, noise, danger—are suffused with masculine qualities. Machine-related skills and physical strength are fundamental measures of masculine status and self-esteem according to this model. The workplace culture of engineering illustrates a crucial point: that the ideology of masculinity is remarkably flexible. Masculinity is expressed both in terms of muscular physical strength and aggression and in terms of analytical power. "At one moment, in order to fortify their identification with physical engineering, men dismiss the intellectual world as 'soft.' At the next moment, however, they need to appropriate sedentary, intellectual engineering work for masculinity too" (Cockburn, 1985, p. 190). No matter how masculinity is defined according to this diverse and fluid ideology, it always constructs women as ill-suited to technological pursuits.

Conclusion: Where are We Now?

This chapter has looked at the connections between gender, technology, and society from the perspective of the social studies of technology. I have argued that a gendered approach to technology cannot be reduced to a view that treats technology as a set of neutral artifacts manipulated by men to women's detriment. Rather, this approach insists that technology is always the product of social relations. Although there are other equally powerful forces shaping technology, such as militarism, capitalist profitability, and racism, I have concentrated on gender. This means looking at how the production and use of technology are shaped by male power and interests.

Such an account of technology and gender relations, however, is still at a general level. There are few cases where feminists have really got inside the "black box" of technology to do detailed empirical research, as some of the recent sociological literature has attempted (Bijker, Hughes, & Pinch, 1987). Over the last few years, a new sociology of technology has emerged that is studying the invention, development, stabilization, and diffusion of specific artifacts. This literature 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.

[p. 204 ↓] So far, however, this approach has paid little attention to the ways in which technological objects may be shaped by the operation of gender interests. Its blindness to gender issues is 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.

A concept of power is by no means absent from sociological theories of technology, but it does not readily accommodate what feminist theory has come to understand by "male power." The process of technological development, and preferences for different technologies, are shaped by a set of social arrangements that reflect men's power in the wider society. Recent feminist work is providing new insights into the way that specific social interests, including men's interests, structure the knowledge and practice of particular kinds of technology. It is also enriching theoretical developments within feminism more generally. Empirical and theoretical work is now under way to show that gender relations are an integral constituent of the institutions and projects from which technologies emerge. It is my belief that the social studies of technology can only be strengthened by a feminist critique. Without it, we are not getting the full story.