The Power and the Pleasure? A Research Agenda for “Making Gender Stick” to Engineers

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This article seeks to open up a new avenue for feminist technology studies—gender-aware research on engineers and engineering practice—on the grounds that engineers are powerful symbols of the equation between masculinity and technology and occupy significant roles in shaping new technologies. Drawing on the disparate evidence available, the author explores four themes. The first asks why the equation between masculinity and technology is so durable when there are such huge mismatches between image and practice. The second examines this mismatch in the detail of engineering knowledge and practice to reveal that fractured and contradictory constructions of masculinity frequently coexist. The third theme addresses the suggestion that women and men might bring different styles to engineering. Finally, the author explores subjective experiences of engineering to argue that engineers’ shared pleasures in and identification with technology both define what it means to be an engineer and provide appealing symbols of power that act to compensate for a perceived lack of power or competence in other arenas.

In the past (roughly) two decades, a growing body of feminist work has explored the gender-technology relation. It is possible to chart the emergence of four streams of (still current) work in this area. The first—women in
technology—focuses on the question "why so few?" now firmly on the agendas of governments and industry. The literature on women in engineering is small compared with that on women in science and, for the most part, is not informed by technology studies. A recent U.S. study by Judith McIlwee and Gregg Robinson (1992; Robinson and McIlwee 1991) is notable for its detailed investigation of engineers working in industry, highlighting aspects of engineering cultures that act to retard women's career advancement compared with men's. The second stream of work—on women and technology—emerged during the late 1970s, prompted by the advent of word-processing technology and by growing unhappiness about women's encounters with medical technologies. This shift reflected a desire to broaden the agenda beyond the obvious equity issue, on the basis that the vast majority of women encounter technology as users rather than designers. Much feminist scholarship continues to be couched in terms of women and technology, with a tendency to portray women as victims of men's technology (Berg 1997, chap. 1). By contrast, feminists working within technology studies soon framed their concerns in terms of gender and technology—the third stream. This shift signaled two things: first, a recognition that one has to understand relations between men as well as between women and men to make sense of the position of women (e.g., Cockburn 1983); second, an insistence that technology be understood as socially shaped and thus potentially reshapeable. Accordingly, feminist technology studies emphasize the two-way mutual shaping relationship between gender and technology—with technology as both a source and consequence of gender relations.

Unlike feminist science studies, feminist technology studies is no longer on the margins of science and technology studies (Faulkner 1995, 1998). Indeed, some of the most interesting developments in technology studies are coming from or inspired by feminist scholars, in the spirit of Ruth Schwartz Cowan's (1987) memorable call for a research focus on the "consumption junction." I am thinking of that stream of research on the use and users of technologies in everyday life, highlighting (among other things) that flexible interpretation continues long after an artifact has left the factory gates (e.g., Sørensen and Berg 1991; Lie and Sørensen 1996; Silverstone and Hirsch 1992; Cockburn and Dilic 1994; Cockburn and Ormrod 1993). As Anne-Jorunn Berg (1997) ruefully observes, gender "sticks" most readily in the context of use because women are present. There is nonetheless important gender-aware work to be done—important for technology studies as well as feminism—on the men-only domains of technology, which suggests a fourth stream, a new avenue for feminist technology studies, on men/masculinity and technology.

Already, we have studies that address masculine gender identities in the context of men's use of technology.¹ My own project in this article is to
encourage people to get “inside the belly of the beast” of technological design, to examine how gender “sticks” to the engineers involved. Bluntly put, I believe engineers represent an important research focus for feminist technology studies because they are powerful instantiations and symbols of the equation between masculinity and technology. A better understanding of engineering practice and how engineers tick should contribute to a better understanding of how that equation works. It might also yield fresh insights into why there are so few women in engineering, though this is not my concern in this article. I focus primarily on design engineers at this stage because, in addition to their symbolic importance, design engineers also play significant roles in shaping new technologies—roles that are of great theoretical and political import for feminist technology studies. However, much of what follows is relevant to all engineers. Indeed, it would be very revealing to explore the gender-technology relation comparatively—in relation to professional and technician engineers; to those working in manufacturing, marketing, and maintenance as well as design; to the full range of specialisms and organizations involved; and in different countries.

Before elaborating on the research program I am proposing in this article, let me pause to outline the theoretical predilections that I bring (and that bring me) to the subject.

Underlying much feminist scholarship on technology is a debate, crudely put, about whether technology is male dominated because it demands some essentially masculine traits or simply because technology is where the power is. The more essentialist end of this debate encompasses a range of views. Brian Easlea (1981, 1983) argues that men gravitate to science and technology to compensate for a shared “womb envy;” ecofeminists emphasize men’s emotional detachment from the natural world (e.g., Cox 1992; Merchant 1992), and others draw on psychoanalytical theory to explain the tenacious link between masculinity, abstraction, and objectivity (Keller 1990; Turkle and Papert 1990). For many feminists, myself included, gender essentialism—the belief in universal forms or features of femininity and masculinity—runs the danger of conflating gender with sex (where sex refers to biological female-ness and maleness, and gender refers to socially constructed femininities and masculinities). The distinction is problematic in a number of respects. Perhaps most profoundly, gender, while not the same as sex, is connected to it in each individual woman and man; our biological bodies house gendered beings (MacInnes 1998). Nevertheless, the distinction between sex and gender remains vital for feminist politics insomuch as it highlights the potential for iniquitous relations between women and men to change and the diverse range of gender identities that exists empirically.
Accordingly, the alternative "power" position in the gender and technology debate appeals to an understanding of the social context within which particular gender constructions and particular technologies appear. Thus, Cynthia Cockburn (1985a, chap. 1) demonstrates how groups of men have positioned themselves in key technological roles historically: metalworking in feudal times and machine tooling in industrial times. And Judy Wajcman (1991, chap. 7) reminds us that modern technology is supported and directed by powerful institutions and interests. Because both modern technology and hegemonic masculinity (see below) are historically associated with industrial capitalism, they are linked culturally by themes of control and domination. Achieving control and domination over nature was a central plank in the Baconian project (Merchant 1980; Easlea 1981; Noble 1991), and the "mastery of nature" remains a powerful emblem of technology—both within engineering (e.g., Florman 1976, 121-26) and in wider culture (e.g., Caputi 1988). In this sense, technology is understood as a "masculine culture" (Wajcman 1991, chap. 7).

During the 1990s, writers in this tradition have been challenged by colleagues in technology studies for tending to essentialize both gender and technology, despite protests to the contrary (e.g., Grint and Gill 1995, chap. 1; Grint and Woolgar 1995).4 Certainly, there is a tension between, on one hand, the structuralist emphasis on the historical roots and durability of the cultural equation between masculinity and technology and, on the other hand, the antiessentialist refusal to see either technology or men as necessarily about control and domination. My own response is to accept and live with this tension: to adopt some of the principles of poststructuralism, particularly its emphasis on complexity and contingency, without losing sight of "power" altogether.5 In this spirit, I embrace the framework of the coproduction of gender and technology, favored by many feminist scholars of technology, where gender and technology are each seen as performed and processual in character, rather than given and unchanging, and where the mutual shaping of gender and technology is seen as happening simultaneously, in a context of multiple, decentered agencies with no singular line of causation.6 In this spirit, too, and like others (Berg 1997; Lerman, Mohun, and Oldenziel 1997), I embrace the crude but useful triad proposed by Sandra Harding (1986, chap. 1) and Joan Scott (1988) for analyzing gender relations—of gender structures (e.g., occupations, education), gender symbolism (e.g., cultural associations between masculinity and technology), and gender identity (how people see themselves as women and men). As I will elaborate at the end of this article, I believe this framework reminds us that there is more to the male dominance of technology than power and that we must explore much more closely the distinct-but-related links between structure, symbolism, and identity in the gender-technology relation.
The shift to "men/masculinity and technology" that I detect and wish to encourage within feminist technology studies builds on growing concerns in wider feminist theory with gender identity and with masculinity. I will highlight three concepts that have gained currency from these literatures. First is the insistence that because gender is socially constructed and cuts across other differences (not least class and race), there are numerous masculinities and femininities. Second, and related, is the distinction between individually practiced gender identity and collectively held gender stereotypes or norms. Bob Connell's (1987) notion of hegemonic masculinity is helpful here. Hegemonic masculinity is counterpoised to "subjugated femininity"; it is the standard against which other men are measured and which is wielded to exclude women from public life. It connotes the particular version of manhood associated with men who are in power: in Western culture, it is associated with white, heterosexual men who are successful in terms of the capitalist marketplace (Kimmel 1994). Of course, most men do not meet the standard, but in general the performance of masculinity combines outward "homosocial enactment" (i.e., displays to other men) with inward repression of "the feminine" (Kimmel 1994). This brings us to a central paradox in men's studies—the third useful concept—namely, that while men as a group hold and exercise power, most do not feel powerful individually (Kaufman 1994; Brod and Kaufman 1994).

Surprisingly, the growing field of masculinity studies has so far failed to look at engineering, even though science and technology are widely acknowledged as powerful motifs of hegemonic masculinity and even though the gendering of industrial organizations, in which most engineers work, has been scrutinized (e.g., Roper 1994). Conversely, science and technology studies on engineering, for all the depth of some recent work (e.g., Vincenti 1990; Bucciarelli 1994), have been largely gender blind—even though engineers' ambivalent relationship with power has been a recurring theme in this literature (see Downey and Lucena 1995 for a review) and even though the male dominance of design activities is recognized as in principle relevant to the social shaping of technology (MacKenzie and Wajcman 1985, chap. 1). And for the reasons outlined above, few feminists have looked "inside the black box" of technological knowledge and practice. The notable exceptions are some studies of women engineers (Cockburn 1985a, chaps. 5-6, 1985b; Sørensen and Berg 1987; Carter and Kirkup 1990; Kvande and Rasmussen 1990; Sørensen 1992); a recent ethnography of engineering design in Sweden by Ulf Mellström (1995), which highlights masculinity to some degree; and the pioneering work of the late Sally Hacker (1989, 1990), who became interested in engineers through labor process studies and conducted participant observation in three different U.S. engineering
educational establishments. In addition, we now have a handful of rather disparate studies that together I believe are suggestive of the complex gendering that takes place in engineering practice.

What follows is a threading together of this diverse material to suggest a set of questions for future research and a broad framework for their analysis. The spirit of this article is to invite others to share in developing research on a topic that in my view is wide open for exploration—gender of and in engineering. This article is structured around four interrelated themes. The first briefly explores some of the equations between masculinity and technology that arguably contribute to the continued exclusion of women from engineering. It asks why this equation is so durable when there are frequent and visible mismatches between masculine images of technology and actual practice. The second theme examines more closely the mismatch between image and practice with findings that point to contradictory constructions of masculinity in the detail of engineering knowledge and practice. I tentatively draw on the sociology of engineering to make sense of such findings. I also highlight the tendency for engineering to be conceived in dichotomous terms and wonder how this relates to gender dualisms, if at all. The third theme explores the contested suggestion, from both "diversity" politics and standpoint epistemologies, that a stronger presence of women in engineering design could change the shape of artifacts. This debate takes us to the heart of wider debates about gender essentialism. While the evidence is limited, it seems likely that there could be considerable epistemological pluralism in engineering practice but that this potential is severely constrained by normative pressures to conform—pressures that may be gendered. Finally, the fourth theme picks up the challenge in the title of this article—to explore subjective experiences of engineers, particularly their pleasures in technology and their ambivalent relationships with power. Returning to the theoretical framework outlined in this introduction, I conclude that the interactions between gender identity, symbolism, and structures may be quite seamless and that all sides of this triad must be addressed if we are to make sense of the gender-technology relation in the lives and practice of engineers.

Masculinity and Technology: Mismatches between Image and Practice

It is notable that whereas women are pushing open the doors of other powerful institutions (including science) and despite nearly two decades of government- and industry-backed "women into engineering" campaigns, the numbers entering engineering are still derisory in most countries. Whether or
not they are subject to discrimination and/or discouragement, most girls and women are voting with their feet: it does not even occur to them to get into design roles in technology; they just are not interested. This crucial point is frequently missed by initiatives to get more women into engineering, which typically start from the assumption that women (their socialization, etc.) have to be modified to fit into engineering, not the other way around (Henwood 1996). The virtual failure of these initiatives suggests that the symbolic association of masculinity and technology must be operating strongly.

Within this association, one can discern a series of highly gendered dichotomies, of which three stand out for me. First and foremost is the assumed-to-be mutually exclusive distinction between being people focused and machine focused—one version of the sociological distinction between feminine expressiveness and masculine instrumentalism. Sherry Turkle (1988) shows that women starting out in computing are often reticent about computing because they see hobbyist hackers as the only model for intimacy with computers, and so many hackers appear to eschew or be incapable of human intimacy. Similarly, Tove Håpnes and Bente Rasmussen (1991) demonstrate that a central reason for the declining intake of young women into computer science in Norway is girls’ rejection of the “nerd” image of computer hackers. It seems that for a women to opt to work so closely with technology is potentially to reject any meaningful engagement in the social world and so face “gender inauthenticity” (Keller 1985; Cockburn 1985b).

Of course, most women routinely interact with people and technologies; some even develop strong emotional attachments to particular artifacts.7 As feminist scholars of technology have long argued, however, women’s everyday encounters with technological artifacts are rarely recognized as such (Berg and Lie 1995). Our most common cultural images of technology—industrial plants, space rockets, weapon systems, and so on—are large technological systems associated with powerful institutions. Here we meet a second interesting dualism—in this case, implicitly rather than explicitly gendered. “Hard” technology is inert and powerful like the examples above; this is real technology. “Soft” technology is likely to be smaller scale, like kitchen appliances, or more organic, like drugs; most people do not readily identify such products as “technology.” So the world of technology is made to feel remote and overwhelmingly powerful because the hard-soft dualism factors out those other technologies that we all meet on a daily basis and can in some sense “relate to.”8

Third, the hard-soft dualism also finds expression in relation to styles of thought (Edwards 1996, 167-72) since the association of engineering with science brings with it longstanding gender dualisms. On the masculine side of those dualisms, we have an objectivist rationality associated with
emotional detachment and with abstract theoretical (especially mathematical) and reductionist approaches to problem solving. On the feminine side, we have a more subjective rationality associated with emotional connectedness and with concrete, empirical, and holistic approaches to problem solving. As we will see under the next two themes, abstract styles of thinking and working are often associated more with men and concrete ones with women. Yet both sides of the concrete-abstract dualism are required within engineering. I return to these familiar dualisms for the same reason Evelyn Fox Keller (1990) does in relation to science: they are widely held as truths by technical and nontechnical people, women and men alike. The fact that popular images of both science and technology are strongly associated with the masculine side of these dualisms must be one of the reasons why, in a deeply gender divided world, most girls and women do not even consider a career in engineering.

Evidence from studies of technology education in schools tends to confirm the operation of all three sets of dualisms addressed here (namely, people vs. technology focused, soft vs. hard technology, and concrete vs. abstract approaches). Early differences in interests and role-playing developed outside school shape how girls and boys respond to, and are interpreted as responding to, technology inside. For example, girls are more likely than boys to feel confident about, and to succeed in, working with tables of data concerning health, reproduction, or domestic situations but anticipate failure—“I don’t know anything about that”—when faced with tables of data on machinery, building sites, or cars (Murphy 1990). The reverse holds for most boys: the task is the same, but the content is gendered. Girls are usually less confident than boys in handling “real technology”—and this extends to the use of all sorts of equipment in school, which boys tend to monopolize. The greater people-centeredness of most girls also is reflected in how they approach technical tasks. Recent surveys undertaken in U.K. schools reveal that teenage girls in design and technology classes are more likely than boys to “identify the issues that underlie tasks in empathizing with users and evaluating products and systems in terms of how well they might perform for the user,” whereas boys are more likely to approach technical tasks in isolation and judge the context to be irrelevant (Kimbell, Stables, and Green 1996, 94; also Murphy 1990). This is an astounding result: it seems that girls demonstrate greater potential in precisely those holistic and heterogeneous approaches so necessary to success in technological design, as well as a thirst for what educationalists call “deep understanding,” yet their different “learning styles” are read by teachers as indicating a lack of confidence or ability.

Of course, many of the ways of thinking and doing that we stereotypically deem feminine are useful if not essential in technical work: linguistic abilities
in computer programming, for instance. And plenty of women now do jobs that are extremely technical, just as plenty of men are technically incompetent. In short, there are huge mismatches between the image and practice of technology with respect to gender. This crucial point is often missed. Yet I believe it obliges us to look more closely at why the gendered dualisms so palpable in cultural images of technology are so effective in keeping it a male domain. Specifically, we need to examine the relationship between the continued male dominance of engineering and masculine images of technology and how these images are sustained. For example, how much do engineers contribute to promoting these images, and how are they influenced by them? What influence do these images have on young people more generally? How much do “we” nontechnical people “need” to believe in the objectivity of our experts and thus contribute to sustaining these images? What other interests do they serve?

**Contradictory Gendering in Engineering Knowledge and Practice**

The mismatch between image and practice highlighted above invites us to bring a gender gaze to the “black box” of engineering knowledge and practice. Though there is a crying need for detailed empirical work, we do have a small number of studies that together appear to suggest that the gendering taking place at this level is both more complex than conventionally assumed and highly contradictory.

A useful way to view this complexity is to focus on some of the dichotomous ways in which engineering work is often categorized. The most obvious and perhaps pivotal of these is the distinction between the manual labor of the craft or technician engineer, who works directly on the artifact in a greasy workshop, and the mental labor of the professional (graduate) engineer, who frequently works remotely from the artifact (via a computer) in an almost clinically clean office. As Wajcman (1991, chap. 6) argues, these two versions of masculinity are essentially class based and embody the often gendered dualism of mind-body. But the distinction is also reproduced within professional engineering practice since it nevertheless involves hands-on “tinkering” work as well as mathematical analysis. So, the dichotomy from science, which labels concrete, empirical approaches as feminine, is clearly at odds with the importance of hands-on work in technician and professional engineering. Men are deemed to be more “natural” technologists because they possess both the appropriate rationality and good mechanical skills.
Paradoxically, while men’s relationships with artifacts can be cast as instrumental in the sense of being task rather than people centered, it is also expressive. Like others, McIlwee and Robinson (1992) found that most men engineers display a deep fascination with tools, machinery, and gadgets. They conclude that

the culture of engineering involves a preoccupation with tinkering that goes beyond the requirements of the job. Vocation becomes avocation, and, in turn, devotion. It is not enough to be competent in the hands-on aspects of engineering: one should be obsessed with them. It is not enough to know the difference between a piston and a rod: one should take obvious joy in this knowledge. The engineers must be ready not only to engage in technical exchanges during work periods, but interested in participating in them during breaks as well. To be seen as a competent engineer means throwing one’s self into these rituals of tinkering. (McIlwee and Robinson 1992, 139)

The women engineers studied did not share this obsession; they had other topics of conversations and sources of joy. Hobbyist hackers, like tinkering engineers, have a very expressive relationship with their artifacts (which, as we saw earlier, often alienates aspiring women computer specialists). To a lesser extent, so do “ordinary” male users of home computers, where their wives are quite instrumental—they use them as a tool (Aune 1996). I believe the pleasures that men engineers take in technology are a very important element of “what makes them tick,” and I will return to this point in the last of my four themes.

Juxtapositions of apparently dualistic concrete and abstract approaches are also found in computing. Software developers often draw a distinction between top-down planning approaches to programming and more “bottom-up” approaches involving trial and error. The term hacking is often used to describe the latter approach, yet hobbyist hackers are generally boys and young men. So once again we see one version of masculinity associated with concrete approaches coexisting with another version of masculinity based on more abstract approaches. Håpnes and Rasmussen (1991) found that while computer science teachers favor the “dedicated” computer science students who adopt the more formal approaches they teach, they nonetheless respect the hackers. Moreover, Håpnes (1996) provides some rich evidence to show that many familiar and often gendered dichotomies are ambiguously but intimately and necessarily combined in the course of programming work. So hobbyists consciously use judicious mixtures of concrete and abstract approaches because while logical planning and command approaches are effective for many tasks, interaction with the system—“muddling through,”
as one called it—is often essential, for example, in identifying bugs or in finding one’s way around unfamiliar software.

Within engineering education (at least until recently in the United States), higher status and credit attach to the more mathematical and abstract analytical work and less to hands-on concrete work—even though it is widely recognized in the profession that those who become the best engineers are often not those who perform the best academically (Hacker 1989, chap. 3). Sally Hacker’s (1989) account of life as an engineering student is reminiscent of the “hazing experience” that new recruits to the military forces are put through. Engineering education is characterized by seemingly endless and repetitive drills of mathematical problem solving (Hacker 1989, chap. 3). As well as cementing a mathematical approach to engineering (see below), Hacker saw this induction as channeling the passions and erotic energies of would-be engineers, creating a profound mind-body split that she argued is alien to many women. To explore this theme further, she interviewed humanities and engineering faculty members at an elite institute about their early life (Hacker 1990, chap. 4). She found that while both groups were strongly cerebral as opposed to corporeal in their interests at high school—most had not excelled at sport and were shy of romantic and sexual relationships—in adult life, the engineers continued to experience far more anxiety about their bodies and about emotionally demanding personal relationships than did the humanities academics. Hacker’s academic elite are probably an extreme case in terms of the mind-body split, given the evidence cited above for the prominence of concrete approaches and of displays of technical competence in engineering work in industry. Moreover, the evidence that sport is a primary outside interest for many engineers (Mellström 1995; McIlwee and Robinson 1992) does not tally with the picture of engineers “having a problem with their bodies.” But since anecdotally it seems that substantial numbers of engineers do not include sport or fitness in their lives, this may be an interesting area of divergence among engineers.

While the mind-body dichotomy should not be overstated, that between rationality and emotionality is very evident. It is common to find at least some engineers who seek refuge from human relationships in mathematics or technology (e.g., Mellström 1995; Håpnes 1996). More subtle signs of a “problem with emotions” can be found in relation to the use of mathematics in engineering design. Typical of much engineering discourse, literary engineer Samuel Florman (1976, 142) talks of the “pristine realm of pure mathematics” and “the pure beauty of mathematics” and sees human complexity as the other messy but necessary side of this coin in engineering. In a very interesting passage, Louis Bucciarelli (1994, 108) deconstructs a typical university
engineering problem to demonstrate just how much of this complexity has to be pared away: "The student must learn to perceive the world of mechanisms and machinery as embodying mathematical and physical principle alone, must in effect learn to not see what is there but irrelevant . . . Reductionism is the lesson." Two things stand out here. First, the emotional detachment of the dry, formal processes of analytical problem solving learned at university stands in stark contrast to the emotionally laden dramas that ethnologists (Bucciarelli 1994; Mellström 1995) and journalists (Kidder 1981; Lovell and Kluger 1994) have observed unfolding in the course of engineering design and problem-solving work in industry. Second, exercises of reductionism exclude much "social" information that is vital to successful design.

Sociologists of technology have long argued that engineers must take a holistic view and integrate heterogeneous technical and nontechnical elements if artifacts are to "work" and meet a "real" need (Sørensen and Levold 1992; Law 1987; Vincenti 1990; Faulkner 1994). This provides an interesting contrast to science, where reductionist approaches and specialisms are generally esteemed far more highly than holistic ones and where holism tends to be gendered feminine. As Knut Sørensen (1997) reminds us, however, the rather heroic model of the heterogeneous engineer—the "captains of industry," such as Thomas Hughes’s (1983) portrayal of Thomas Edison—is increasingly at odds with the reality facing most engineers today since engineers are increasingly defined by their technical specialism and only participate in a holistic project to the extent that they are organized into multiskilled collective endeavors. The fragmented labor process in engineering (e.g., Constant 1984) therefore houses a dichotomy between narrowly defined specialist tasks, where reductionism is acceptable, and heterogeneous tasks, where holism is necessary and "the social" cannot be deemed irrelevant. Fieldwork observations in Scotland reveal interesting differences in how the heterogeneous role of user interaction in information systems gets gendered. In universities, where the users are individuals and the role is seen in terms of supporting, we see a higher proportion of women in these roles than in the technical jobs; in companies, where the users are other businesses and the role has marketing connotations, we see it occupied by men, leaving comparatively more women in the "backroom" technical jobs. By contrast, McIlwee and Robinson (1992) found that in U.S. companies, design roles remain higher status among engineers, and women are generally making greater incursions into engineering marketing and management.

I have shown that many dualistic epistemologies found in engineering practice are gendered in contradictory ways and that many fractured masculinities within engineering are sustained simultaneously—among engineers as a group and, to varying degrees, by individuals: they coexist in tension.
Like Håpnes (1996), I am struck by the clear evidence that both sides of these dichotomies—concrete and abstract, specialist and holist, technical and social (one could go on)—are necessary to engineering work. Bucciarelli (1994, 48) comments that “when we look at the contemporary world and see technology, we often oversimplify and split the world in two.” Engineering knowledge and practice are conceptualized in dichotomous terms even when there is no necessary hierarchy or obvious gendering implied—for example, formal versus experiential knowledge (Vincenti 1990), visual versus analytical knowledge (Ferguson 1992). Mellström (1995, 76) also notes the primacy of what he calls “binary thinking”: “Technical problems are given the character of either-or, plus-minus, negative-positive, and in its most basic technical form: zero or one.” He sees this binary thinking as grounded in “a complete faith in cause and effect,” epitomized for him by the outburst of a frustrated designer one day: “Either things work or they don’t!”

There is nothing inherently gendered about the distinctions addressed here, nor (I suspect) are they intrinsic to engineering. For this reason, it might be worth exploring further why dichotomous or dualistic thinking appears so endemic to engineering (and engineers) and whether this relates at all to gender. Gender is generally conceived of in dichotomous terms—because of the obvious link with sex (as in femaleness and maleness) but also because heterosexuality is usually posited ideologically on an attraction of gendered opposites. I agree with Henwood (1994) that heterosexism is an underresearched theme in the gendering of technology and believe that it may provide at least partial answers. But I would also stress that dualistic ideologies are still ideologies; real women and men do not fit dichotomous assumptions any more readily than do real engineers.

**Sex and Gender in Engineering: The Question of “Styles”**

This third theme explores another potential but contested aspect of gender in engineering—namely, whether there are gender differences in how engineering is done or whether women and men (might) bring different styles, perspectives, and priorities to engineering. Let me establish some “facts” from the outset: there are no innate differences in technical ability between women and men, girls and boys; there are no universal differences in how females and males engage with technical tasks. But there is suggestive evidence of some differences in some settings—for instance, the evidence that girls tend to bring a more heterogeneous approach to design tasks in school.
In their study on the acquisition of programming skills by school and college students, Sherry Turkle and Seymour Papert (1990) found that girls and women tend to adopt an interactive or relational, “bricoleur” approach, while boys and men tend to adopt a formal, linear, and hierarchical planning approach.¹⁶ Both approaches “work,” yet the bricoleurs found themselves actively discouraged by their teachers, forced to pursue this approach surreptitiously or unlearn it or give up on computing. Turkle and Papert see a clear link between the two styles and wider patterns of gendering, invoking object-relations psychoanalytical theory to argue that boys will tend to favor abstract approaches, while girls will tend to favor concrete, relational approaches. Personally I am not convinced that appeal to psychology is necessary since early socialization is extremely influential. And I am not convinced that the gender split found by Turkle and Papert obtains among working programmers; many women programmers favor abstract approaches because they lack teenage experience at hacking. However, I am struck by their conclusion that “the computer supports epistemological pluralism, but the computer culture does not” (Turkle and Papert 1990, 132). The point is, then, that in both the design and programming classes, dominant gendered assumptions—about males having an aptitude and about the value of nominally “masculine” styles—are sustained even in the face of counterevidence.

This phenomenon indicates aspects of the exclusion of would-be female technologists rarely grasped by equal opportunity campaigns. It also begs some intriguing questions about the consequences of the gendering and male dominance of engineering on the design of technological artifacts. Might the greater participation of women in engineering in any way change technological design and thus the shape of new technologies in the future? Or, more broadly, could engineering support different epistemological styles of work? These questions are being raised (albeit in different languages) in both liberal discourses within equal opportunities campaigns and radical discourses within technology studies and feminism.

The liberal discourse is essentially a democratic case for inclusion: should such a powerful occupation as engineering be predominantly shaped by a singular set of values and styles? Certainly this is the thrust of much recent equal opportunities campaigning throughout the industrialized world, where the current fashion is to stress the possible benefits to male-dominated areas (quite apart from equity) of the diversity that it is argued would accompany the higher representation of both women and ethnic minorities: diversity in inputs to innovation or marketing, for instance.¹⁷ The “diversity” position builds implicitly on an assumption that women by being women bring different approaches and priorities—an assumption that many see as dangerously
essentialist. At the very least, it fails to challenge stereotypical constructions of femininity and masculinity or to acknowledge that these constructions are not just different but unequal (in the sense that femininity is associated with subordinate and masculinity with controlling roles in society). For example, a common strategy used to encourage more women into computing and engineering is to emphasize the social elements of technical work—such as the growing importance of organization or communication in information technology—on the assumption that women will both be more attracted to and have more to offer to engineering if it is defined in nontechnical terms. As Håpnes and Rasmussen argue, this strategy leaves intact the equation of technology and masculinity—and, I might add, the dichotomy between feminine expressiveness and masculine instrumentalism on which this equation partially rests.

The radical discourse within technology studies is an extension of social constructivism, which carries the possibility that technological artifacts, once deconstructed, can be reconstructed (e.g., Bijker and Law 1992) or, to use the language of social shaping, that there are “roads not taken” that could in principle be followed (MacKenzie and Wajcman 1985). In addition, the notion of “styles” is familiar in the sociology of scientific knowledge. Yet, very few studies have given detailed consideration to how the male dominance of engineering affects the actual shape of technological artifacts, and none has really “got inside” the design process to explore the possibility of there being differently gendered “styles” or outcomes.

The radical discourse within feminism is reflected in the insistence of many activists that men’s interests, priorities, perceptions, and experiences are bound to be reflected in the design of artifacts. For some, it has long been an article of faith that the better representation of women in technology would, by itself, begin to transform both the products of technology and its modus operandi (e.g., Arnold and Faulkner 1985). Yet feminist standpoint epistemology has not been formally applied to technology—theoretically or empirically. Few would argue with the notion that women designers should be more likely to “see” the needs of particular female users (e.g., for wider gangways on buses, to allow for women with young children, or airbags that are not lethal to short women). More contested is Hilary Rose’s (1983, 1994, chap. 2) argument that women are more likely to bring a “caring rationality” to technical work because their position in the sexual division of labor means that they generally do (or are more socialized to do) more caring work than men. This argument is appealing insomuch as it would be “a good thing” if there were a greater “professional ethic of care” in engineering (Andersen and Sørensen 1994).
As yet, however, the evidence is limited and inconclusive. In particular, no one has yet explored this question using the kind of close ethnographic work that might reveal any methodological differences. Martha Trescott's (e.g., 1984) historical studies suggest that early women pioneers in the profession tended to bring a more holistic approach to problem solving in engineering, and I have heard anecdotally that in some U.S. firms, women engineers often prefer jobs characterized by breadth rather than narrowly specialist depth. Norwegian studies of engineers (Sørensen and Berg 1987; Sørensen 1992) and of computer science students (Håpnes and Rasmussen 1991) suggest that women are more likely to choose specialisms that are more “applied” or more closely related to everyday life. The U.S. engineers surveyed by McIlwee and Robinson (1992, 140) all identified interpersonal skills as an area where women do better than men engineers, and in a U.K. ethnography of software developers, Ruth Woodfield (forthcoming) found that women were perceived as facilitating teamwork and team spirit. Similarly, Anne Kerr (1995) found that the main practical changes that feminist scientists are able to bring to the way they do science is that they run their laboratories more cooperatively than is normal. While such evidence seems to indicate greater expressiveness and/or sociotechnical heterogeneity in women, we cannot assume this to hold in all cases. The women engineers in Tarja Cronberg’s (1995) fascinating study of the Russian defense industry, like the men, take great pride in their work and “sanitize” it by talking about “components” rather than tanks and bombs.

The question of gendered styles tends to divide women engineers as it does women scientists (Barinaga 1993). The politics of diversity have made it more acceptable for women engineers to talk about the particular contributions they can make, but the pressure to become accepted as “one of the guys” (Cockburn 1985b, chap. 6; Hacker 1989, chap. 3; Carter and Kirkup 1990) means that many vehemently deny any differences. Keller (1992) has argued that we need to “learn to count past two”—past the two popular choices that either see women as the same as men, and so deny gender, or see women as different from men, and so treat gender as fixed. In seeking, tentatively, to count past two, I am inclined to adopt the language of “styles”—but without embracing essentialism. I do so with the expectation that epistemological pluralism is in principle possible but that normative pressures of various types will generally result in the suppression of all but a few styles.

My belief in the potential for epistemological pluralism builds on Bucciarelli’s (1994, chap. 3) finding that there is considerable individual variation in how engineers interpret problems—because of the unique blends of individual background, education, specialization, work experiences, and character. I would also suggest that different social frameworks—in engineering
education and workplaces as well as in wider political ideologies—could produce radically different perceptions of priorities and different approaches to pursuing them. They might even alter significantly the “framework for common discourse” (including the dichotomies addressed earlier) that engineers share (Bucciarelli 1994, chap. 4): we just don’t know! This said, it is clear that the normative pressures are real enough. In the case of programming styles discussed earlier, most practicing programmers maintain that bricolage approaches “just don’t work” in the development of large-scale and complex information systems because of the demands for hierarchical control over the production and testing of software in the main military and industrial organizations involved. It may well be that both women and men with nonconventional styles are effectively weeded out or face strong pressures to conform. Engineering education clearly plays a major role in this. In addition, Sørensen (1992) has evidence that both women and men engineers become socialized into their employers’ values and priorities once they have been working in industry for a few years (see also Gardner 1976).

We do not know to what extent this occurs or what kinds of normative pressure are exerted in education and industry. But it seems to me that both the potential for pluralism in technological design and the actual suppression of some styles and voices are extremely interesting politically. It would be very useful to explore further which “styles” get suppressed and whether this is gendered at all. Such work might serve to open a door between liberal and radical discourses, as well as shedding further light on the complex gendering of engineering practice. At this stage, some general conclusions can be anticipated. First, professional socialization and pressures to conform are likely to be most visible in the course of education and first career jobs; those established in their fields are unlikely to see such pressures since they are now part of the normative culture. Women may be especially subject to professional socialization and so less likely to demonstrate alternative styles. In any case, it seems unlikely that the styles of actual women and men will be that distinct—precisely because (as I showed in the previous section) the very technical practice of engineering is subject to contradictory and fractured gendering and because gender identities themselves are typically fractured and contradictory. Finally, even if some gender differences in style are found, these may not necessarily work to women’s advantage. Gender inequality can still be reasserted even where rhetoric suggests otherwise. This is dramatically illustrated in Woodfield’s (forthcoming) study of a progressive computing firm where the widespread assumption that women have stronger interpersonal skills than men and where these skills were valued organizationally did not translate into easier career advancement for women in management.
Subjectivities in Engineering: The Power and the Pleasure

It will be apparent following my introductory comments that for me the durability of the equation between masculinity and technology remains problematic and insufficiently explored—hence my concern with the mismatch between masculine images of technology and technical practice and with the complex and contradictory gendering that takes place within engineering. Like Fergus Murray (1993), I believe we need to take a closer look at engineers’ subjective experiences—my fourth theme—to explore the equation further. In particular, I propose that three subjectivities warrant further attention: the pleasure engineers so palpably take in technology, their ambivalent relationships with power, and the identity work they do. I will argue that engineers’ pleasure in technology and their close identification with technology are crucial elements in the individual identity and shared culture of engineers. They provide some solace and reward to engineers whose everyday work and lives often offer only limited excitement or power. And they cement a fraternity that effectively excludes women engineers from important informal networks.

First some brief observations about changing images of engineers and the implications of this for identity work: in 1976, civil engineer Samuel Florman (1976) wrote a popular book titled The Existential Pleasures of Engineering, most important of which, he suggested, is the overriding gratification in “having participated in a great undertaking” (p. 149) and in helping to improve the human lot by the design of new technologies, which he sees as the “central mission of the professional engineer” (p. 143). The book may be read as a voice from an older generation of engineers, lamenting the demise of a “Golden Age of Engineering” (from 1850 to 1950), when engineers were unequivocally allied with progress, and the rise of the now-tarnished and equivocal image of technology (and hence engineers) following the antitechnology movements of the 1960s and 1970s. It is not clear how many engineers today would share Florman’s sense of mission. The younger generation of Swedish engineers studied by Mellström (1995, chap. 7) are motivated more by prospects of a good career, although in the United Kingdom there is also a perception of engineers contributing to national economic prosperity through technological innovation. The point is that engineers are no longer revered as the “priesthood of Progress” (Florman 1976, 45), nor, as Sørensen (1997) reminds us, are they likely to become “captains of industry.” In this context, the most readily available cultural image of today’s engineer is that of the nerd. While respected (if not revered) for their technical competence, nerds are derided for their lack of competence in other areas; it is not a terribly
appealing or positive image to outsiders. Certainly, some engineers reject the "humiliating stereotype" of having a "binary mindset" (Mellström 1995, 77) or being inadequate in human relationships (Håpnes 1996). This begs questions about why (some) men are still attracted to engineering and what they get out of it—which brings us to the pleasures of engineering.

The "glint in the eyes" of obsessive tinkerers and hobbyists is evident to all who have cared to look. This theme became a central focus of Sally Hacker’s (1990) later work. She both witnessed and experienced the sensual, even erotic, pleasures to be had in making things work. Similarly, in *The Existential Pleasures of Engineering*, Florman (1976) extols at length the sensual absorption, spiritual connection, emotional comfort, and aesthetic pleasures to be found in engineers’ intimacy with technical artifacts. In all of the studies reported here, engineers manifest sensual and emotional pleasures (if not spiritual or aesthetic ones) in working with technology. And in virtually all cases, such pleasures are first experienced in early childhood, and they strengthen during adolescence—in the classic case of taking cars apart, technology provides a rare focus for bonding between fathers and sons—with the result that engineering is a "self-evident" career choice for most male engineers (Mellström 1995, chap. 7).

Underlying engineers’ central mission, Florman (1976) argues, is a more basic pleasure that, in effusively gendered language, he sees as grounded in an instinctive desire to change if not conquer the natural world; "born of human need, [this desire] has taken on a life of its own. Man the creator is by his very nature not satisfied to accept the world as it is" (Florman 1976, 120). Conscious that nature is "not to be tampered with unthinkingly," Florman suggests that the awesome and intimidating scale of nature nevertheless inspires in the civil engineer a "yearning for immensity," an existential impulse for the "vanity of pyramids or dams"—constructions that "inevitably invoke thoughts of the divine" (pp. 122, 126, 124). In another delightful passage, he describes engineers’ pride in the machine:

The machine still stands as one of mankind’s most notable achievements. Man is weak, and yet the machine is incredibly strong and productive. The primordial joy of the successful hunt of the abundant harvest has its modern counterpart in the exhilaration of the man who has invented or produced a successful machine. (P. 130)

Hacker (1989, chap. 3; 1990, chap. 9) also perceived that part of the pleasure of engineering is a pleasure in domination and control—over workers as well as the natural world—but sees this pleasure as echoing prominent themes in present-day eroticism rather than male instincts. The connection
with eroticism is frequently hinted at by feminists, not least because it is overwhelming in the language of potency and birth that surrounds military technology (Easlea 1983). In her very thoughtful and illuminating ethnography of defense intellectuals, Carol Cohn ([1987] 1996) suggests that this language does not necessarily reflect individual motivations; rather, it may function to tame or make tenable "thinking the unthinkable"—of nuclear annihilation. In a similar vein perhaps, Hacker suggested that the fun engineers have with technology is a compensation for contributing to larger systems of dominance and control—an especially important "reward" when so many engineers occupy fragmented roles in the labor process and other sources of job satisfaction may be limited (Hacker 1989, chap. 3).

Hacker's (1989, 1990) crucial contribution was to show us how the power and the pleasure of engineering are linked—hence the title of this article. I see a resonance with Florman's (1976) rhetoric about dams and machines: the power of the technology symbolically extends engineers' limited sense of strength or potency. Often the men who appear to take the most pleasure in technology are relatively unpowerful—hackers and other technical hobbyists are obvious examples. Maureen McNeil (1987, 194) asks, "Couldn't the obsessional knowledge of some working class lads who are car buffs, or some of the avid readers of mechanics or computer magazines, be interpreted as evidence of impotence?" Flis Henwood (1993, 41) responds that in such cases, technology offers a symbolic promise of power, as well as the potential to compensate materially for their relative lack of class power by "a strengthening of their gender power" through the acquisition of technical expertise. Perhaps another kind of power promised by engineering is power over wayward bodies and emotions, given Hacker's (1990, chap. 4) evidence, cited under my second theme, about adolescent anxieties. Drawing on Turkle (1984), Paul Edwards (1996, 171) suggests that the "holding power" of computer programming lies in the simulated character of the "microworlds" so created. These microworlds are appealing because, on one hand, they offer "vast powers to transform, refine, and produce information" and, on the other, they are free of unwanted emotional complexity. Within them, "things make sense in a way human intersubjectivity cannot," and "the programmer is omnipotent" (if not omniscient). So, Edwards suggests, "For men, to whom power is an icon of identity and an index of success, a microworld can become a challenging arena for an adult quest for power and control" (p. 172).

It seems that mathematical and technical prowess offers some engineers at least compensation for a lack of prowess or control in various realms. As Downey and Lucena (1995, 1987) note, "Engineers routinely feel powerless themselves but are viewed as highly empowered by outsiders"—a rather clear case of men's contradictory experience of power (cf. Kaufman 1994).
Even accomplished professional engineers are prone to feeling powerless in relation to politics—witness the number who, privately at least, harbor technocratic dreams in the belief that the world would be a better place if it were run by people like them. Engineers' ambivalent relationship with power has roots in their structural location within capitalist industry. Situated ambiguously between capital, labor, and the state, they have collectively identified themselves with technology because this self-ascription provided them with a cloak of neutrality (Berner 1992). So throughout their history, engineers have faced tensions between a desire for professional autonomy and the demands of corporate employers (e.g., Layton 1971). Mellström's (1995, 54) engineers all complained about clashes between engineering perspectives and business perspectives—over time required to develop a design, for instance—and saw the latter "as threatening the technical core of their professional identity." The ambivalence is profound: the limited opportunities to do "real engineering" is probably the single largest source of dissatisfaction among engineers (Downey and Lucena 1995; Mellström 1995), yet several studies report that most engineers are interested in acquiring organizational power (Zussman 1985; Whalley 1986; McIlwee and Robinson 1992, 20)—which usually implies moving away from narrowly technical work.

The collective identification with technology attributed to engineers' structural location has a subjective counterpart. Florman's (1976) rhetoric about pleasure captures just how profoundly engineers identify themselves with their technology. Engineers in the car industry are proud to be associated with such a visible artifact and see themselves as "hardware men"; the design jobs that hold the highest status and challenge are those associated with the "hard mechanical core" of the engine, drive line, and chassis (Mellström, 1995, chap. 3). Similarly, engineers in microprocessors have an "unmistakable identification with future technology" and experience great professional pride when they can demonstrate their technical virtuosity to their peers, in producing "a beautiful layout," for instance (Mellström 1995, chap. 4).

I suspect that engineers' close identification with technology is precisely what makes it harder to establish a positive identity for themselves among nonengineers; it gives them a "separate reality," to use Murray's (1993) phrase. Indeed, we may view engineering as a fraternity built around this common identity with, and pleasure and pride in, technology. Higher education is typically where engineers meet others like themselves in large numbers for the first time. They survive the "hazing experience" through solidarity: they are "all in it together." In Sweden, the shared social life of engineering students revolves around displays of drinking prowess and a common interest in sports (Mellström 1995, chap. 7). And in the United States, where fewer engineers seem to be athletic, this culture spills over into
the “technical locker room” of the workplace populated as it is by “jocks” engaged in ritualistic displays of hands-on technical competence; “the image of technical virtuosity is revered—even where actions of technical virtuosity in the lab are rare” (McIlwee and Robinson 1992, 139). The ethnographic work of both Mellström (1995, chap. 5) and Hacker (1990, chap. 4) shows that this is a recurring theme in the jokes and stories that engineers share with one another. Engineers’ humor typically celebrates their technical prowess and ridicules the lack of it in others.24 By this stroke, technical prowess is what defines them as engineers and what gives them power (since the “out-group” is defined as less powerful because they lack such prowess).

The fraternity of engineers is thus a homosocial enactment (cf. Kimmel 1994) affirming particular versions of masculinity. But it is also a primary resource in furthering their position and interests. McIlwee and Robinson (1992, 138, chap. 1) conclude that in organizations and disciplines where engineers enjoy high status, they benefit from the “power to create a work-style comfortable to them as men”: an engineering culture will dominate when the centrality of technology is stressed and aggressive displays of competence are the accepted means of landing the more interesting assignments and jobs. Mellström (1995) finds that career progression is based on association with successful projects and on a membership of networks of contacts and mentors. In a situation where “engineering practice tends to reproduce patterns of homosociality” (Mellström 1995, 152; see also Kvande and Rasmussen 1990) and where most women engineers initially lack hands-on experience and confidence and, even when competent, never quite feel or parade the thrill and obsession of their male colleagues (McIlwee and Robinson 1992), it is hardly surprising that women engineers tend to drop out or to lose out in career terms: they never really “belong to the club.” And it is hardly surprising that the entry of women is (still) greeted with hostility by many engineers: it challenges what it means to be a man (Murray 1993). Perhaps it also threatens to spoil their fun.

Murray (1993) points out that the collective identity of engineers draws heavily on the image of the war hero—withdrawal from normal life and sacrificing all for the common good. Dramatic examples are provided in Tom Wolfe’s (1980) account of the hardship and privation that early male astronauts went through, aptly titled The Right Stuff; Tracy Kidder’s (1981) portrayal of computer hardware design in The Soul of a New Machine; and Brian Easlea’s (1983) study of the Manhattan Project. Murray suggests that the same phenomenon occurs more routinely in the development of business applications software. Here, engineers in project teams experience strong bonding and loyalty, working together on a common objective for which personal commitments, and sometimes their health and sanity, have to be
sacrificed to get the new software to the customer on time. It is likely that this experience is repeated in numerous industries as companies compete under the market pressure to “innovate or die” (Freeman 1982, chap. 1). The thrill of the shared mission and its successful completion in a new product launch is short-lived as the new product becomes superseded and the process must begin all over again (often with teams being disbanded and regrouped in the process). Bucciarelli (1994, 195) and Mellström (1995, 99) both observe how lifeless and lacking in human imprint the final artifact seems once all the drama of its design is over. The pain and the pleasure experienced by engineers on this roller coaster thus manifest and reflect the demands of capitalist competition for market share.

In sum, engineers chose their work for more than money or status. The pleasure in technology is a strong motivator and a significant reward. Together with a shared pride in technology and in technical competence, it is a central element in the individual identities and shared culture of engineers—and so acts to demarcate the engineers from outsiders (and often men engineers from women engineers). The symbolic associations of both technology and technical prowess with power may act as compensation in a situation where most engineers perceive themselves to have only limited power.

**Toward a Research Agenda**

As an exploratory think piece, drawing on a very patchy literature, this article has been written to raise more questions than it answers. Before outlining a research agenda, I would nonetheless like to emphasize two very general theoretical conclusions that, though by no means novel, have gained greater significance for me as a consequence of writing this article.

First, the analyses of the subjective experiences and identity of engineers presented above underline the need for a more nuanced and sophisticated framework for understanding the equation between technology and masculinity—and, in part, the male dominance of technology—than is provided by appeals to “an omniscient male power protecting and reproducing its known interests” (Murray 1993, 78). They highlight the need to look at cultural, subjective, and structural elements of gender (cf. the familiar triad outlined in the introduction), recognizing that each of these elements is distinct and often only loosely interrelated. Individual experience and identity provide a link between structures and symbols, on one hand, and everyday practice, on the other. But as Murray (1993) stresses, subjectivities are not a direct or simple reflection of power relations. At the same time, the analyses presented here underline the need for a more “seamless” approach to how we
conceptualize the interactions between gender identity, symbols, and structures. While I would argue for greater attention to subjectivities in engineering, it seems to me vital that analyses of gender identity be located in context and not undertaken as it were *toute seule*. The interplay between gender identity and gender structures in relation to technology should not need stressing but is frequently missed. Little boys only get the leisure time in which to tinker (e.g., Haddon 1990), and male engineers working in “high-tech” companies only have the “freedom” to spend long hours at work (Massey 1995) because neither are expected to assume the same level of domestic responsibilities as their sisters or wives. Interplays between gender identity and gender symbolism with respect to technology are highlighted, for instance, by Henwood’s (1993) and McNeil’s (1987) analyses of working-class lads’ tinkering. More systematic work, along the lines of that being pioneered notably by Merete Lie (1996a, 1996b, 1998), is warranted.26

Second, in reflecting on the four themes addressed in this article, I have come to a deepened sense of the complexity of gender and the necessary coexistence of multiple tensions—both in the lived masculine (or feminine) identities of engineers and in the material and symbolic gendering of engineering practice and culture. We have yet to acknowledge this complexity in either technology studies or gender studies, let alone make sense of it. I believe these various tensions are contingent on an interplay of diverse factors concerning structures, culture, and identities of both gender and technology—like engineers’ ambiguous relationship to power and perhaps to issues of control and domination (discussed under the fourth theme), the historical development of engineering epistemology and education (e.g., its quest for scientific legitimacy), the particular social organizations where engineers work, deep-seated gender dualisms (e.g., mind-body, rationality-emotionality), iniquitous divisions of public and private labor, and changing images and perceptions of both technology and gender. In turn, the coexistence of multiple tensions highlights why the performance of such a (for many people) taken-for-granted aspect of our personal identities as gender nonetheless demands considerable and often continuous effort. Thus, men engineers constantly negotiate relationships with business managers, other engineers, nonengineers, wives, and so forth in an attempt to find an identity and modus vivendi that they can (more or less) live with. And in different countries, types of institutions, fields and organizational cultures, as well as in individual engineers of different ages, upbringing, class, ethnicity, domestic circumstances, and inclination, this will yield diverse constellations of masculinities.

Above all, this article is offered as a challenge to further unravel the technology-masculinity nexus by bringing a gender gaze to the study of engineers and engineering practice. It has shown that engineering may be
gendered in four ways: (1) in symbolic representations and images of engineering available to those outside of engineering, (2) in symbolic gendering of engineering knowledge and practice, (3) in gender differences in how engineering is done, and (4) in engineers' subjective experiences and identities as engineers. I believe further research on these themes is justified because engineers represent such a powerful instantiation of the equation between masculinity and technology, and I believe that one important consequence of such work will be to destabilize that equation (cf. Haraway 1986). Clearly, the evidence reviewed here—highlighting the mismatch between image and practice and the contradictory constructions of masculinity in engineering practice—already serves to destabilize that equation in some modest way. In this spirit, and by way of summary, I propose that the following research questions warrant serious attention in both technology studies and gender studies:

*Masculine images of technology*
What is the relationship between masculine images of technology and the continued male dominance of engineering?
Why are masculine images of technology so durable even though (because?) they so often diverge from practice?

*Contradictory gendering of engineering knowledge and practice*
In what ways (if at all) are the images, language, and symbols found in the detail of engineering practice gendered?
Why are engineering and technology so often conceived in dichotomous terms, and what relation does this have to gender dualisms?
How widespread are apparently contradictory gender constructions in various branches of engineering work?
How might we understand gender of/in engineering (contradictory or otherwise) in relation to both the social organization of engineering work and gender relations and constructions more generally?

*Epistemological styles and the gender shaping of technology*
What is the extent of and scope for epistemological pluralism in engineering, and to what extent are certain epistemological styles suppressed?
To what extent does gender influence engineering styles? In particular, how (if at all) does or might the sex/gender of the design engineer shape technological artifacts?

*Subjectivity and identity*
What are the pains and pleasures experienced by engineers, and what are their relationships with and feelings about technology?
To what extent is technical prowess and/or pleasure in technology a symbolic compensation for lacking competencies or power in other areas? To what extent do engineers feel themselves to be ambiguously located and perceived with respect to power?
What images do engineers identify with, and what identity work do they engage in? How are we to understand this? What is the significance of engineers'
identification with and pride in technology, for engineering and for gender relations?

Finally, I believe that the kind of theoretical sensitivities discussed immediately above have practical implications for the design of research on gender of/in engineering. First, we need to look in detail at engineering practice while keeping our eye on wider masculine emblems of technology if we are to remove the gender blinders but retain the depth of previous ethnographic studies. Second, we need to look to the contingent—the specificities of context, including the particular demands and culture of the organizations employing engineers—if we are to make sense of the contradictory patterns of gendering observed. And third, we need to view engineers as whole people, with histories and lives outside of engineering, if we are to get at a full picture of their gender identities in relation to technology.

Notes

1. For example, three out of seven of the empirical chapters in Lie and Sørensen’s (1996) recent collection on technology in everyday life focus exclusively on men’s use of technology.

2. Of course it should be acknowledged that gender essentialism does not necessarily imply that gender traits are biologically determined; appeals to psychoanalysis or to divisions of labor and attendant socialization (cf. Rose 1983) are specifically not invoking biology.

3. As we have been powerfully reminded by Judith Butler (1990), even the attribution of biological sex is a social and therefore contested process.

4. At the same time, constructivist and actor network approaches to the study of technological change have been criticized by feminists in the field for failing to take account of the history and durability of particular gender arrangements and for neglecting the social construction of artifacts and the building of networks that take place in the context of the use of technology (e.g., Cockburn 1992). Various positions taken around feminism and constructivism in technology studies are presented in a special issue of Science, Technology, & Human Values (“Feminist and Constructivist Perspectives” 1995) and in Grint and Gill (1995).

5. Like Cockburn (1992), I believe that the perception of power as “capacity” embedded in actor network approaches just misses the point that many women (and men) experience power as domination.

6. The performed nature of the two-way shaping of gender and technology is nicely articulated and illustrated empirically in the recent collection of Berg’s (1997) work and in Cockburn and Ormrod’s (1993) detailed study of microwaves and domestic food preparation.

7. This is delightfully illustrated by Inga’s outpouring of love for her washing machine in Berg (1997, chap. 4).

8. Dominant cultural images of technology may be changing as information and communication technologies become increasingly accessible, but even here the hard-soft dualism is evident.

9. An illustration of this was provided by the 1993 special issue of Science on women in science, which gave considerable credence to the notion that women bring different “styles” to science—on
the basis of interviews of both female and male scientists (Barinaga 1993) and popular accounts of how early women entrants brought "empathy" and "patience" to the field of primatology (Morell 1993).

10. An example here might be the task of specifying a fabric for use in mountain conditions: girls would be more likely to ask what fabric is being used for. For example, will its wearer be active or stationary, which, of course, has a bearing on whether the fabric used needs to be breathable (Patricia Murphy, private communication, October 1996).

11. The label "craft engineer" may not have meaning outside the United Kingdom: it connotes someone who is not university trained and who usually works in the maintenance, installation, or manufacture of artifacts.

12. The term hazing is uniquely American; the parallel was suggested to me during 1998 by Ginger Melton (of the University of Colorado at Boulder) but is widely recognized among U.S. engineers.

13. Within the life sciences, for example, molecular biology is seen as very exciting while whole organism and observational sciences, such as animal behavior and primatology, are seen as decidedly more "girlie."

14. This material was shared with me during 1996 by Jan Webb of the University of Edinburgh's Sociology Department.

15. For example, longitudinal studies show no significant difference in how girls and boys do mathematics—either in how well they perform or in how they approach the task (Walkerdine and The Girls and Mathematics Unit 1989).

16. In her earlier study, Turkle (1984) used the terms hard and soft mastery. I believe this was unfortunate since, like the terms hard and soft technology, they infer a gendered hierarchy even where none may exist or be warranted.

17. I take it as significant that a senior policy person in the United Kingdom was willing to endorse my proposal for a pilot study on gender in engineering on the basis that it sought to explore whether there were differences in style and whether companies suppress styles (including "feminine" styles), which might be useful to them.

18. I believe the approach of simultaneously investigating the design and use of technology—to reveal the interaction between them—is extremely worthwhile and warrants more widespread adoption. It has been put to good use in terms of further gender analyses of technology in some recent historical work collected in a special issue of Technology and Culture ("Gender Analysis" 1997) and in the European collaborative Vienna project (Cockburn and Dilic 1994; Cockburn and Ormrod 1993), both of which investigate a series of everyday technologies, as well as a recent study on how cockpit design has been geared to "fitting" the average bodily proportions of men, not women (Weber 1997).

19. There is a considerable literature on gendered styles in management (see, e.g., Wajcman 1998).

20. By "identity work," I understand the work that individuals and groups do to create or sustain an image or identity with which they can feel comfortable.

21. Florman's (1976) book was written as a response to the "antitechnology" movement of the late 1960s and early 1970s, and it provides an interesting instance of identity work by engineers. The first half responds to criticisms of technology (illustrating how closely engineers identify with technology), while the second seeks to challenge the tarnished image of engineers as antiemotional "dullards" (hence the title).

22. I am grateful to Knut Sørensen for highlighting this theme for me. I would like to alert readers to the work he is currently doing, which contrasts self-images of former engineering captains of industry with those of present-day engineers working in fragmented labor processes (Sørensen 1997).
23. This may vary in different countries and communities. In the United States, the exciting, progressive image of technology appears to rub off on engineers more than in the United Kingdom. Even the nerd image is often viewed rather fondly—witness the popularity of Scott Adams’s pitiful but still heroic cartoon character, Dilbert.

24. One relatively well-known example is the list often pinned to a door or wall that starts, “Real programmers....” Mellström (1995, 77) found one such list that included the entry, “Real programmers don’t write in BASIC. Actually, no programmers write in BASIC, after the age of 12.”

25. Engineers in the United Kingdom, uniquely I suspect, enjoy little of either money or status, which makes the resistance to women entrants in that country particularly interesting.

26. For example, Lie (1995, 391) explores what happens when individual men do not match up to hegemonic masculinities around technology: “Even if far from all men are masters of technology, what is experienced as failure by individual men may not affect the general image of hegemonic masculinity. Those who are masters demonstrate not only that they are ‘real men’ themselves, but they demonstrate a phenomenon recognized as masculinity and confirm the meaning of the concept.”

References


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