and also how our own assumptions and expectations bias our reading of the source. Such questions have only recently been applied to technological knowledge, and not yet systematically.

Masculinity and Technology

CARROLL PURSELL

Masculinity, that is, what makes a male manly, is something that we can all recognize despite the fact that we might disagree widely on what precisely that something is. It has been suggested that in most, if indeed not all, societies, the mere facts of anatomy are not sufficient to make a man feel, or to get a community to agree, on that person's masculinity. Being a "real man" is always something earned or acquired, something that is socially defined and individually displayed. As a category of gender, masculinity always implies an Other, in some cases the category Woman, in others, Boy.

Masculinity is both socially constructed and historically contingent, and therefore there can be no such thing as a male essence. It is not necessary, or even possible, to explain at once the presence and import of masculinity in all phases of the history of technology in all places and times, for it has meaning only in specific historical contexts. In fact, gender itself is a flexible and changing construct, ideas of masculinity are constantly being negotiated and none, at any one time, is perfectly hegemonic. David Leverenz, for example, has argued that "three basic masculine ideals were available in the mid-nineteenth century. The genteel patrician was the cultured gentleman of the old school. The artisan valued personal independence and pride in work. The aggressive self-made man was at the center of the new business culture. He was preoccupied with power and force, imposing his will upon the world out of fear of being crushed by it." Alongside these three there were undoubtedly others, and many of them overlapped to some degree. . . .

The way in which styles of masculinity relate to styles of technology is also not straightforward. The roles of patrician, artisan, and entrepreneur, to take these categories, each immediately suggest appropriate and widely divergent technologies. . . .

I have been set on this quest for masculinity by Judith McGaw, who has recently insisted that "we can make a start toward serious gender studies by consistently recognizing and acknowledging that the male actors who predominated historically in American engineering, business, and manufacturing were men and not merely people. In other words, we can no longer afford to write the history of technology as though it were normal to be male and aberrant to be female." In taking up that challenge, I feel particularly the weight of Evelyn Fox Keller's observation that "the association of masculinity with scientific thought has the status of a myth which either cannot or should not be examined seriously. It has simultaneously the air of being 'self-evident' and 'nonsensical'—the former by virtue of existing in the realm of common knowledge (that is, everybody knows it), and the latter by virtue of lying outside the realm of formal knowledge, indeed conflicting with our image of science as emotionally and sexually neutral."

The same is certainly true of technology as well. On the one hand, technology is so obviously masculine that it hardly seems worth making the point. On the other, even though an increasing number of scholars are choosing to identify with the notion that technology is socially constructed, masculinity, which is itself socially constructed, has hardly found a place as one of the forces to be studied as a part of this process. It has not gone unnoticed that like those other powerful social categories class and race, gender has not been much used as an analytical tool to help us understand technology. When gender has been raised as an issue, it is women, not men, who have been studied.

As we study the role of masculinity in the history of technology, it is important to remember that gender is a matter of boundaries, and boundaries always have two sides. From the perspective of masculinity, women (and sometimes boys also) are the Other (so is Nature), at the same time attractive and threatening. One way to control women (and to emphasize their otherness) is to technologize them, that is, to see them as less than human (and specifically, as machines). . . .

The role of gender in the history of technology has probably been studied most intensively in the area of work. Perhaps because the sexual division of labor is older even than that discovered by Adam Smith, the interplay between changing technologies and seemingly eternal patriarchy is an obvious subject for study. Maxine Berg has shown that even before the Industrial Revolution, the adoption of new machines was gendered in often complex ways even if the design of the machine was not. Cynthia Cockburn has noted that while independence was seen to flow from a skilled trade and was linked to manhood, it "was a negative quality in women, threatening economic competition and sexual emergence." Employers played upon this fear, seeking to replace independence among male workers with the feminine attribute of docility through such techniques as lightening the physical burden of labor and by then threatening to replace the men with either women or boys.

The psycho-sexual roots of masculinized technology are powerful and not to be ignored, but we should also keep in mind Mort Sahl's surprise when told that Edsels did not sell because their front ends suggested the female vulva rather than the male penis. He had always assumed, he said, that it was because the Edsel cost more than a Pontiac and wasn't as good a car. American historians are familiar with the way in which race has been used to mask class interest in our society, and no doubt gender has been used in the same way. Losing one's job to a woman may be emasculating, but it is also impoverishing. Yet one is struck by the many times in which male workers appear to sacrifice class power to patriarchal advantage, giving every indication that the latter is more important to them than the former. And to complete the circle, there is no reason to believe that the employer who, for example, uses patriarchy to separate (for his own interests) the male workers from the female, himself believes any less in the importance of patriarchy for all his cynicism. As Cockburn insists, the two hierarchies of class and gender "are clearly Interactive."

The case of Frederick Douglass suggests that even when a man was not an independent producer, the possession of a craft skill provided a sense of manhood. Douglass, while still a slave, had been taught [to] caulk boats and for a while, worked side by side with white craftsmen. When he gained his freedom and went North, he noted that in the shipyards of New Bedford "every man appeared to understand his work, and went at it with a sober, yet cheerful earnestness, which betokened the

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deep interest which he felt in what he was doing, as well as a sense of his own dignity as a man." Though he often felt the deep wound of racism from these same men, Douglass clearly counted a craft skill as an indispensable ingredient of his own escape from slavery. With a technological skill, he was not only his own man, he was a Man.

"Strive on—The control of nature is won, not given," reads the motto above the door of the engineering building at the University of Wyoming. Control is the most important word in engineering: self-control, control of others, control of nature. Technology gives us control, but it also takes (self) control. Women especially need controlling, but so does Nature which is seen as female. Self-control is to resist the feminine (natural) in ourselves, and is something women are thought not to have much of. It is, of course, no surprise that engineering is the most male-dominated of all professions, and that even in our own time, women have found it extremely difficult, for both institutional and cultural reasons, to break into the field.

In America the golden age of the engineer as a cultural type was from the mid-19th to the mid-20th century. Partaking at once of the patrician, the artisan and the entrepreneur, increasingly collegiately educated but seen to be in his natural element on the Frontier, the engineer was a manly ideal. . . .

. . . Annette Kolodny has alerted us to the fact that the western mind feminized those places and peoples over which it gained intellectual and emotional control. In the 1960s the Atomic Energy Commission was able to make a film entitled "No Greater Challenge" designed to promote the use of nuclear powered desalting plants to irrigate the arid coastal lands of the world. In this award-winning film, the desert lands are described as fertile, but barren, awaiting and perhaps even desiring to be made fruitful by the engineering application of tools and irrigation waters. Women appear only as white American consumers, women of color with large families or Hispanic fruit-packing workers. The white (with one exception) male engineers design and impose what the film calls an "agro-industrial complex" on a feminized nature, making her productive at last, bristling no longer with cactii and scorpions, but now with nuclear power plants, aluminum sheet rolling mills, harvesting machinery and port facilities. This is the great challenge facing man today, we are told, and the overcoming of challenges is the very stuff of man's history.

The glorification of the engineer has permeated American cultural forms in the 20th century. Camel cigarettes and Velvet pipe tobacco both ran full pages magazine ads in the 1920s showing engineers at work, smoking their product, very much like the Marlboro Man of a later generation. In the opening chapter of H. Irving Hancock's book for boys, *The Young Engineers in Nevada* (1913), one happily entitled "Alf and His 'Makings of Manhood,'" the description of Tom Reade's physique borders on the homoerotic. As the engineer sucked in his stomach and expanded his chest, "Alf watched. For that matter he seemed unable to remove his gaze from the splendid chest development that young Reade displayed so easily." He looked, we are told, "a good deal more like some Greek god of old than a twentieth century civil engineer." In the 1958 juvenile book *Civil Engineering Is Fun,* we are introduced to "lean, clear-eyed engineers whose very calm confidence suggests high adventure in exciting places." They are responsible for "huge bridges being flung across mighty chasms, and mighty mountains blasted and gouged until they yield a place for man to move with machines." The adventure comes "to engineers who fight the wilderness, the desert, the

unrelenting reluctance of an ancient, undisturbed nature to give way to man." Since masculinity is socially constructed rather than innate, it has to be constantly reproduced. The engineering ideal, held up to boys in countless volumes of juvenalia, was an important part of that reproduction. The evolution since the 1950s away from a view of idealized engineering masculinity is itself a significant cultural shift. . . .

. . . Masculinity is not merely another aspect of technology to be studied, it has the potential of changing the way we look at the entire field. I suspect that masculine attitudes and assumptions underlie much of the way we define our field and the way in which we formulate and choose topics. The History of Technology, as an academic field, represents our "formal knowledge" of technology, but there is also an informal knowledge—that knowledge which arises not from scholarly work but from our common cultural attitudes. Indeed, I wonder if this in itself is not gendered: that is, that men have been attracted to and have dominated the field because of the perceived masculinity of the subject (technology), and that in turn we have shaped it in masculine ways. What would we find if we took our informal knowledge seriously and studied those popular insights? In a society where rape is being talked about more openly, and seen more commonly as an expression of power and control and a crime of violence rather than sex, can we continue to ignore the obvious and universally acknowledged rape metaphor in much of the rhetoric of technology? And would it not be potentially important if we took seriously S. I. Hayakawa's crack in the 1950s that any car with a horsepower larger than that of the contemporary MG was used merely to suppress male fears of impotence? Surely charges, largely justified, that such connections are crudely made and lack theoretical rigor is no reason for not *subjecting* them to critical rigor.

. . . Why do we define production exclusively in terms of what men do, and at the same time ignore consumption, which we associate with women? Why do we shy away from all but the invention and design of machines and tools? If we ignore gender, we assume that technologies are designed to accomplish ungendered "human" ends, since purpose is always necessary. If we take account of gender, it suggests that much of our technology is designed not only by but for men. Can we find examples of this?

The history of technology, as a field, has always been interested in the artisan and master craftsman, working independently with his own tools and operating as an independent producer. Yet when that artisan, at some point in the industrializing process, became proletarianized, he became also labor history and of only marginal interest to historians of technology. I would suggest that we are accepting a masculine notion that the loss of skill and independence, and presumably of agency, is a feminizing process, and the now "womanly" worker is not as worthy of study as the inventor, engineer, entrepreneur or even manager. These are the actors, the feminized workers are merely acted upon. Because we deny agency to women, we do so also to workers, thus missing the many ways in which they might help shape the technologies presented to them. Ruth Schwartz Cowan has described a similar, female, agency among housewives. If one can think of technological systems (or cultures) as hegemonic, one can also expect to find counter-cultures, especially perhaps in liminal situations. Technological change always involves liminality and we are perhaps too Whiggish in ignoring the complexity of that process. Paul Forman has recently taken historians of science to task for trying to be "transcendent" rather than "independent"—for accepting the definition of their subject matter from scientists rather

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. . . The evidence is clear, I believe, that historians of technology would do well to add gender to the several analytical categories with which they now attempt to understand their subject. The feminist analysis of our field, as in the larger historical discourse, has added a rich, subtle and powerful set of meanings to our work. In a survey of historical writings on sex done over twenty years ago, John C. Burnham dryly noted that "it is a comment on male chauvinism in the profession that most of this work on sex . . . centers upon the history of women and women's status in America. It is neither fair nor accurate to continue to imply that like sex, gender is something that only women experience. Through time gender roles, for both men and women, have been as varied and numerous as technologies, and the way in which these two powerful forces have interacted is surely worthy of our attention.

The history of technology will be bountifully enriched by a willingness to admit that men sometimes act in their own self-interest as men, and that this often involves the creation, definition, and use of technology. Nor is the importance merely academic. Judy Wajcman, in her recent book *Feminism Confronts Technology,* has written that "gender is not just about difference but about power; this technical expertise is a source of men's actual or potential power over women. It is also an important part of women's experience of being less than, and dependent on, men." Both scholarship and justice, I think, will be served by a closer attention to the role played through time by the shifting and sometimes contradictory, but always significant, social constructions of masculinity.

The Proliferation of Hybrids

BRUNO LATOUR

On page four of my daily newspaper, I learn that the measurements taken above the Antarctic are not good this year: the hole in the ozone layer is growing ominously larger. Reading on, I turn from upper-atmosphere chemists to Chief Executive Officers of Atochem and Monsanto, companies that are modifying their assembly lines in order to replace the innocent chlorofluorocarbons, accused of crimes against the ecosphere. A few paragraphs later, I come across heads of state of major industrialized countries who are getting involved with chemistry, refrigerators, aerosols and inert gases. But at the end of the article, I discover that the meteorologists don't agree with the chemists; they're talking about cyclical fluctuations unrelated to human activity. So now the industrialists don't know what to do. The heads of state are also holding back. Should we wait? Is it already too late? Toward the bottom of the page, Third World countries and ecologists add their grain of salt and talk about international treaties, moratoriums, the rights of future generations, and the right to development.

The same article mixes together chemical reactions and political reactions. A single thread links the most esoteric sciences and the most sordid politics, the most distant sky and some factory in the Lyon suburbs, dangers on a global scale and the