Centre for Science Studies
Lancaster University

Publication Details

This web page was last revised on 6th December 2003; the paper was previously published at http://www.comp.lancs.ac.uk/sociology/soc039ls.htm in 2000

Located Accountabilities in Technology Production

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Author's note: This paper is a work-in-progress, undergoing revision from an earlier paper titled "Working Relations of Technology Production and Use," published in the journal Computer-Supported Cooperative Work (CSCW) 2:21-39, 1994 and, in abbreviated form, in Mackenzie, D. and Wajcman, J. (Eds.) *The Social Shaping of Technology, Second Edition*. Buckingham, UK: Open University Press, pp. 258-265, 1999. This version was presented at the Sawyer Seminar on Heterarchies, Santa Fe Institute, October 2000.

Abstract

This paper explores the relevance of recent feminist reconstructions of objectivity for the development of alternative practices of technology production and use. I take as my starting place the working relations that make up the design and use of technical systems. Working relations are understood as sociomaterial connections that sustain the visible and invisible work required to construct coherent technologies and put them into use. I outline the boundaries that characterize current relations of development and use, and the boundary crossings required to transform them. Three contrasting positions for design – the view from nowhere, detached intimacy, and located accountability – are discussed as alternative bases for a politics of professional design practice. From the position of located accountability, I close by sketching aspects of what a feminist politics and associated practices of technology production could be.

This essay takes up the question of cultural practices in the production and use of technical systems, and of what some alternative approaches to our understanding and development of those practices might be. My starting place is recent moves to reframe objectivity from the epistemic stance necessary to achieve a definitive body of knowledge, to a contingent accomplishment of dynamic processes of knowing and acting.(1) I will argue that these reconceptualizations of objectivity are relevant to our thinking about technologies insofar as technologies comprise the objectification of knowledges and practices in new material forms. Of course the story is more complicated than that, as relations of human practice and technical artifact become ever more layered and intertwined. At the same time that the technological project is one of congealing and objectifying human activities, it is increasingly also one of animating and finding subjectivity in technical artifacts. The assimilation of lived experience to technique goes both ways, which only makes the project of re-imagining technological objects the more urgent.

The discussions on which I propose to draw involve, among other things, a shift from a view of objective knowledge as a single, asituated, master perspective that bases its claims to objectivity in the closure of controversy, to multiple, located, partial perspectives that find their objective character through ongoing processes of debate.(2) The premise is that the latter is not only a better route to objectivity, but that it is in actuality the only way in which claims to objectivity are or ever could be grounded, however much the lived work of knowledge production is deleted from traditional scientific discourse. The feminist move in particular reframes the locus of objectivity from an established body of knowledge not produced or owned by anyone, to knowledges in dynamic production, reproduction and transformation, for which we are all responsible.

For technology designers and developers, the basic change implied by rethinking the technological object is from a view of design as the creation of discrete devices, or even networks of devices, to a view of systems development as entry into the networks of working relations – including both contests and alliances – that make technical systems possible. This represents a change insofar as the prevailing order of technology production is based not in acknowledgement and cultivation of these networks but in their denial, in favor of the myth of the lone creator of new technology on the one hand, and the passive recipients of new technology on the other. The fact that this myth belies the lived reality of systems development and use has so far gone largely unchallenged, as has the simple designer/user opposition that underwrites the myth. My project here is to develop the proposal that feminist theorizing offers a way to begin to replace the designer/user opposition – an opposition that closes off our possibilities for recognizing the subtle and profound differences that actually do divide us – with a rich, densely structured landscape of identities and working relations within which we might begin to move with some awareness and clarity regarding our own positions.

A primary resource for reconstructing technological relations is Donna Haraway's widely cited essay 'Situated Knowledges':

> Feminists don't need a doctrine of objectivity that promises transcendence, a story that loses track of its mediations just where someone might be held responsible for something, and unlimited instrumental power. We don't want a theory of innocent powers to represent the world, where languages and bodies both fall into the bliss of organic symbiosis. We also don't want to theorize the world, much less act within it, in terms of Global Systems, but we do need an earthwide network of connections, including the ability partially to translate knowledges among very different – and power differentiated – communities. We need the power of modern critical theories of how meanings and bodies get made, not in order to deny meanings and bodies, but in order to live in meanings and bodies that have a chance for a future (1991, p. 187).

In this passage are the themes that I want to take up: mediations and responsibility, limited power, networks of connections, partial translations, and the cultural production of lived sociomaterial worlds. To contextualize these themes, however, I need to back up a bit, to describe the particular pathways that have brought me to my present concerns. These pathways are structured through the networks of sociomaterial relations that sustain the visible and invisible work required to construct technical systems and put them into use.(3)

Working across boundaries

My experience of the working relations of technology production and use has led among other things to a preoccupation with boundaries, including efforts to recognize them, problematize them, at times maintain them, and at others times to work across them. The first set of relevant boundaries have been those closest to home, among the various networks that make up the multinational corporation in which I worked for twenty years. Within the company's United States operations alone there exist multiple social worlds differentiated by geographical, organizational and professional locations and identities. My own position within the corporation was defined in relation to these worlds and by an additional set of working relationships which was perhaps the most important. That was a small network of allies that cut across the boundaries, including anthropologists, computer scientists, engineers, and product designers distributed among several sites within the U.S. and England. What bound us together were a series of dissatisfactions regarding the regime within which we were asked to work, and a set of partial but related imaginings of how things might be different.

Our dissatisfactions and imaginings, in turn, were related to a further set of boundaries, drawn between professional technology design and the sites of a technology's local configuration for use. More specifically, as workers in the fields of technology research and development we found ourselves cut off from relevant sites of technologies-in-use at the same time that our enterprise was legitimised by them. A crucial assumption underwriting these persistent boundaries is the premise that technical expertise is not only *a necessary*, but is *the sufficient*, form of knowledge for the production of new technologies.

It is at this point that our enterprise joins with recent feminist efforts to open up the closed sphere of Western knowledge systems. Philosopher Helen Verran’s work (1993, 1998) with members of the Yolngu Aboriginal Australian community, for example, is about crossing boundaries as a project of mutual learning and partial translation: in Verran's case, between 'Western' academy-based sciences and Yolngu knowledges, in ours between technical knowledges and knowledgeable others for whom emerging technologies might be relevant, but only if what they know assumes a central, legitimated place in technology production. The agenda in the case of design becomes working for the presence of multiple voices not only in knowledge production, but in the production of technologies as knowledges objectified in a particular way.

This agenda requires crossing boundaries both within technology production, and between technology production and use. For inspiration we have turned to other parts of the industrialized world, in particular to Scandinavia where a network of computer systems developers has been working for the past twenty years or so to cross over onto the sites of technology use.(4) A premise of their travels is that there is in fact no distinct boundary between technology design and use insofar as professional designers, in order to develop systems with any integrity, must develop them in relation to the specific settings in which they are to be used. Similarly, if technologies are to be made useful, practitioners of other forms of work must effectively take up the work of design, as those activities currently glossed under the notion of technology adoption; that is, appropriating the technology so as to incorporate it into an existing material environment and set of practices. Integration, local configuration, customization, maintenance and redesign on this view represent not discrete phases in some 'system life cycle' but complex, densely structured courses of articulation work without clearly distinguishable boundaries between.(5)

Reconstructing relations of technology production and use to acknowledge this reality is an enormously difficult task. The boundaries that currently define professional practice are realized through institutionalized arrangements crafted precisely to their reproduction. As Mike Hales puts it, in a paper titled 'Where are Designers':

> Our times present us with a *de facto* economic and cultural separation between production and use. In our work world, producers are professionally (i.e. culturally) specialized; to a large extent, system-production is located in specialized and distinct sectors and/or geographical locations within an international division of labor (1994, p. 156).

In those cases where boundary crossings do occur, we discover that they involve encountering difference; entering onto territory with which one is unfamiliar and, to some significant extent therefore, unqualified to act. For those who have spent many years building

up competence and identity within a domain of specialized professional practice, placing oneself again onto unknown ground is a difficult thing to do, particularly insofar as it may lead to painful reflections on one's own life and positioning.(6)

To move beyond simple dichotomies in our understanding of who and where we are within the divided terrain of technology production and use, we need to begin by problematizing the terms 'designer' and 'user' and reconstructing relevant social relations that cross the boundaries between them. Attempts to avoid this conclusion lead to various sorts of surrogates, proxies, stand-in's for 'the user,' designed to allow the creation of usable technologies in the absence of these other relations.(7) But as Hales points out, the technological *usefulness* of artifacts created in this way remains unknown, or known only indirectly, and relies upon extensive forms of articulation work that remain invisible to professional design:

> Users 'construct' technology; they do this both symbolically, in their 'reading' of artefacts, and literally, in the articulation work that is essential before a concrete *configuration* of artefacts (as distinct from the generic system-products that emerge from usability labs in Silicon Valley) can serve as an adequate day-by-day supporting structure for a live practice (ibid, p. 162, original emphasis).

A consequence of the specialization of technology production and its separation from locations of use, in sum, is that the development of useful systems must be a boundary-crossing activity, taking place through the deliberate creation of situations that allow for the meeting of different partial knowledges. To further this process requires in turn that system developers become responsible for locating themselves within the extended networks of sociomaterial relations and forms of work that constitute technical systems. That is not to say that they can in any strong sense control those networks. On the contrary, a primary implication of this view is that developers must give up control over technology design (which is in any case illusory), and see themselves instead as entering into an extended set of working relations for which the question at each next turn becomes: How do we proceed in a responsible way?

Locating design

A crucial aspect of the alternative implied by these reconceptualizations is that design work becomes located; that is, we replace "ways of being nowhere while claiming to see comprehensively" (Haraway, op cit, p. 193), with "views from somewhere" (p. 196); (see also Star 1991). This means identifying our participation in the various mediations that define the production and use of new technologies, and taking some responsibility for them. It requires analyzing the processes by which boundaries within and between technology production and use are constructed and maintained, and understanding our contributions to their reproduction or transformation. And it means mapping not only our local networks, but locating those as well within more extended networks, including an increasingly globalized division of labor.

My own work moved through a series of projects that placed me increasingly within the worlds of professionalized technology production. The impetus for this movement was at once practical, political, intellectual and personal. Practically, the project of establishing a place for an anthropology of technology within industrial research required simultaneously discovering and demonstrating what that place could be (including struggling against the preconceptions of others, for much of the time in the absence of an articulable alternative conception). Politically, while there remains much to be done in the way of critical analyses of the politics of technology production as it currently proceeds, critical analyses beg for the synthesis of alternative imaginings of how it might be done differently. Intellectually, both critical analyses and alternative imaginings require progressively closer, more detailed inquiries into the elaborate structures and intricate dynamics that comprise technical systems. And personally, moving within these worlds one encounters others engaged in different, but recognizably related efforts with whom one gradually joins forces, and to whom one becomes increasingly committed.

Design from nowhere

Becoming a participant in the worlds of technology production necessarily involves finding a relation to professional design. A recurring question for me as a participant in discussions on design is "Who is doing what to whom here?" Within prevailing discourses anonymous and unlocatable designers, with a license afforded by their professional training, problematise the world in such a way as to make themselves indispensable to it and then discuss their obligation to intervene, in order to deliver technological solutions to equally decontextualized and consequently unlocatable users. This stance of *design from nowhere* is closely tied to the goal of construing technical systems as commodities that can be stabilized and cut loose from the sites of their production long enough to be exported *en masse* to the sites of their use. While computer systems to a large extent resist commodification in this sense (demanding instead continuing relations of development, support and redesign), this ethos of commodity production and marketing stands as an ideal for many manufacturers of computer systems, and explains in part the proliferation of intermediaries (value-added resellers, systems integrators and the like) growing up to fill the gap.

A consequence of the prevalence of the view from nowhere within professional design is that designers are effectively encouraged to be ignorant of their own positions within the social relations that comprise technical systems, to view technologies as objects and themselves as their creators. As Haraway points out in the quote with which I began, this objectivist stance, by losing track of the social mediations of technical production, supports the impossibility of specifically locating responsibility for it.

Detached Intimacy

At the same time that professional designers are encouraged to maintain their distance from the specific sites of technologies-in-use, they are invited into progressively more intimate relations with their own professions and with the companies for which they work. Wagner (1994) identifies three processes that underwrite the combined detachment (from other sites) and intimacy (within their own) of scientific and technical communities. *Organizational egocentrism* refers to a kind of 'autopoesis' of such communities, through which they "select those aspects of reality that can be grasped by existing cognitive structures and create their own artificial worlds in which their potential can unfold" (ibid. p. 260). The structures are not only cognitive, of course, but political, economic and practical as well. *Fake collectivity* is the common assumption of a kind of shared reality that provides the self-evidence, for anyone within the community, of the logic of individual actions. Finally, *de-realization* is the establishment and maintenance of "an environment (a lab, a mathematical theory, a computer screen)" that provides distance from practicalities that must eventually be faced as the products of scientific and technical labor are exported beyond their local sites (ibid., p. 260).

A consequence of these processes is a kind of detached intimacy that characterizes much of scientific and technical production work, through the joint creation of an elaborate social world within which one can be deeply engaged, but which remains largely self-referential, cut-off from others who might seriously challenge aspects of the community's practice. At the same time, the creation of this world is not fully under designers' control. Professionalized producers of technologies are themselves enmeshed in webs of human actors and nonhuman actants only partially visible to them, which form a kind of naturalized landscape in relation to which they do their work. Design in this respect places designers in an ambiguous position between their accountability within the terms provided by those who employ them, and the premise that their value to their employer lies in the autonomous exercise of their professional skill. Gideon Kunda, in an ethnography of research and development in a high technology company titled *Engineering Culture* (1992), argues that the self-conscious construction of 'corporate culture' is designed to mediate this potential contradiction by engaging engineers in a form of voluntary commitment to corporate goals. Post-Taylorist management practice has, according to Kunda, taken a turn toward what he calls "a sort of creeping annexation of the workers' selves, an attempt to capture the norms of the workplace and embed control 'inside' members" (p. 12). Corporate control in this sense is a kind of extension of the patriarchal family, casting management in the role of all-knowing, benevolent father, organization members in the role of children. As Kunda points out:

> The self is often associated in Western tradition with the right to – if not always the actual enjoyment of – a measure of personal automony for adults; and it is precisely this autonomy over one's own experience that is challenged by corporate attempts at normative control (p. 243, fn. 14).

Struggles to find alternatives to patriarchy as a model for working relations are in this respect not only efforts to construct an alternative design practice but, in Kunda's sense, are struggles for our selves.

Located Accountability

While the discourse of design from nowhere obscures responsibility for the relations of technology production and use, detached intimacy effectively yields up responsibility to the relations of employment. To find a different stance for design I turn back to Haraway's argument for a feminist objectivity, as a starting point for an alternative conception of what the responsible production and dissemination of new technical artifacts might be.(8) Haraway writes:

> Feminist objectivity is about limited location and situated knowledge, not about transcendence and splitting of subject and object. In this way we might become answerable for what we learn how to see (op cit., pp. 190-91).

And, I would add, for what we learn how to build. Located accountability is built on what Haraway terms "partial, locatable, critical knowledges" (p. 191). As she makes clear, the fact that our knowing is relative to and limited by our locations does not in any sense relieve us of responsibility for it. On the contrary, it is precisely the fact that our vision of the world is a vision from somewhere – that it is inextricably based in an embodied, and therefore partial, perspective – which makes us personally responsible for it. The only possible route to objectivity on this view is through collective knowledge of the specific locations of our respective visions. By extension, the only possibility for the creation of effective objects is through collective knowledge of the particular and multiple locations of their production and use.

Aspects of located accountability in technology production

To consider more concretely what technology production based on located accountability could mean, I offer some reflections on my own work experience in these terms. The possibility of an alternative practice inspires my working relations but is only partially realized in them. What follows is therefore a reporting in part on current practice, in part on desired transformations to it.

Relations of production

As members of a very large enterprise engaged in the production of new technologies, I and my colleagues found ourselves enmeshed in an overwhelmingly complex network of sociomaterial relations, for the most part made up of others (both human and nonhuman) we had never met and of which we were only dimly aware. The simple dichotomy of technology production and use masks (or indexes as we begin to respecify it) what is in actuality an increasingly dense and differentiated layering of people, activities and things, each operating within a limited sphere of knowing and acting that includes variously crude or sophisticated conceptualizations of the others. Within industrial research the distinctions are primarily disciplinary: computer science, electrical engineering, mathematics, cognitive psychology, linguistics, anthropology all orient not only to different problems but more significantly to different, sometimes incommensurate conceptions of the social/technical world. And as researchers we were all defined in contradistinction to enterprises of product design, development, manufacturing, finance, strategic planning, human resource management, marketing, sales and service, each of which in turn is itself a complex world comprising distinctive concerns, identities, accountabilities and working practices.

A central dilemma of our participation in these increasingly complex divisions of labor and professional specialization were the layers of mediation between each of us and the consequences of our work. In some real sense, no one of us *is* responsible for the outcomes of our collective labor. The possibility of invoking this reality as a rationale for abdicating

responsibility for the products of technological labor are well known. But the question concerns our responsibilities toward the *process* of technology production as well. Traditionally, the relations among disparate activities of technology production have been viewed as a series of hand-offs along a kind of multi-disciplinary assembly line. On this premise, for example, the role of research is to construct the technological foundations on top of which future devices will be built, including visions of how the future will be. A longstanding mutual dissatisfaction between research and product development arises from the failure of technologies and ideas to 'transfer' from one to the other, understood by one side as a failure of development to take advantage of the results of research, by the other as a failure of research to address the needs of development.

My own experience of this gap began in the early 1980s in grappling with the question of how an anthropology of technology might be made relevant to the design of machine interfaces. The first proposal was that, as ethnographers, we might mediate relations between designers and users. Increasingly, however, our reluctance to translate our practice directly into design terms was met with frustrations from the design community.(9) Our hesitation to produce such translations led to our characterization as recalcitrant social scientists, unwilling to roll up our sleeves and engage in the real work of design. For a time I at least was confused by this, feeling that to deliver design implications was indeed my responsibility but that I was unable to do so. I dwelled uncomfortably for several years within this gap between my practice and that of my design co-workers, seeing it not as a systemic discontinuity but as a personal shortcoming.

Gradually, however, we came to see that the problem lay neither in ourselves nor in our colleagues, but in the division of professional labor and the assumptions about knowledge production that lay behind it. The discontinuities across our intellectual and professional traditions and associated practices meant that we could not simpy produce results that could be handed off to our colleagues. What we were learning was inextricably tied to the ongoing development of our own theorizing and practice, such that it could not be cut loose and exported elsewhere. Rather than feeling inadequate in the face of demands that our work produce design implications, we began to resist those demands. We resisted them not on grounds of scientific purity or by denying our responsibility for design, but by rejecting assumptions on the basis of which the demands for our knowledge were being made. In place of the model of knowledge as a product that can be assembled through hand-offs in some neutral or universal language, we began to argue the need for mutual learning and partial translations. This in turn required new working relations not then in place.

At the same time, we began to find allies within the design community itself. Within the corporation, our colleagues who had spent much of their professional lives designing control panels for discrete 'stand alone boxes' now were being told by their management to envision a future of devices that would be tied together through networks, with the functionality of the overall system distributed dynamically among them. Increasingly, our colleagues were finding that their traditional methods for generating design ideas (for example, with reference to prior products and the results of marketing focus groups), or establishing the adequacy of their designs (for example, through usability testing) were ineffective. Motivated first on our part by economic exigencies (in particular, the necessity of obtaining funding from the product organization to support our anthropological research activities) and then increasingly by genuine affinity, a small network of working relations grew up across the divide.(10) Together, we realized, we might actually be able to bring our respective knowledges to bear on the shared problem of how to develop new grounds for technology design.

Our attempts to develop those grounds involved projects intended deliberately to cut across the organizational boundaries that separated us, both from each other as design professionals within the corporation and from the potential users of the technologies we were designing.(11) The goal of the projects was to develop a work-oriented design practice that engaged members of a specific site of potential technology use as collaborators in technology production. The sites of these experimental projects included a large law firm and a state department of transportation, each with its own highly elaborated and power differentiated network of working relations.

Relations of use

Just as the term 'designer' opens out, on closer inspection, onto an extended field of alliances and contests, so does the term 'user.' Organizations comprise multiple constituencies each with their own professional identities and views of others. For example, our investigations of work at a large law firm revealed the contested nature of members' representations of their own work and the work of others.(12) Attorneys with whom we spoke described a status hierarchy within the firm comprising partners, associates, junior attorneys, paralegals, case assistants, and litigation support. The work of litigation support was quite literally invisible to the attorneys (being located on a lower floor of the firm, to which the attorneys seldom went). In addition, attorneys described this work to us as a mindless, routine form of labor, representing a prime target for automation or out-sourcing as part of a general cost-cutting initiative within the firm.

Our direct investigations of the work of litigation support contradicted this view. In place of mindless workers we found a lively group of temporary workers supervised by a former paralegal with extensive experience in the maintenance and use of computerized databases. These 'document analysts,' as the supervisor called them, were engaged in carefully examining and encoding the thousands of documents used to assemble each case with the goal, vigorously instilled by their supervisor, of creating a valid and usable database for the attorneys. The litigation support supervisor expressed to us her belief that, given their familiarity with the document corpus, the document analysts could be responsible for certain other aspects of the document production process as well, now handled by junior attorneys. She also expressed her view that the attorneys underutilized the database, due to their ignorance of its capabilities and how to exploit them.

So we found ourselves cast into the middle of a contest over professional identities and practices within the firm, framed by the attorneys as a distinction between 'knowledge work' on the one hand and 'mindless labor' on the other, framed very differently by the workers within litigation support themselves. Our own observations of the work of the attorneys revealed no small measure of routine or tedious activities, all of which were, when brought into their awareness, acknowledged by them as inevitable if regrettable accompaniments of their professional practice. At the same time, the more we looked into the work of litigation support the more we saw the interpretive and judgmental work that the document coders were required to bring to it. We could not escape confronting directly these contrasting views as we realized that the work of document coding, which involved translations and transformations between paper and electronically-based media, was well-suited to our design agenda.(13) As a result, we decided to work with the supervisor of litigation support and her staff to prototype a redesigned document coding practice, incorporating some of our technologies. What interested us was the possibility of embedding bits of automation into the practice in a way that would relieve the tedium, while maintaining the level of interactive control over the process necessary for interpretation and the exercise of judgement.

After working for some time on the design of a document coding application, we coincidentally received a call from the firm's Director of Technology inquiring into the progress of our project. On hearing that, among other things, we were developing a proposal with respect to document coding he responded that we should know that, in the interest of cost-cutting, the senior management of the firm were considering very seriously closing down the in-house coding operation altogether and shipping the documents instead to the Phillipines. He added that the supervisor of litigation support did not yet know the extent of this plan, and that he would appreciate it if we would not mention it to her.

This conversation placed us in an obvious dilemma, which we attempted to resolve at least partially in the following way. We arranged with the Director of Technology that we would provide him with an update on our work, including our observations and proposals regarding document coding. We then called the supervisor of litigation support and explained to her, without mentioning the off-shore plan, that we were preparing a progress report for the Director of Technology and others, and that we would like to review with her what we planned to say to be sure that we were not misrepresenting her operation in any way, and to see whether she might have anything to add. In that way we hoped to speak at least in part on her behalf. We then attempted to construct our presentation in such a way that it called out the interpretive and judgemental work involved in document coding and its importance to the

production of useful databases, as well as the impossibility of automating or out-sourcing it without losing the value of that work.(14)

Our design efforts with respect to litigation support at the law firm ended with the research prototype. Nor do we have any illusions that our presentation alone could dissuade the management of the firm from pursuing outsourcing as a means of cost-cutting. Meanwhile, however, the litigation support staff took their own initiatives to increase the cost-effectiveness of their practice. At the time that our project ended, they had changed their practice to coding documents directly into the database rather than in two separate passes for document coding (on paper forms) and data entry (from forms into the database). At the same time, they had managed successfully to counter claims by outside sources to be able to do accurate database creation at a significantly cheaper rate. For the moment, then, their place within the firm seemed secure. We hope at least to have contributed to their efforts by seeing their work and acknowledging what we saw, both in our representations of it and our designing for it.

Artful integrations

Our efforts to develop a work-oriented design practice were based in the recognition that systems development is not the creation of discrete, intrinsically meaningful objects, but the cultural production of new forms of material practice. Objects themselves, as Haraway says, are boundary projects (op cit., p. 201). As such, they can be assessed only in their relations to the sites of their use. Professional design practice manages this reality by establishing enclosed sites that provide more easily assimilable terms of assessment; for example, through the practices of professional usability testing. Our agenda, in contrast, is to bring developing objects out into the environments of their intended use, such that their appropriability into those environments becomes a central criterion of adequacy for their design.

An implication of this agenda is that in place of the vision of a single technology that subsumes all others (*the* workstation, *the* ultimate multi-function machine), we assume the continued existence of hybrid systems composed of heterogeneous devices. Powerful technical systems on this view comprise not hegemonies but artful integrations. Design success rests on the extent and efficacy of one's analysis of specific environments of devices and working practices, finding a place for one's own technology within them. Design awards, by this reasoning, should be given not for discrete, decontextualized artifacts, but for the collective achievement of new, more productive interactions among devices, and more powerful integrations across devices and between devices and the settings of their use.

Change from this standpoint is no longer the prerogative of professional design but an aspect of everyday practice. New ways of working and new technologies grow out of old ones. They do so neither through a process of simple incremental change, nor through wholesale displacement and transformation, but out of an ongoing interaction between understandings based in prior experience on the one hand, and leaps of faith inspired by imagination on the other. In *The Shape of Time,* George Kubler writes:

> Everything made now is either a replica or a variant of something made a little time ago and so on without break to the first morning of human time (1962, p. 2).

This statement of continuity provides a corrective to heady pronouncements of so-called 'revolutionary' technological change. Its premise is that through juxtapositions and connections of existing forms new forms emerge. This seems paradoxical to many professional designers, for whom innovation is mythologized as the rejection of things past. If current practices using existing technologies are assumed to be stagnant until the professional designer appears on the scene, the designer's ignorance becomes his or her credential.

Partial translations

The proliferation of heterogeneous devices results in a preoccupation on the part of producers with problems of standardization. One strategy for standardization in technology production is to attempt to set up what in actor-network theory are called 'obligatory passage points' (Callon 1986); that is, points in the production and use of hybrid systems controlled by one actor, or by an alliance of actors, which are essential to the operations of others. For example, in the

domain of information technologies a number of producers have made claims to the development of universal languages for translation across devices. Levy (1993) suggests, however, that with respect to so-called document interchange languages what has actually occurred in place of universal translations is better described as the growth of densely structured islands of customization.

An alternative design approach would recognize the reality of partial translation in place of claims for universality. Haraway puts it this way with respect to science, but her suggestions hold equally for technology:

> Science has been about a search for translation, convertibility, mobility of meanings, and universality – which I call reductionism only when one language (guess whose) must be enforced as the standard for all the translations and conversions (op cit. p. 187).

Wagner (1994) points out that the univocality of scientifically legitimated professional discourse is supported by what Lyotard describes as practitioners' control not only of the languages of their professional practice, but of the metanarratives that set the terms of accountability for the profession. The relevance of this for systems design is elaborated by Wagner as follows:

> We can think of scientific communication as an ongoing self-directive process which unfolds relatively independent of critique from other communities of practice and attempts at creating partial translations; e.g. into another language such as the language of people who use or are affected by a technology and try to introduce their experiences into the scientific discourse (p. 260).

In our own work the requirement for partial translation addresses not only the obvious divide between professional producers of technology and users but, as our experience in developing a work-oriented design practice makes clear, the multiple divides within the specialized worlds of both. Finding our place within these worlds is finding a voice that is distinctively our own, while also capable of moving and being moved by others.

Conclusion

I have been attempting here to lay some groundwork for an approach to technology design informed by feminist theorizing and an awareness of the working relations of technology production and use. My premise is that insofar as the design of technical systems is a process of inscribing knowledges and activities into new material forms, feminist arguments regarding the production of knowledge systems point the way to transformations of technology design as well. Such transformations might entail at least the following:

1. Recognizing the various forms of visible and invisible work that make up the production/use of technical systems, locating ourselves within that extended web of connections, and taking responsibility for our participation;
2. Understanding technology use as the recontextualization of technologies designed at greater or lesser distances in some local site of practice;
3. Acknowledging and accepting the limited power of any actors or artifacts to control technology production/use;
4. Establishing new bases for technology integration, not in universal languages, but in partial translations;
5. Valuing heterogeneity in technical systems, achieved through practices of artful integration, over homogeneity and domination.

Feminist scholars such as Cynthia Cockburn (1993) have argued compellingly that much existing technology systematically, and in manifold ways, incorporates masculinist assumptions and values, and that the relative absence of women from technical practice must be understood not only as the result of exclusion but as reflecting forms of resistance as well. In her book *Feminism Confronts Technology* (1991), Judy Wajcman suggests that really to understand these processes of exclusion and resistance, feminist scholars need to get inside the 'black box' of technology production: that there is room for an effective politics around

gaining access to technological work and institutions, and that there are, as she puts it, "opportunities for disruption in the engine rooms of technological production" (p. 164). Similarly Jane Flax outlines what she calls a four-fold task for feminist theorists:

> We need to (1) articulate feminist viewpoints of/within the social worlds in which we live; (2) think about how we are affected by these worlds; (3) consider the ways in which how we think about them may be implicated in existing power/knowledge relationships; and (4) imagine ways in which these worlds ought to and can be transformed (1990, p. 55).

I take Flax's four-fold task as both description of and directive for constructing alternative practices of technology production and use. Technologies can be understood as materials whose stability relies upon the continuous reproduction of their meaning and usefulness in practice. There are two basic forms that technology stabilization can take. The first, prevailing form is stabilization through the handing-off of technologies across multiple, discontinuous worlds each of which stands as a black box for the others. Actors within these discontinuous worlds work to achieve enough coherence in the artifact that it becomes possible to hand it off to others. So product developers hand off a technology to sales and marketing, whose work makes it possible to effect hand-offs to third party developers and system integrators, whose work makes it possible to effect hand-offs to purchasers, whose work makes it possible to effect hand-offs to local implementers, whose work in turn makes it possible to effect hand-offs to end-users. Two aspects of this process as currently constituted are crucial. It relies upon articulation work at each boundary crossing and that work, whether mythologized or denigrated, is largely invisible. The alternative form of technical practice that I hope to have outlined here is built around a deepening awareness of and orientation to the work required to achieve technology stabilization, and one's location within the extended network of working relations that makes technical systems possible.

Acknowledgements

I am grateful to Phil Agre, Jeanette Blomberg, Andrew Clement, Mike Hales, Susan Newman, Leigh Star, Randy Trigg, and Ina Wagner for their careful readings and critical suggestions on earlier versions of this paper.

Notes

1. This discussion forms an extensive literature within feminist studies. I draw primarily in this paper on Anzaldua 1987, Haraway 1991, Star 1991, Verran 1993 and Wacjman 1991. The relations between feminism and postmodernism have received extensive discussion, for example in Nicholson 1990 and Hekman 1990, and the views of epistemology that emerge from these writings are closely aligned with much of recent social studies of scientific and technical practice as well, for example Bijker et al 1987, Collins 1985, Fujimura 1987, 1996, Knorr and Mulkay 1983, Knorr et al 1981, Lynch 1993, Lynch and Woolgar 1990, Star 1989, Shapin and Schaffer 1985, Pickering 1995.
2. See also Latour's discussion of the "parliament of things," 1993 and the collective of humans and nonhumans, 1999.
3. On invisible work see for example Shapin 1989, Star 1991, Suchman and Jordan 1989.
4. See, for example, Bjerknes et al 1991, Floyd et al 1989, Greenbaum and Kyng 1991, Schuler and Namioka 1993.
5. For a case study of the design work involved in use, see Clement 1993. On articulation work, see Star 1991, Fujimura 1987, and for its relevance to system design see Schmidt and Bannon 1992.
6. This includes positions within more pervasive geographies of class, race, ethnicity and gender. For a recounting of the pain and power associated with living on these borderlands, see Anzaldua 1987.
7. See Agre 1995, Grudin 1993, Grint and Woolgar 1997, chpt 3, Hoffman 1999.
8. For a clear re-articulation of the ethics of Haraway's epistemology, see Prins 1993.

9. For an account of these frustrations and proposals for their resolution see Blomberg et al 1993.
10. The core of this network was a small group comprising researchers and product designers, distributed between research centers based on the West coast of the U.S. and in England, and development organizations on the East coast. Among us we drew on backgrounds in anthropology, sociology, computer science, industrial psychology, graphic design and product design. In addition, this core group had ties to a slightly larger network of approximately 50 researchers, designers and engineers within the company who began to meet periodically to exchange stories and provide mutual support.
11. For more on these projects see Blomberg, Suchman and Trigg 1996, 1997.
12. For a further analysis see Suchman, in press.
13. Specifically, we were interested in exploring the potential usefulness of a class of image processing technologies, emerging from research and making their way into product development. These technologies are aimed at supporting relations between paper and electronic documents, by turning marks made on paper into instructions to the machine at the point that a paper document is scanned. So, for example, the machine can "recognize" a circled text region on a paper document and store just the circled text in a designated electronic file for subsequent reuse.
14. It is notable that when one is seen as designing hi-tech support for knowledge workers, the injunction is to capitalize the more expensive forms of labor. This in contrast to the goal of automating away the less expensive forms of labor.

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