Robert Gehl

15 July 2008

Science and Technology Studies Field Statement

Introduction

Broadly speaking, science and technology studies (STS) takes as its object the discourses, ideologies, and products of scientific disciplines such as physics, biology, genetics, information technology and computer science. STS has sought to dissect scientists' claims to truth and objectivity, seeking to uncover the contingent, social, and sometimes accidental nature of scientific and technological innovations. To do so, STS scholars typically examine the ways in which science and technology are coproduced with social mores and regulations. STS scholars see science/technology and society in a dialectical relationship, which challenges the notion of a transcendent, apolitical truth produced in laboratories. This also refutes the idea that science can be mapped directly onto the natural world. In other words, the Enlightenment dream of a mechanistic universe which could be known and whose actions could be predicted through scientific theory is soundly denied by STS. In addition, these scholars recognize that technology is a political force which serves the interests of different social groups in different historical contexts. In these ways, science and technology are seen as sociological problems, not an epistemological one. In addition, STS studies the impact of new technologies on culture, and in some cases, STS scholars conjecture about "what might have been" if actors shaping technologies had worked under different constraints or made different decisions.

Since STS is a rather young field, arising in the 1970s, there are many intriguing and formative debates happening, far too many to include in a brief field statement. Rather than be overly broad, this field statement will focus on five major areas of contention in the field: 1) the refutation of technological determinism; 2) theories of how science and technology can be made more democratic;

3) how STS relates to modernity and postmodernity; 4) an outline of STS engagements with identity politics; and 5) a special focus on STS theories of cyberculture. These are areas that will inform my dissertation work. My dissertation plans, as well as my current research, include studying the social development and impact of media, network, and communications technologies, particularly the WWW, so I will focus much of this field in that direction. A secondary facet of this field will be an interrogation of the relationship between technological development and subjectivity. This secondary area links directly with my other field statement, Marxist political economy.

However, before examining these five aspects of STS, I will outline the philosophical heritage of STS, and I will discuss the definitions – or lack of definitions – of the terms "science" and "technology" as used in this field.

The philosophical matrix of STS

As with any discipline, there are competing histories either visible in or just below the surface of science and technology studies. Western philosophy has a wide range of perspectives on the methodology we now call science and the material goods we now call technology. For brevity's sake, I will discuss recent, minor figures and concepts which precede contemporary STS, followed by a more extensive discussion of the two key philosophers who are the most influential in this field.

STS is preceded by political economic interrogations of science and technology found in the Marxian tradition, running from Marx to the Frankfurt School and into David Noble's work as well as Bob Young's Radical Science Journal and Science as Culture. The sociologist Weber is somewhat in this vein, engaging with science in his lecture "Science as a vocation" (Weber 1946). However, STS is largely divorced from these prior debates and lines of inquiry. There are several in the field who rely on Marxist political economy, but they are in the minority.

In all the historical and genealogical currents which precedes contemporary STS, Kuhn (1962) is the most influential upon the field of STS. His argument about "paradigm shifts," where scientific progress undergoes occasional ruptures, undermined the logical empirical concept of science as the slow and inexorable accretion of facts. However, his arguments remained largely within the field of scientific philosophy, which is to say he was interested in how scientists gain knowledge about the world. His concept of the “paradigm” presupposes that science is autonomous from social structures (Pinch 1997). In this sense, he is similar to another figure in the prehistory of contemporary STS, Robert Merton, who studied science without regard to the content or context of scientific research (Pinch 1997). In contrast, as this field will demonstrate, STS is concerned with the very claims to knowledge that scientists make. Moreover, STS is explicitly concerned with the way science and technology are articulated in the larger spheres of politics, culture, and economics, areas which are beyond the ken of Kuhn's major work. As the obituary of Kuhn in Social Studies of Science attests, he is still widely read in STS, but he is not nearly as influential as it first appears (Edge et al 1997).

As it is currently constituted, science and technology studies mainly relies on the work of two key philosophers: Ludwig Wittgenstein and Michel Foucault. Decades before STS and cultural studies suffered through the Sokal Hoax, Wittgenstein engaged in what could now be called a "proto-science war” with a famous contemporary, mathematician Alan Turing (Monk 1990; Hodges 2000; Pinch 2001). According to Pinch, during this skirmish, the younger Turing attended Wittgenstein's Cambridge course “The Foundations of Mathematics,” where he watched as Wittgenstein claimed that mathematics was simply a language game. Wittgenstein argued that a proof in mathematics is not the establishment of truth but is simply a series of signs with socially fixed meanings (Pinch 2001: 15). The certainty in mathematics is *grammatical* certainty, and nothing more (Wittgenstein and Kenny 2006: 228). This was, of course, part of Wittgenstein's larger project in his later years: to pierce the veil of science and deflate the tendency to see it as epistemologically superior to other disciplines. According to Monk, Wittgenstein hoped to convince Turing that mathematics was merely language by other means, but Turing simply dropped the course.

While Wittgenstein failed to influence Turing, he has had an impact on STS by way of David Bloor. Bloor (1973; 1983; 1997) argues that the sociology of knowledge had failed to understand how mathematics (and other scientific disciplines) are socially constructed. mathematics was seen as something outside of the social realm and therefore not an object of inquiry for science studies (1973: 172). However, Bloor translates Wittgenstein's concept of mathematics as a language game into sociological language. Formulas derive their meaning not from their inherent qualities but from social practice: “To see an arithmetical formula in use is to have before one an indicator and expression of a complex underlying social process” (1973: 184). Application of a formula is simply a matter of training and of practice; the discourse used to describe the formula's intended action is not representative of some object (such as a series of numbers), but is part of an agreed-upon “way of life.”[1] In one way or another, this is a point expressed many times throughout the bibliography of STS.

Bloor's work is the beginning of the “strong program” in science studies, where all scientific disciplines – including natural sciences and mathematics – could be proper objects of sociological inquiry. In addition, the strong program holds that the researcher must not examine only the successful scientific and technological innovations, but failed ones as well. This move denies a *de facto* scientific or technological determinism (that is, in the act of pretending that the current technoscientific order is the only one possible). Pinch (2001) calls this “one of the crowning achievements of science studies in the 1970s and 1980s” (18). The “strong program” includes Barnes (1974) and Edge, and Wittgenstein's influence *qua* Bloor is seen in the social construction of technology (SCOT) approach starting with Pinch (1981; 1987; 2001), Bijker (1987; 1995), Collins (1981a; 1981b; 1993; 1998; 2005), Hughes (1983; 1987; 1991) and Shapin et al (1985). Bloor continued his work with Barnes and Henry (Barnes et al 1996). In turn, this largely British school of science studies and the sociology of knowledge had a

1 Pinch (1997) argues that the Wittgensteinian idea of “way of life” is similar to Kuhn's idea of the paradigm; however, as discussed above, Kuhn's concept lends itself to a more conservative approach to science, whereas Wittgenstein was specifically interested in piercing the veil of natural sciences and mathematics. In that same paper, and in subsequent writings, Pinch advocated that the Kuhnian interpretation “be laid to rest” (478).

large impact on STS as it spread across the Atlantic. These works will be discussed later on in this field statement.

Certainly, another important achievement in this discipline is the work of Foucault. Foucault's focus on the archeology of science has provided STS with a theoretical perspective that moves away from seeing science as a historically progressive, almost reified institution. Rather, for Foucault, science is a body of knowledge which is underpinned by the shared assumptions of those engaged in it. Moreover, Foucault argues that scientific discourse is not distinct from political or cultural knowledge; in fact, discourse in science derives its power from the social structures that support it, not from its intrinsic value as a reflection of reality. Scientific progress is not, then, a slow evolution similar to our common conception of biological change, but is marked by ruptures and discontinuities, which are driven by modifications

> in the rules of formation of statements which are accepted as scientifically true. Thus it is not a change of content (refutation of old errors, recovery of old truths), nor is it a change of theoretical form (renewal of paradigm, modification of systematic ensembles). It is a question of what *governs* statements, and the way in which they *govern* each other so as to constitute a set of propositions which are scientifically acceptable, and hence capable of being verified or falsified by scientific procedures (Foucault and Rabinow 54).

In this sense, there is much affinity between Wittgenstein's language games and Foucault's discourses; both philosophers see the *parole* - the rules - as the underpinning logic of science with the utterances of the scientist as its manifestation. However, in the end, Foucault is more valuable than Wittgenstein; where Wittgenstein is content to simply point to the arbitrariness of even the most scientific utterance, Foucault's directs his gaze towards the continuous micropolitical struggles over power and knowledge which arise from the contests over language and meaning.

Foucault's integration into STS differs from Wittgenstein's in the sense that, while Wittgenstein was largely ignored until he was championed by Bloor, Foucault's impact was broad and came during his lifetime. In addition, while Wittgenstein's central idea of language games was explicitly aimed at piercing the veil of mathematics and the natural sciences, Foucault openly expressed doubts about his own ability to critique natural sciences, opting instead to examine psychology (Foucault and Rabinow 51). Thus, Foucault made a call to other to apply his ideas to broader and broader areas of science studies. Foucault's interlocutors include Rabinow, Latour, Jasanoff, Rose (2007), and Redfield. While Wittgenstein's method, once discovered, was a "ready-made" technique to make science an object of sociological study, Foucault's method had to be expanded, which led to a lively series of publications doing just that. These interlocutors drew heavily on The Order of Things (Foucault 1970), Archeology of Knowledge (Foucault 1972), and The History of Sexuality (Foucault 1978); they will be discussed in detail in subsequent sections of this field statement.

This philosophical matrix raises one important question: where is the focus on technology? Both Foucault and Wittgenstein focused on science and the scientist as objects of study, and their followers tend to conflate science with technology. This brings up a significant prerequisite to the main body of this field statement: the need to explore STS's definition of the terms "technology" and "science" and to demonstrate how the two became entangled in a discipline called "science and technology studies."

Definitions

The definitions of both "science" and "technology" in STS reveals much about the presuppositions and methodologies of this field. In sum, the two terms are largely used interchangeably in STS. This is evidenced not only by the name of the discipline but also by commonly used terms like "technoscience" (Aronowitz 1996; Haraway 1999; Latour 1999). At first glance, this refusal to define and to distinguish the two objects seems largely in line with the popular notion that technology is "applied science"; that is, that technology is the material reflection of the scientific method. However, this is not to suggest that STS theorists believe in a form of technological determinism where scientists discover new technologies and technologists apply them to society; this will be addressed later on in this field. Rather, the conflation of these terms reflects STS's recognition of the growing confluence of scientific development and technological change since the 19th century (MacKenzie and Wajcman 1999: 7). In modernity, scientific and technological changes, however apparently radical and transformative, are simply the accretion and overdetermination of little changes in myriad areas of social life – not simply in the scientific laboratory or in the engineering department.[2] In STS, these changes are never seen as outside the existing cultural, political, and economic structures of society. Thus, those in STS are almost always reluctant to define the terms "science" or "technology," presumably because doing so would separate these objects into autonomous spheres, engaging in what Latour (1999) calls the "dualist paradigm" (198, 203-204). In this paradigm, science and technology are divorced from one another *and* (as Latour argues) from society: one studies either scientists or engineers, and the two objects do not meet in any meaningful way.

The result of this can be frustrating, as is often the case in any discipline that believes in a multiplicity of determinations and refuses to separate objects for precise study. For example, consider Bijker et al's "Introduction" (1987: 3-4). This is the passage that the index of their book indicates is "Technology, definition of":

> "Technology" is a slippery term, and concepts such as "technological change" and "technological development" often carry a heavy interpretative load. It seems unfruitful and indeed unnecessary to devote much effort to working out precise definitions at least

2 Of course, Kuhn's (1962) argument about paradigm shifts points to the radical and revolutionary changes in the framing of these changes that occurs from time to time. Where contemporary STS differs from Kuhn is in the concept of co-production of technological and scientific changes – whether they be paradigm shifts or accretions. The evolution of science and technology is therefore not simply about the ruptures of the paradigm shift, but also about the cultural, political, and economic struggles around science and technology. For example, see MacKenzie and Wajcman's (1985) examination of the networks of cultural, political, economic actors who shaped the refrigerator.

> at this stage of the research in progress.... Also, instead of trying to distinguish technology from science (or indeed from any other activity) in general terms, it seems preferable to work from a set of case studies that seem intuitively paradigmatic.

The index leads us to the denial of definition. While this does seem unhelpful, Bijker et al's strategy of working with "intuitively paradigmatic" case studies is largely successful. In addition, fuzzy definitions such as this do have the benefit of orienting a researcher towards a broad range of determinants in the constitution of both science and technology.

With the philosophical matrix and definitions (or lack of them) established, I will now work through five areas of development and dispute in the field of science and technology studies.

1. Technological Determinism

From its origins in the 1970s, a large contingent of STS scholars have sought to debunk the notion that technological and technical changes directly and ultimately determine particular outcomes in culture and society. They had done so with criticisms of the contingency of scientific techniques, discussions of the impact of funding decisions, and a focus on consumers and mediators of new technologies.

An early articulation of the anti-determinism perspective is found in Noble (1977), who argues that one result of modern historians' uncritical invoking of "the demands" of technology as a causative factor is that "modern technology has remained a phantom, a conveniently vague device for explaining historical developments by explaining them away" (xviii). Noble's America by Design is, in great part, a long refutation of this position, as he outlines how technology and technique were largely and consciously incorporated into the American version of capitalism for the benefit of patent holders and large industrial firms.

Hughes (1983), who is credited with the "large systems" approach to science and technology, has argued that technological systems evolve largely because of the "style" of those who develop them, particularly “national style” - the cultural and political imprints of national context upon the technology. This is empirical evidence for the socially constructed nature of technology. His massive Networks of Power, along with several of his other works (1969; 1987; 1991) elaborates on this finding by developing the concept of "momentum," which is a metaphorical way of expressing the *seemingly* inexorable progress of machines and technology. Technological systems are so complex and overwhelming to the lay observer that they appear to have a logic (and a velocity) all their own. However, Hughes argues that a technology gets its momentum from the very actors who put it into motion. The determining factor is the social construction of technology: for example, the engineer of large systems must "deal with the messy economic, political, and social vitality of the production systems that embody the complex objectives of modern men and women" (1983: 1). Engineers do not simply make technology in a social vacuum. Instead, as Hughes demonstrates with empirical findings, technological development is determined in part by social conditions.

MacKenzie (1984) is part of a small group of STS theorists who relies on Karl Marx's work on technology. In his early career, he argues against the idea that Marx was a technological determinist. He begins with Marx's (1847) oft-quoted line "The handmill gives you society with the feudal lord; the steam-mill, society with the industrial capitalist" and Marx's concept of the "forces of production" as the most important cause of social change. MacKenzie argues that historians and theorists of technology from Heilbroner (1967) to Winner (1977) have taken "forces" to mean "technology" and thus have positioned the machine as the maker of history - the "technics out of control" to take Winner's title. Instead, MacKenzie's reading of "The Labor Process and the Valorization Process" in Capital, Volume I leads him to conclude that Marx subsumed any technology under the practice of labor and the process of creating value in capitalism. Machines - those objects that could replace the laborer - do not make history, but are a response to the modern struggle between capital and labor. Thus, Marx was not concerned with the *impact* of machines on history; rather, he was concerned with the social relationship of capitalism which gave rise to particular machines. MacKenzie suggests that Marx has something to contribute to STS, and he and Wajcman (1985) demonstrate this in their work The Social shaping of technology : How the refrigerator got its hum. While MacKenzie's article is not directly addressed at STS, but at interpretations of Marx, it is still influential in STS circles. An excellent example of this influence is seen in Cowan's (1985) article on the development of the refrigerator. In addition, MacKenzie's argument against the idea of Marx is a technological determinist is echoed by Bimber (1990).

In a paper directly addressed to the problem of technological determinism in STS, Misa (1988) argues that philosophers of technology, such as Svennson (1979), Rapp (1981), Ellul (1964; 1980) Chandler (1977), and most importantly for this field statement, Winner (1977) and Rouse (1987), have largely (and sometimes unwittingly) contributed to the sociological idea that technological change not only determines social change, but that technology evolves completely outside the logic of society. Misa argues that STS theorists must continue to write the autonomous “Machine" out of their histories, lest they contribute to this idea.

These interventions into the problem of technological determinism have resulted in a significant strain of STS thought. The social construction of technology (SCOT) approach, which began with Pinch and Bijker's (1987) The social construction of technological systems, and is evident in Mackenzie (1987; 1990), Mackenzie and Wajcman (1985; 1999), Douglas (1987), and Fischer (1992), is now the dominant approach to histories and studies of technology. The approach is threefold: 1) a basic assumption is that the truthfulness of any scientist's claims (that is, how well the scientist's ideas map onto the natural world) should be ignored in favor of an examination of the social construction of those truth claims. The success or failure of any scientific program is thus a sociological problem, not an epistemological one; 2) STS must focus on *failed* technologies and scientific programs. To focus on success is to implicitly accept the idea that technological progress is inevitable and has its own logic.

An example of an examination of a failed program is in Simon (2002); and, 3) technological and technical progress should not be viewed simply from a "consumer/producer" standpoint, but rather should include all the interest groups involved in developing a technology or science. Cowan (1983; 1987), Greenberg (2008) and to a lesser extent Martin (1994) are examples of this third approach, where consumers of technology are influenced not simply by the claims of producers, but also the state of infrastructure associated with that technology.

Even Winner, who was criticized as being a technological determinist by Misa and others, has adopted the SCOT/ momentum perspective. His famous essay "Do artifacts have politics?" (Winner 1986) argues that there is a large degree of flexibility in making political decisions about adopting new technologies. The introduction of a new agricultural technique and technology is not inevitable, but represents a moment when - at least in a democratic culture - a debate can take place about whether or not that technology would be beneficial. However, like Hughes, he argues that once a technology or technique is adopted, the options begin to narrow; the momentum of that technology begins to take hold. "In that sense technological innovations are similar to legislative acts or political foundings that establish a framework for public order that will endure over many generations. For that same reason the same careful attention one would give to the rules, roles, and relationships of politics must also be given to such things as the building of highways, the creation of television networks, and the tailoring of seemingly insignificant features on new machines" (29). Despite the criticism of Winner's (1977) earlier work as determinist (a criticism that seems to be persistent to this day), this essay marks his acknowledgment of the SCOT approach.

The most recent iteration of the SCOT approach and Hughes's concept of momentum is the concept of "coproduction," a term coined by Jasanoff (2004; 2005). This is a theory of overdetermination not unlike that expressed by Marxist political economists Resnick and Wolff (1987). For Jasanoff, science and technology are not independent variables operating outside of the social and natural world, but are deeply and dialectically embedded in those worlds, just as the social and natural are embedded in science and technology. "Scientific knowledge, in particular, is not a transcendent mirror of reality. It both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments and institutions - in short, in all the building blocks of what we term the social. The same can be said even more forcefully of technology" (Jasanoff 2004: 2). The coproduction "approach to thinking about the unfolding of science and technology in society stresses the myriad ways in which knowledge about the world conditions and is conditioned by choices about how people wish to live in it" (Jasanoff 2005: 274). She argues that this theory is applicable to other disciplines, such as political science, economics, history, and the humanities, but her work is firmly in the STS discipline, and it currently is highly influential in that field (for an example, see Reardon 2005). In any field, those who use coproduction as a framework would not accept any essential determinant or cause for any phenomenon.

After all of these works, it would seem that the issue of technological determinism is largely resolved in STS. However, despite the work of these STS theorists, technological determinism repeatedly appears as an issue, even two decades after the first works refuting it. This is due to two factors. First, the general population and popular press largely accepts the idea that technologies determine new social situations (Martin 1994). For STS theorists, particularly those who do ethnographic work, this creates a repeated need to address and refute determinism, even against their sources and informants. Second, and more subtly, technological determinism is a convenient shorthand. That is, given the complexity of technological and scientific systems and ideas, and their overdeterminations, it is rather easy to slip into the logic of technological determinism as one is engaged with all the other theoretical necessities of examining science and technology, particularly in large-scale studies. My analysis largely confirms what Misa (1988) argues: that micro-level analysis is typically conscious of and refutes technological determinism, while macro studies can easily take technological determinism as a given.

Boczkowski's (2004) Digitizing the News is an example of the first factor. This ethnography of the transition from print to online news delivery is rife with informant and popular press remarks about the inevitability of technological progress, so much so that Boczkowski feels compelled to address technological determinism head on, both by commenting on it and citing much of the literature outlined here. It is clear that Boczkowski is not a determinist, but it is also clear that STS theory on determinism has not had a major impact on those decision makers, such as the editors at The New York Times, who make significant technological decisions and therefore help shape technology.

Similarly, Downey (1998) sees determinism as powerful in the cultural imaginary. In the American context, technology, he argues, is presented by engineers and other technocrats as the answer to every social ill, if only the political and social constraints leveled against technological change are relaxed: "Engineers can boast that many problems have technical solutions and then complain about the barriers imposed by a purely social politics, as when they throw up their hands in frustration and say, 'It's all politics'" (11). Downey's anthropological work is an examination of computer engineers who use Computer Aided Design and Manufacturing (CAD/CAM) software and hardware. He argues, in part, that this technology enjoyed its extreme popularity in the 1980s and 90s not because it radically altered manufacturing processes (in fact, it did not live up to its hype), but because it was consistently sold and bought due to its apparent inevitability. This inevitability grew out of reimagining American as beset by foreign rivals in a new age of global capital; technological and market competition begets technological determinism. As Boczkowski and Downey's work show, although the issue of technological determinism is largely settled in academia, its impact on popular thinking, business decisions, and politics will ensure that it must continue to be addressed.

On the second, count, STS theorists who engage with technologies and techniques which are firmly embedded in society often do consider these to be phenomenal rather than epiphenomenal. This is particularly apparent in works that operate on macro scales; that is, focused on centuries of time or on global implications of technologies. Castells's (2000) The information age is a prime example of this. Castells argues that the information "mode of development" as seen contemporarily is largely independent of economic or political influences, thus rendering it the current determining factor of social relations. This criticism has been leveled at Castells by Webster (2004) and Garnham (2004). Castells denies this charge from the outset:

> Of course, technology does not determine society. Nor does society script the course of technological change, since many factors, including individual inventiveness and entrepreneurialism, intervene in the process of scientific discovery, technological innovation, and social applications, so that the final outcome depends on a complex pattern of interaction. Indeed, the dilemma of technological determinism is probably a false problem, since technology *is* society, and society cannot be understood or represented without its technological tools (I.5).

However, I argue that Misa (1988) effectively predicted this when he argued that technological determinism appears in works on this scale, and Castells's work is certainly of an ambitious scope. In such a large work (and here I mean large in scale) it is rather easy to slip into the old historical and philosophical habits of seeing technology as the all-determining, supra-historical force of society as Rapp (1981) and Ellul (1964, 1980) argue. It seems that work on a small scale (that is, focused on individuals and on a micro-scale of time), such as Boczkowski's, is required to expose determinism as false.

The normative implication of these arguments against technological determinism and for a dialectical relationship between society and technique is that decisions regarding science and technology should be made in the realm of democratic politics as opposed to the closed worlds of experts. In fact, I argue that the refutations of theories of technological determinism are in fact the result of STS attempting to constitute itself as a discipline against positivist fields such as economics, political science, and Comtean sociology (not to mention the "hard" sciences). STS's value as a discipline might stem from its political implications. With that, the next step is to survey the controversies and debates around demands from within and without STS for more democratic control over scientific and technological change.

2. Science, technology and democracy

As Aronowitz and DiFrazio (1994) ask,

> In the era of scientific-technological dominance over much of our economic and social life, can democracy survive without scientific and technological citizenship? Should the 'public' intervene in the determination of key aspects of science and technology policy - not merely when their specific interests such as health and safety are potentially threatened by the technological application of scientific discoveries, but also to determine the priorities of public funding for the sciences?

Kleinman (2000) agrees, arguing that "...During a period in which the impacts of science and technology are felt in the daily lives of citizens throughout the world, principles of democracy dictate that we at least consider the plausibility of increasing citizen involvement in the realm of science" (6).

These questions largely stem from the STS line of thinking outlined in the section on technological determinism. If technologies and science are "coproduced" between scientists and the social context and natural context, then it stands to reason that there should be a vehicle by which scientific policy is publicly debated. STS has called for precisely this scenario numerous times (Dickson 1984; Winner 1986; Aronowitz and DiFrazio 1994; Kleinman 2000; Jasanoff 1990, 1995, 2002, 2005). This call stems in large part from the recognition that technology is not inherently democratic (as is often argued in the popular press). However, those in the STS discipline have not simply called for more democratic decision making in scientific policy; they have also searched for specific examples of it. Two key examples illustrate the possibilities, and the pitfalls, of debates, conflicts, cooperation, and interactions between scientists and the lay public.

ACT UP

By far the most cited instance of what a democratic process in scientific work might look like is the case of AIDS activism. Collins and Pinch (1998) and Treichler (1991) explore the history of "lay" scientific knowledge of gays who were dealing with AIDS. Collins and Pinch argue that the gay activists of the AIDS Coalition to Unleash Power (ACT UP) were remarkably able to understand the character of the disease and understand the scientific discourse around treatment. AIDS patients arguably have much more at stake in medical research than do the doctors who do that research. They cite several patients, including Martin Delaney, Mark Harrington, and John James, who argue that they have the right to take the risk of being experimented upon in order to test possible cures for the disease. Collins and Pinch rightly note that this involved an "unholy alliance" with free-market deregulators who wanted to take the teeth out of the FDA, but the authors also imply that these activists were challenging the scientific community's monopoly on power and knowledge, ultimately resulting in bringing life-improving drugs to market faster. More importantly, as they argue, the expert/non-expert gap had been bridged by the AIDS activists (137; 149). Similarly, Treichler argues that AIDS activism has carved out a space where research and policy are more public, more debatable, and less authoritarian. This is the great achievement of ACT UP, and Collins, Pinch, and Treichler imply that this is a powerful model for democratizing scientific research. Works that follow in this vein include Klawiter (2008)

Similarly, Epstein (2000) analyses the success of ACT UP and emphasizes that this episode is important "because it is quite conceivable that these changes in the arena of AIDS research will have an enduring impact on biomedicine in the United States" (23). His argument is supported by the rise of disease-based activisms such as those associated with breast cancer, chronic fatigue, mental illness, and other conditions. However, Epstein is not as enthusiastic about the democratic potential of ACT UP:

> ...My analysis suggests a profound tension built into AIDS treatment activists' own project of democratizing expertise. On the one hand, by pursuing an educational strategy to disseminate AIDs information widely, activists have promoted the development of broad-based knowledge-empowerment at the grassroots. On the other hand, as treatment activist leaders have become quasi-experts, they have tended to replicate the expert/lay divide within the movement itself... Furthermore, as many of the treatment activists moved "inward" [into scientific circles], took their seat at the table and became sensitized to the logic of biomedical research, their conceptions of scientific methods sometimes turned in more conventional directions (24).

Epstein does not see this process as a necessarily democratic one, where competing groups meet, debate issues, and then arrive a solution; rather, he sees this process as simply drawing patients into the logic of scientific work and pharmacological marketing. For him, ACT UP raises many more questions about democratic involvement in science than it answers.

The Chemical Corridor

Less developed in Epstein's work, but also quite important, was the fact that ACT UP activists were primarily male, white, and highly educated (18), begging the question: could this model (for all its faults as a democratic model) be applied in other contexts? Allen's (2003) work is an examination of a similar process in Louisiana's "chemical corridor," the lower Mississippi river and delta where a large mass of chemical and industrial plants are located and where an inordinate amount of cancer and other diseases are recorded among the population. Her theoretical framework comes from Harding (1991), who argues that the distinction between expert and layperson should be blurred. Allen's ethnographic research leads her to conclude that this blurring is possible; hybrid expertise between citizens, activists, and experts can be an effective social movement in seeking redress for damages caused by the chemical industry. She calls this "objective" or "embodied" expertise: "Objective knowledge combined with cross-class, multirace coalitions, if used in the policy and regulatory arenas, leads to more inclusive decision-making processes and effective environmental change as evidenced in the Louisiana industrial corridor" (151). Thus, unlike the example of ACT UP, which willfully ignored or derided regulatory infrastructures and was based on identity politics rather than coalition politics, Allen finds that the most effective democratic control over scientific and technological policy comes from working with and strengthening regulation and creating broad coalitions. However, like the best moments of ACT UP, Allen finds that the distinction between citizen knowledge and expert knowledge blurred during the debates about the environmental impact of the chemical industry in the Louisiana.

Blurring the line between experts and non-experts is not the only democratic structure proposed by STS. Another major perspective offered is the market approach. This is based loosely on "the consumption junction" proposed by Cowan (1987). In Cowan's approach, a consumer is presented with choices between technologies and must decide which to adopt. These choices are constrained by the availability of large networks and infrastructure. Consumers are also affected by mediators such as retailers and wholesalers. However, the decision to adopt a technology is seen as ultimately the consumer's. This approach is exemplified in Greenberg (2008), who examines the process by which VHS video technology eclipsed Betamax. As he argues, in a market economy, a purchase is a vote for a technology. This is not merely metaphorical, but an explicit linking of dollars to votes. However, Greenberg avoids a full-blown freemarket approach to decisions about technologies by also examining other actors, such as video store owners, sales staff, wholesalers, and distributors.

It seems as though many in STS are in agreement about the need for democratizing science and technological change. There is a drive in STS to bridge the chasm between (as Rip [2006] might characterize it) “folk” understandings of science and the scientists themselves – presumably, this would like to a more democratic science. And, by all accounts, this project has had some success: "The social studies of science have helped to position science where it belongs - in the heart of society, rather than as an insular satellite - and even through the rancor it stimulates, brings attention to this question, and thus raises the possibility of alternative programs for the future" (Sarewitz 2000: 97). However, they are in disagreement with precisely how to achieve it, whether it be through government regulation, the market, or something else. This brings us to a larger question: what is the relationship between STS, modernity and postmodernity? How has STS's criticism of the institution of science (which is, after all, a major aspect of modernity) been received? Does this criticism make STS a postmodern discipline?

3. Modernity and Postmodernity

One might take a cursory glance at STS and walk away convinced that it is a postmodern discipline. If modernity is marked by both the rational control of nature as well as the scientific and technical abstraction of local practices from their context and their reinstitution in greater scales of time and space (Thompson 1995; Mattelart 2000; Tomlinson 2002; Giddens 1991, 2003; Edwards 2003), then it would seem that the STS project is postmodern, since it largely criticizes the rationality of science and experts who claim access to truth and therefore are qualified to direct modern institutions and systems. It tends to critique the mechanisms and institutions by which local practices are abstracted. Postmodern philosophy argues that the categories, rationality, and certainty of the modern worldview is unattainable and ultimately destructive, particularly to the individual, and is proto-totalitarian. It would seem then that STS is at the very least allied with this view, if not a major branch of it.

However, as Bruno Latour (2004) argues, STS was never supposed to be about debunking the idea of truth, but about "trying to detect the real prejudices behind the appearance of objective statements" (227). Latour's lament is that the work he and other STS theorists have done has led directly to the "war on science" engaged by free-marketeers who are concerned that the acceptance of global climate change as a fact would lead to government regulation, a practice he calls "instant revisionism" (228). "The question was never to get away from facts but closer to them, not fighting empiricism but, on the contrary, renewing empiricism" (231). However, even as he argues on behalf of the scientific studies which describe climate change, he feels a certain dissonance: "Why does it burn my tongue to say that climate change is a fact whether you like it or not? Why can't I simply say that the argument is closed for good" (227)?

Latour's lament is the lament of STS as a whole. On the one hand, STS has been highly critical of modernity. On the other hand, STS theorists like Latour have watched as conservative reactionary theorists have gleefully disassembled science. Latour's response is to gesture towards something called "nonmodernity"; but what STS seems to be doing is to argue - either implicitly or out loud - for a *different* iteration of modernity (Winner 1996). Exactly what that might look like is unclear and is a matter of tension, especially since most STS work is engaged with demystifying the dominant form of modernity marked by capitalism, statecraft, and the union of science and technology Aronowitz (1996) calls "technoscience." After all, critiquing current forms of modernity and arguing for a different iteration of it are not mutually exclusive; thus, it is clear that STS is not a postmodern field, but one that on the whole believes in modernity, rationality, and the overall project of the Enlightenment.

Noble's America by Design (1977) encapsulates the tension in STS between an outright adherence to a postmodern mode of criticism and the desire for modernity. On the one hand, Noble is highly critical of the particular way the American political, cultural, and economic systems have been designed in the years between the 1880s and the 1920s. For Noble, this period saw the rise of America's modern economic organization, free market capitalism. This economic system has an inherent irrationality, seemingly making it antithetical to modernity. However, market irrationality is tempered by its use of rational management techniques, mechanical and chemical standardization, and the newly formed technical schools, the sort of technocracy that Veblen (1921) dreamed about. The marriage of capitalist industry and science and technology gives rise to a system which mainstream economists argue is the most efficient and productive possible. Noble's purpose is to demystify this marriage, and to thus expose the "rationality" of market capitalism as just one form of modernity, and to ultimately advocate for another form of modernity: socialism.

Noble's argument has been highly influential in STS. However, many in STS have not argued for socialism as explicitly as Noble (MacKenzie is a notable exception). Instead, many in STS tend to follow Noble as far as critiquing modernity. The most influential of these are Leo Marx (1964, 1988, 1995), Thomas Hughes (1983, 1987, 1991), and Latour (1987, 1993, 1999) and Geoffrey Bowker (1999, 2005).

Leo Marx's (1964) The machine in the garden contrasts the "take off" of American industrial power in the late 19th century with the concurrent rise of the "pastoral ideal," a phenomenon he calls the "counterforce" to the rise of industrial modernity (25). For Leo Marx, the historical rise of American technological power is necessarily linked to the conception of America as an Edenic garden. Unfettered nature, as would be evident in an Eden, must be constrained with mills, steam power, or other mechanisms (163). In line with the Newtonian and Cartesian mechanistic thinking of the time, advocates of industry argued that any machines would be linked to nature through the physical laws of the natural world. Thus, despite the contemporary criticisms of industrialization (which rightfully argued that machinery would control - not free - labor), American policy inexorably moved to industrialize, even while simultaneously celebrating America as a garden:

> The pastoral idea of America had, of course, lent itself to [the illusion that there could be a balance between tech and rural] from the beginning. In the eighteenth century it had embraced a strangely ambiguous idea of history. It then had provided a clear sanction for the conquest of the wilderness, for improving upon raw nature and for economic and

> technological development - up to a point. The objective, in theory at least, was a society of the middle landscape, a rural nation exhibiting a happy balance of art and nature. But no one, not even Jefferson, had been able to identify the point of arrest, the critical moment when the tilt might be expected and progress cease to be progress. As time went on, accordingly, the idea became more vague, a rhetorical formula rather than a conception of society... (226).

The metaphor and analysis expressed in Leo Marx has been highly influential on other critics of American modernity, particularly Nye (1994, 1997, 2003, 2006) Carey (2008), and Winner (1986).

Leo Marx's later work (1995) continues his critique of modernity. He argues that postmodern thinking is simply a subset of modernity, arising out of the pessimism many feel when they consider the dangerous side-effects of modern science and technology. For Leo Marx, the hope of the Enlightenment has not quite lived up to expectations, particularly among the lay public, even as it has offered many advances. Postmodernism is linked to the deterministic popular idea that technology would simultaneously solve and cause all problems, making it only subtly distinct from the problems of modernity: "This postmodernism outlook in effect ratifies the idea of the domination of life by large technological systems... In many respects, postmodernism seems to be a perpetuation of - and an acquiescence in - the continuous aggrandizement of 'technology' in its modern, institutionalized, systemic guises" (24-25). In the end, however, whether dealing with modernity or postmodernity, Marx's work remains descriptive; he does not advocate any other system as Noble has.

Hughes's work (1983) is also a critique of modernity, but largely from a historical and comparative point of view on a large scale. In fact, his conception of modernity is arguably grounded in a refusal to accept any sort of narrowness. His massive <u>Networks of Power</u> is a comparison of the advent of electricity infrastructures in the United States, Germany, and the U.K.. It captures modernity's seemingly inherent expansionist tendencies by tracing the drive to increase the market for electricity throughout the West. This expansion butts up against "reverse salients" - those small pockets of technical problems or social resistance to the political, social, and technological powers of electricity networks. However, in the final analysis, the value of Hughes's work is in his ability to understand the complexity of modern infrastructure, not in his advocacy for alternatives or his normative judgments. If Hughes takes any sides, it is on the side of large industry; he implicitly argues that the ethos of capitalism is the driving force of the rise of electric infrastructure. The impact of Hughes theories of modernity (the idea of momentum; the concept of the reverse salient; the focus on comparison and the large scale, and national style) is more readily seen in the work of Edwards (1996, 2003), Eden (2004), and Hecht (1998), who do advocate alternatives to the current iteration of modernity and are less celebratory of modern capitalism. Moreover, as Giere (1993) argues, there is room for a synthesis of the certainty of modernity's conception of nature with the constructivism of postmodernity, resulting in the “middle ground” between these extremes.

Finally, it would be a mistake to leave out anthropological STS studies which examine modernity at the level of the individual, particularly since a major aspect of modernity is the creation of a category known as “identity” (Tomlinson 2002). One major branch of these studies focuses on those people who have largely (and I would argue are necessarily) excluded from the modern project. For example, Biehl (2005) and Redfield (2000) have produced ethnographies which examine the dialectical opposites of modernity, what Bauman (2005) calls "human waste." That is, they examine the processes of modernity which create surplus humanity, "othered" peoples who provide proof of modernity's progress by failing to adapt to it, largely drawing on the critical work of Adas (1989). Another major branch considers individuals and their relationship to the modern state. Zabusky (1995), Traweek (1988), Downey (1998), and Gusterson (2004) are strong examples of this vein. These anthropologists consider the way in which national identity determines attitudes towards to politics and uses of technology. They criticism the modern concept of identity without suggesting postmodern alternative formations.

The modern concept of “identity” is extremely important in many fields, including STS. Many in STS are highly attuned to the classic political-identity categories of race, gender/sexuality, and class. These categories warrant further attention.

4. Science, Technology and Identity

Contemporary STS places technoscience and society in a dialectical relationship. Thus, when they deal with issues of identity politics, those STS theorists who deal with identity do not simply celebrate resistance or indulge in radical individualism. Rather, they tend to closely consider the dialectical relationship between technological and scientific change and identity. Technology and technique are seen as not simply new methods for identity formation, but rather social forces which interpolate identity. In STS, then, there are many complex and nuanced interrogations of identity-political categories such as race, class, gender, sexuality, and nationality.

It is not the goal of this section of the field statement to resolve the controversies around identity politics: which identity should take the fore when discussing resistance; what to do about multiple identity positions; whether identity has a determining impact on society or culture (Aronowitz 1992). Rather, I will survey STS engagements with identity politics in the traditional, pluralistic cultural studies style: by category.

Gender

Cowan's (1983) work is an excellent example of the complex relationship between gender and sexual identity and contemporary structural constraints such as modernity and capitalism. She refuses to take for granted that home technologies such as dishwashers, vacuums, and stoves have reduced the workload for American housewives. In fact, her method of examining not only the technologies themselves, but also examining the networks that make them possible, reveals that housewives have borne increasing domestic work burdens as technologies have been introduced. Moreover, she finds that home technologies typically decrease the workload for *husbands*. The roots of this seeming paradox are in American gender roles as well as the contingencies of industrialization. For example, in America, men typically gathered fuel for hearths. As stoves were introduced, they increased fuel efficiency, thus reducing the time men spent gathering fuel. In contrast, stoves did nothing to reduce the workload of housewives, since cooking was a primarily female activity. In fact, since stoves require cleaning every night, they increased the workload for women, since the previous technology, hearths, required only sporadic cleaning throughout the year. In Cowan's work, then, gender identities are not simply sites of play but are deeply implicated in social mores, technologies, and the reproduction of the household.

Turkle (1995; 2005), Downey (1998), Cockburn (1985; 1999), Cohn (1987), Edwards (1990), and Traweek (1988; 1996) have examined the ways in which male-dominated fields such as computer engineering, high-tech labor, and the military have interpellated women (and men) in particular ways. For Turkle, computer programming is a practice in mastery, and she argues there is a feminized "soft" mastery marked by play and discovery and masculinized "hard" mastery marked by control, planning, and linear logic. Her observations of children programmers in The Second Self (2005, originally published in 1984) were later extended into a distinction between Macs and DOS systems in Life on the Screen (1995); Macs are akin to "soft" mastery and surface play, whereas DOS systems allow for greater "hard" control. However, this gendered conception of computer programming grates against the postmodern gender-bending and experimentation Turkle observes in online communities, where as is now commonly accepted, identity is in flux as people adopt avatars which reflect their fantasies more than their real life contexts.

Downey and Cockburn both focus on the male-dominated fields of engineering and manufacturing. Downey does not deal with virtual identity, but his findings do support Turkle's:

computer technology largely caters to masculine concepts of control and potency. Unlike Turkle, his contextualization of this need for control is not psychoanalytic, but lies in globalization. Engineers in the 1980s and 90s found themselves increasingly caught up in the ideology of market competition, and for them, computer technology was a way of asserting and maintaining control in the face of uncertain economic circumstances. Cockburn's broader feminist theories about engineering support Downey's particular findings; she argues that women have not only been excluded from engineering but also have rejected it because of its modern, rational masculinist bias. "Engineering represents everything that is manly - the propensity to control and manipulate nature; the celebration of muscle and machine in action upon raw materials... it implies control - designing solutions to physical problems, making energy work for you" (1999: 128).

Looking at the world of defense intellectuals in the United States, Cohn (1987) engages in ethnographic work and traces her surprising acceptance of the cold metaphorical and euphemistic language of the male-dominated field of defense. While she admits that she attempted to resist masculinist language in that field, she notes that it is used so casually that she could not help but use it herself. Moreover, she initially felt the highly determinist “missle-envy” argument about males in defense was reductive and misleading, she argues that her ethnographic work supports this idea.

Edwards (1990) extends Turkle's (and implicitly Cohn's and Downey's) ideas into a larger scale, specifically contextualizing computer technologies within the greater systems of militarism, capitalism, and cultural practices. For Edwards, the question of "hard" or "soft" mastery is not the issue; instead, the computer's roots in military research is why women are largely excluded from working with them at a programming level. Since computer technology was developed mainly to control nuclear weapons, the distinction between a home front and a front line, and its attendant gender distinctions, were erased. Women were excluded from computer engineering because it was seen as a "front line" activity, and women were seen as a liability on the front line. This cultural prohibition against female computer engineers is still in evidence today.

Edwards argues that women must embrace computer technology, even if they must "learn to think in the styles the culture has constructed as male, as well as to apply other styles to create unprecedented new methods." Furthermore, "The greater challenge is to reconstruct the gender codes that surround that thinking without reinscribing biological arguments" (125). With that, he turns to Haraway's (2004) arguments, and so will I. For Haraway (as well as Cockburn), technology must be used by women for their liberation. In fact, she sees this sort of liberation as made possible by computer technology. She argues that identity politics will (continue) to fail in the face of "the informatics of domination" unless women and minorities abandon a search for a transcendent political identity and challenge technocratic modernity, while simultaneously (and paradoxically?) accepting the radical contingency made possible by new cyber technologies. Haraway's work will be examined further in the section on "Cyberculture."

Martin's (1991; 1994) work on discourses of bodily system shows how gender metaphors shape the ways in which we popularly view our bodies. While many of the other STS works on gender tend to examine how science and technology interpolate gender, Martin's work focuses on how the simple language of popular science texts (such as schoolbooks and magazines) is rife with metaphors and phrases which anthropomorphically and irrationally assign gender roles to our internal organs. Sperm and eggs, macrophages and T cells are each assigned gender based on their perceived passivity or assertiveness. Moreover, she argues that these metaphors become ossified in Western culture and repeat themselves in new scientific research papers, a site where one would not necessarily expect to find these bizarre metaphors.

Taken together, these STS works make a compelling case that science and technology is part of a larger social project to rigidly design gender roles. Cowan's, Martin's, and Downey's works are particularly valuable in this regard.

Race

Like gender, STS has examined the ways in which race has been constructed by technologies and sciences, as well as the ways in which prior social conceptions of race shape the course of science and technology.

An excellent theoretical frame for questions of science and race is in the introduction to Harding's (1993) The Racial Economy of Science. Harding starts with the concept of "scientific illiteracy" and turns it on its head, arguing that even the best-trained scientists are "illiterate" when it comes to understanding how social forces shape their work. "These elite science educations rarely expose students to systematic analyses of the social origins, traditions, meanings, practices, institutions, technologies, uses, and consequences of the natural sciences that ensure the fully historical character of the results of scientific research. Consequently, most scientists are not in a position to evaluate in a maximally objective way important parts of the evidence that they use in arriving at their results of research..." (1). The result of this is an inability in Western scientific traditions to link their work to social justice, a result she refers to as "weak objectivity." This has a disastrous impact upon any group the West has "othered" and is also responsible for the current, undemocratic state of scientific policy (3). This is the thesis of Harding's edited collection, which includes contributions from Traweek (1993), Haraway (1993), and Shiva (1993).

Allen's (2003) ethnographic and archival work in Louisiana develops and supports the ideas in Harding. She argues that legitimate (to use her words, "strongly objective") questions about racism in the chemical industry and the Department of Environmental Quality are elided with seemingly objective metrics for measuring the impact of pollution and the economics of where highly pollutant plants are located. For Allen, race and other identity political categories are the sites of struggle over what is knowledge and what is not. "The claim that these chemical companies make their siting decisions based on impartial and objective criteria is only partially true. The biases that corporate decision makers have erased in their so-called objective decision making are the social values held by the communities that their decisions will ultimately affect. This gives corporate pseudo-objectivity a flexibility incommensurable with any real notion of a strongly objective process" (112). In other words, in Louisiana's "Cancer Alley," corporate objectivity is largely about discounting accusations of racism while enjoying the fruits of the centuries old racist system: cheap land, cheap labor, and an uncaring regulatory body.

Since a large portion of the scientific community has accepted that race is socially constructed, scientific studies of human diversity are based on genome mapping. However, this new technique is certainly steeped in the long history of scientific racism. The old metaphors, ideas, and biases do not simply fade away with a new technique. Reardon (2005) argues against typical critical analyses of scientific racism, which "draw upon an understanding of ideology that opposes it to science and knowledge, positioning the use of race in science on the side of ideology, and claims that race is biologically meaningless on the side of science and right knowledge" (18). Instead, she argues that the line between ideology and science has been unclear to scientists working on race. Since it has been unclear, Reardon argues that scientists have attempted to take the lead on race as a modern category, attempting to define it and clarify it scientifically through projects such as eugenics and the Human Genome Diversity Project. This echoes a claim made by Harding (1993: 9). She concludes that "debates about natural (or biological) human difference cannot be disconnected from debates about how to categorize human diversity in society" (160). Her ultimate argument is that race and science have continued to be linked, even as science has shifted its focus from old theories about the specific knowable characteristics of blacks, Hispanics, and Asians to the seemingly racially objective process of genome mapping.

Class

The relationship between capital, machines, and labor are basic to Marx's examination of capitalism, and the concept of class is a key entry point into this relationship. Simply put, when technology is utilized by capital, it has a profound effect upon the proletariat, either displacing large sections of the working class or disciplining them in certain ways. Likewise, science, when produced in a capitalist economy, is often subject to the logic of capitalist profit making. While political economy is not an influence upon STS, STS scholars remain mindful of economic disparities and how they are exacerbated or reinforced by science and technology.

For example, Winner's (1986) "Do artifacts have politics?" is an influential articulation of technology used according to capitalist logic. As he argues that technologies are subject to the political whims of those who deploy them, he describes a factory which made threshing machines in the 1880s. The factory owner introduced pneumatic molding machines into the process. Winner argues that if we consider this introduction from an apolitical perspective, it makes no sense: the parts the molding machine produced took longer to make and were of poorer quality than the previous method of using skilled laborers. However, when placed in its political context, these machines were used primarily to displace skilled labor, which was organizing at the time.

Zuboff (1988) certainly is not a Marxist, but her sociological study of the transition from hands-on work to computer automated work in paper mills reveals precisely how owners of plants, engineers, and software vendors envision computer technology as a replacement for skilled laborers. Prior to the introduction of computer paper mixing and chemical management, floor laborers had deeply embodied knowledges of how the process worked, relying on their senses to judge the quality of paper pulp. Computer-aided milling rendered these workers largely redundant, with only their union status helping them to keep their jobs (and one gets the sense that this protection would not last long). In addition, Zuboff describes the exploitation of computers as surveillance tools in certain plants, allowing mill owners to document accidents and thus place blame on individual workers if any part of the process failed.

Aronowitz is probably the most visible theorist combining Marxist political economy and STS. An important work in this regard is a book he co-edited with DiFazio (1994), The jobless future, which contrasts the near-utopian vision of an high-tech, knowledge-based American economy with the reality of degradation of work, outsourcing, and decline of unionism. These effects, the authors argue, are made possible and necessary by the so-called "information economy." At the heart of this examination of technology is a consideration of class and class politics.

Finally, Sunder Rajan's (2006) Biocapital outlines what might be called the primitive accumulation of the body's genetic information production capability. States have taken a keen interest in controlling the genetic information of their populations and selling it to bioengineering firms. In addition, Sunder Rajan also examines firms which archive this information, hoping to leverage these archives for profit when techniques are developed to exploit genetic code. This has implications for labor, in that part and parcel of this "information economy" is an ethos of flexibility and shape-shifting among laborers in the early stages of genetic engineering start-ups. However, as firms gather and archive more information, and once these firms begin to standardize operations and employ refined technologies and techniques, Sunder Rajan argues that they tend to "deskill" the very laborers who enjoyed a large degree of flexibility (255-258), a process Marx would call "real subsumption" – the process by which capitalism is made hegemonic in culture and politics. Other STS scholars in this vein include Hayden (2003, 2005).

Cyberculture

Science and technology studies' (STS) history has roughly coincided with the mass marketing of digital computers and computer networking technologies. It is not surprising that STS has engaged with, and some would say helped shape, so-called "cyberculture," defined as the culture of computer use. To use Sherry Turkle's (2005) excellent phrase, computers are fascinating "objects to the think with." In other words, the ways in which individuals engage with computers reveals much about their perceptions of mind and body, and their bodily engagement with space and time, whether these engagements take place as part of work or leisure. Moreover, notions of "cyberspace" (the virtual space imagined to exist within computers and computer networks) have raised questions about the truth claims of economics, psychology, sociology, as well as identity. Virtual lives, lived on screen and within networks, are seen by many people as a key means to restructure social relations and test new ideas and identities, and STS scholars have been actively engaged in analyzing this space. Thus, cyberspace is also a space of contention in the field of STS - at the risk of being too simplistic, it is yet another site of contestation between theories of modernity and postmodernity. This section of the field statement will explore STS’s engagement with cyberspace and cyberculture.

STS has used three approaches to the study of cyberculture and space: postmodern, anthropological, and large-systems. The postmodern approach is exemplified by Donna Haraway's work; the famous Cyborg Manifesto is highly influential among the postmodernists who examine cyberculture (Rheingold 1993; Kroker 1994, 1996; Penley and Ross 1991; Dyer-Witheford 1999; Castronova 2002, 2005; Jenkins 2004; Bigge 2006; Swyngedouw 2006). In this perspective, the hero of cyberculture is the cyborg, the hacker, and the avatar, and the villain is the “informatics of domination.” This perspective has much in common with the anthropological view (Turkle 1990, 1995, 1999, 2005; Zuboff 1998; Downey 1998; Boczkowski 2004), where individuals and groups struggle with the machine and how the machines and technologies impact agency, identity, and subjectivity. What I call the large-systems approach (Edwards 1990, 1994, 1996, 2003; Abbate 1999; Castells 2000, 2002; Aronowitz and DiFrazio 1994; Gerovitch 2002) contextualizes cyberculture and computer technology in the systems of capitalism, militarism, language systems, and politics.

The postmodern perspective on cyberculture is highly influenced by Haraway. For Haraway (1991a; 1991b; 2004), the cyborg is the hero of cyberspace. Cyborgs function as the postmodern subject, capable of either transcending or deconstructing (and subsequently reconstructing) the modern ontologies of class, gender, and the organic family. She writes, "A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction. Social reality is lived social relations, our most important political construction, a world-changing fiction" (2004: 7). This hybrid organism, Haraway claims, is each of us: "By the late twentieth century, our time, a mythic time, we are all chimeras, theorized and fabricated hybrids of machine and organism: in short, we are hybrids" (8). Haraway argues that the cyborg is capable of navigating a postmodern landscape where the distinction between machine, human, and animal is blurred and troubled. Cyborgs and their culture, cyberculture, are engaged in what she argues is a radical shift in emphasis away from an essential, united political project (based on, for example, biological/natural notions of womanhood) to one which is accepting of contingency and fluidity (1991b: 21). This being said, Haraway argues for a unified political project founded on opposition to oppression (largely conceived of as patriarchal and economic) instead of upon essentialist categories, such as labor and family.

Her work, however, produces its own essentialism: the ontology of information. In this Manifesto, electronic/organic information coding, writing, processing, and storage are the sites of control and struggle. This is what she calls the "informatics of domination" (2004: 20). From this perspective, it is easy to see why Haraway (and, as it will be shown, those theorists she has influenced) have attempted to move beyond modern categories such as "woman" and "race"; all disciplines, categories, and politics converges into informatics, with greater or lesser degrees of effectiveness in a postmodern, information-drenched technoscape. The cyborg, she argues, is best equipped to challenge this "perfect communication... the one code that translates everything perfectly" (2004: 34) because the cyborg is not afraid of science and technology nor is it willing to allow science and technology a privileged epistemological position.

Sherry Turkle's The Second Self is another influential description of cyberculture, one that has resonated through the past two decades. Since both Haraway and Turkle view the computer as altering our perception of the relationship between mind and machine, the distinction between the two approaches seems subtle, but their theoretical implications are highly divergent. While Haraway is actively using the cyborg metaphor as a means to advocate for the blurring of the human/machine dichotomy, Turkle's view is rooted in the history of psychology. She sees the computer as another in a long line of "objects to think with"; that is, objects that humanity has used as an *other* to define itself. Turkle's argument of the "subjective computer" - the idea that the computer demands our attention by enabling us to imagine "microworlds" - diverges from Haraway's argument in that it reminds us that the computer is interpreted in radically different ways by different people. This argument is supported by her observation of children who program computers in either the "hard" and "soft" mastery styles. Thus, for Turkle, the computer/human relationship is not a postmodern political union, but it is another technology which enables particular (typically male) users to gain greater control over their environment, or failing that, their own subjectivity. This search for control implies that computers can be used for precisely the opposite: management and control of subjects for the benefit of people in power.

This view has been expanded in both Turkle's subsequent works, which deal out of necessity with the ever-increasingly networked nature of computer technology, and those that Turkle has influenced. Turkle's more recent works (1995, 1999) examine the ways in which identity becomes malleable in cyberspace. When networked, the computer, the "object to think with" she originally descibes, becomes "the object to think with for thinking about identity" (1999: 645). One imagines that Haraway's cyborg is the feminist response to the masculinist urge for control that is evident in the groups Turkle observed. Thus, the Haraway view and the Turkle view are not wholly incompatible. However, those in STS who are influenced by these theories do diverge significantly.

The final major perspective on cyberculture is the systems approach. Unlike either Turkle's or Haraway's, this perspective is less concerned with individual subjectivity and interaction with computers and cyberspace, and more with examining computer systems and cyberculture in the micro, meso, and macro scales of modern institutions such as government, military, capital, and networks of influence and communication (Edwards 2003). In this approach, the object is infrastructure, with individual subjectivity providing an implicit context. This approach was pioneered by Thomas Hughes (1983), who deals with electricity infrastructures, but its application to the world of computers is exemplified by Paul Edwards.

In "The Army and the Microworld: Computers and the Politics of Gender Identity," Edwards (1990) picks up a thread from Turkle when he further contextualizes the distinction between "hard" and "soft" mastery. While Turkle equates these forms of computer mastery to masculinity and femininity, Edwards traces these computer techniques through the larger system of American military technology and the modernist impulse for rational control over time and space. In so doing, he moves from the micro, personal scale which Turkle explicitly engages, and into the meso scale of infrastructure and political economy. This approach is repeated in Edwards's later works (1996; 2003).

Each of these highly influential approaches has advantages and disadvantages for STS scholars. Haraway's cyborg metaphor offers a clear and explicit political position. However, the cyborg has been seen by too many as an excuse for celebrations of popular cultural forms. Turkle's approach orients the researcher to the intense interaction between computer user and computer, but this approach is highly atomizing, rendering one largely blind to the greater political economic and social forces which interpolate the user and constrain the machine. Edwards's systems approach is highly useful on the meso- and macro-scales, but when researchers work in this mode, there is a tendency to focus significant attention to the "great men" who bring about structural changes in these systems.

Conclusion

Even after preparing this field statement, I cannot say what the future holds for STS, but I can say that it is a field with a viable future. One indication is the field's strong presence on the Web. STS programs are remarkably adept at creating online spaces for collaboration and collection of information. For example, the STS Wiki[3] is a three year old web project started by Bryan Pfaffenberger, a professor at Virginia Tech's Science, Technology, and Society program. Using the same engine as Wikipedia (Mediawiki), the STS Wiki allows for registered users to post encyclopedia articles, bibliographies, and announcements. Another example is the Society for Social Study of Sciences (4S)'s web collection of syllabi,[4] as well as RPI's Science and Technology program's collection.[5] all of these sites demonstrate that STS scholars are attempting to solidify the field's methodologies, theories, and canon. Compared to more established disciplines, STS does not have a large group of scholars, but that group is very active in trying to define this field and institutionalize it.[6]

Instead of projecting where STS might be heading, I will offer my anticipated uses of this field in my dissertation. I intend to write a cultural and political economy of Web 2.0. Web 2.0 is a term used to describe recent developments in Web applications, such as blogs, video sharing sites, wikis, and social networks. There is significant literature on Web 2.0 as it relates to business and marketing, but very little which places it in the historical context of communications technologies. This is where the issues that STS raises will be useful, guiding me to the following research questions: How do the various actors involved in this technology shape its current formation? What alternative forms were considered, and why were or weren't they adopted? Does this technology contest or reinforce modernity? What are its politics? Can it be used democratically? How is its history reflected in its present?

This research program thus orients me to consider Web 2.0's in the greater historical context of the Internet, which began as a military project and is now a highly contested space where libertarians,

3 Available at http://en.stswiki.org/index.php/Main_Page
4 Available at http://www.4sonline.org/syllabi.htm
5 http://www.sts.rpi.edu/index.php?siteid=20&pageid=284
6 STS does not seem to have the same contradictory feelings about being institutionalized that cultural studies has had.

anarchists, state officials, academics, and entrepreneurs cross paths. The very concept of “Web 2.0” implies improvements and changes to Web applications; the question is: who benefits from these changes? Moreover, why are they proposed? How do they relate to their putative predecessor, the applications of “Web 1.0”? How is the contested modern concept of identity – which has repeatedly been a focus for any examination of the Internet – shaped by social networking sites? How valid are claims about Web 2.0's democratic features? STS, along with my other focus on political economy, provides a valuable framework to answer these questions.

Bibliography

Abbate, J. (1999). Inventing the Internet. Cambridge, MIT P.

Adas, M. (1989). Machines as the measure of men : science, technology, and ideologies of Western dominance. Ithaca, Cornell University Press.

Allen, B. L. (2003). Uneasy alchemy : citizens and experts in Louisiana's chemical corridor disputes. Cambridge, Mass., MIT Press.

Aronowitz, S. (1992). The politics of identity : class, culture, social movements. New York, Routledge.

Aronowitz, S. (1996). Technoscience and cyberculture. New York, Routledge.

Aronowitz, S. and W. DiFazio (1994). The jobless future : sci-tech and the dogma of work. Minneapolis, University of Minnesota Press.

Aronowitz, S. and M. Mesner (1996). On cultural studies, science, and technology. Technoscience and cyberculture. S. Aronowitz, B. Martinsons, M. Menser and J. Rich. New York, Routledge: 7 - 30.

Barnes, B. (1974). Scientific knowledge and sociological theory. London ; Boston, Routledge & K. Paul.

Barnes, B., D. Bloor, et al. (1996). Scientific knowledge : a sociological analysis. Chicago, University of Chicago Press.

Biehl, J. G. (2005). Vita : life in a zone of social abandonment. Berkeley, University of California Press.

Bigge, R. (2006). "The cost of (anti-)social networks: Identity, agency and neo-luddites." First Monday 11 (12).

Bijker, W., T. Hughes, et al. (1987). Introduction. The Social construction of technological systems : new directions in the sociology and history of technology. W. E. Bijker, T. P. Hughes and T. J. Pinch. Cambridge, Mass., MIT Press: 9 - 16.

Bijker, W. E., T. P. Hughes, et al. (1987). The Social construction of technological systems : new directions in the sociology and history of technology. Cambridge, Mass., MIT Press.

Bijker, W. E. (1995). Of bicycles, bakelites, and bulbs : toward a theory of sociotechnical change. Cambridge, Mass., MIT Press.

Bimber, B. (1990). "Karl Marx and the three faces of technological determinism." Social Studies of Science 20: 333 - 351.

Bloor, D. (1973). "Wittgenstein and Mannheim on the sociology of mathematics." Studies in History and Philosophy of Science 4 (2): 173-191.

Bloor, D. (1983). Wittgenstein: a social theory of knowledge. London, Macmillan.

Bloor, D. (1997). Wittgenstein, rules and institutions. London ; New York, Routledge.

Boczkowski, P. J. (2004). Digitizing the news : innovation in online newspapers. Cambridge, Mass., MIT Press.

Bowker, G. C. (2005). Memory practices in the sciences. Cambridge, Mass., MIT Press.

Bowker, G. C. and S. L. Star (1999). Sorting things out : classification and its consequences. Cambridge, Mass., MIT Press.

Carey, J. W. (2008). Communication as culture : essays on media and society. New York, Routledge.

Castells, M. (2000). The rise of the network society. Oxford ; Malden, MA, Blackwell Publishers.

Castells, M. (2002). Global informational capitalism. Global transformations reader: an introduction to the globalization debate. D. Held and A. G. McGrew. Malden, MA, Polity: 311 - 333.

Castronova, E. (2002). "On virtual economies." CESifo Working Paper Series(752).

Castronova, E. (2005). Synthetic worlds : the business and culture of online games. Chicago, University of Chicago Press.

Chandler, A. D. (1977). The visible hand : the managerial revolution in American business. Cambridge, Mass., Belknap Press.

Cockburn, C. (1983). Brothers : male dominance and technological change. London, Pluto Press.

Cockburn, C. (1985). Machinery of dominance : women, men, and technical know-how. London ; Dover, N.H., Pluto Press.

Cockburn, C. (1999). Caught in the wheels: the high cost of being a female cog in the male machinery of engineering. The social shaping of technology. D. A. MacKenzie and J. Wajcman. Buckingham [Eng.] ; Philadelphia, Open University Press: 126 - 133.

Cockburn, C. (1999). The material of male power. The social shaping of technology. D. A. MacKenzie and J. Wajcman. Buckingham [Eng.] ; Philadelphia, Open University Press: 177 - 198.

Cockburn, C. and R. Furst-Dilic (1994). Bringing technology home : gender and technology in a changing Europe. Buckingham [England] ; Philadelphia, Open University Press.

Cockburn, C. and S. Ormrod (1993). Gender and technology in the making. London ; Thousand Oaks, Calif., Sage.

Collins, H. M. (1981a). "Stages in the Empirical Programme of Relativism " Social Studies of Science 11 (1): 3 – 10.

Collins, H. M. (1981b). "Son of Seven Sexes: The Social Destruction of a Physical Phenomenon." Social Studies of Science 11 (1): 33-62.

Collins, H. M. and T. J. Pinch (1993). The golem : what everyone should know about science. Cambridge [England] ; New York, NY, USA, Cambridge University Press.

Collins, H. M. and T. J. Pinch (1998a). The golem at large : what you should know about technology. Cambridge, UK New York, Cambridge University Press.

Collins, H. M. and T. J. Pinch (2005). Dr. Golem : how to think about medicine. Chicago, University of Chicago Press.

Cowan, R. S. (1983). More work for mother : the ironies of household technology from the open hearth to the microwave. New York, Basic Books.

Cowan, R. S. (1985). How the refrigerator got its hum. The Social shaping of technology : how the refrigerator got its hum. D. A. MacKenzie and J. Wajcman. Milton Keynes ; Philadelphia, Open University Press: 202-218.

Cowan, R. S. (1987). The consumption junction: a proposal for research strategies in the sociology of technology. The Social construction of technological systems : new directions in the sociology and history of technology. W. E. Bijker, T. P. Hughes and T. J. Pinch. Cambridge, Mass., MIT Press: 261 - 280.

Dickson, D. (1984). The new politics of science. New York, Pantheon Books.

Douglas, S. J. (1987). Inventing American broadcasting, 1899-1922. Baltimore, Johns Hopkins University Press.

Douglas, S. J. (2004). Listening in : radio and the American imagination. Minneapolis, University of Minnesota Press.

Downey, G. L. (1998). The machine in me : an anthropologist sits among computer engineers. New York, Routledge.

Dyer-Witheford, N. (1999). Cyber-Marx : cycles and circuits of struggle in high-technology capitalism. Urbana, University of Illinois Press.

Eden, L. (2004). Whole world on fire : organizations, knowledge, and nuclear weapons devastation. Ithaca, N.Y., Cornell University Press.

Edge, D., R. Harré, et al. (1997). "Thomas S. Kuhn (18 July 1922 - 17 June 1996)." Social Studies of Science 27: 483 - 502.

Edwards, P. N. (1990). "The Army and the Microworld: Computers and the Politics of Gender Identity." Signs: Journal of Women in Culture and Society 16 (1): 102-127.

Edwards, P. N. (1994). "Hyper Text and Hypertension: Post-Structuralist Critical Theory, Social Studies of Science and Software." Social Studies of Science 24 (2): 229-278.

Edwards, P. N. (1996). The closed world : computers and the politics of discourse in Cold War America. Cambridge, Mass., MIT Press.

Edwards, P. N. (2003). Infrastructure and modernity: force, time, and social organization in the history of sociotechnical systems. Modernity and technology. T. J. Misa, P. Brey and A. Feenberg. Cambridge, Mass., MIT Press: 185 - 226.

Ellul, J. (1964). The technological society. New York, Random House.

Ellul, J. (1980). The Technological System. New York, Continuum.

Epstein, S. (2000). Democracy, expertise, and AIDS treatment activism. Science, technology, and democracy. D. L. Kleinman. Albany, State University of New York Press: 15 - 32.

Fischer, C. S. (1992). America calling : a social history of the telephone to 1940. Berkeley, University of California Press.

Foucault, M. (1970). The order of things: an archaeology of the human sciences. London, Tavistock Publications.

Foucault, M. (1972). The archaeology of knowledge ; and, The discourse on language. New York, Pantheon Books.

Foucault, M. (1978). The history of sexuality; an introduction. New York, Pantheon Books.

Foucault, M. and P. Rabinow (1984). The Foucault reader. New York, Pantheon Books.

Garnham, N. (2004). Information Society Theory as Ideology. The Information Society Reader. F. Webster. New York, Routledge.

Gerovitch, S. (2002). From newspeak to cyberspeak : a history of Soviet cybernetics. Cambridge, Mass., MIT Press.

Giddens, A. (1991). Modernity and self-identity : self and society in the late modern age. Stanford, Calif., Stanford University Press.

Giddens, A. (2003). The globalization of modernity. The global transformations reader. D. Held and A.

G. McGrew. Malden, MA, Blackwell: 60 - 66.

Giere, R. N. (1993). "Science and Technology Studies: Prospects for an Enlightened Postmodern Synthesis." Science, Technology, & Human Values 18 (1: Theme Issue: Technological Choices): 102 - 112.

Greenberg, J. M. (2008). From BetaMax to Blockbuster : video stores and the invention of movies on video. Cambridge, Mass., The MIT Press.

Gusterson, H. (2004). People of the bomb : portraits of America's nuclear complex. Minneapolis, University of Minnesota Press.

Haraway, D. J. (1991a). The actors are cyborg, nature is coyote, and the geography is elsewhere: postscript to 'cyborgs at large'. Technoculture. C. Penley and A. Ross. Minneapolis, University of Minnesota Press: 21 - 26.

Haraway, D. J. (1991b). Cyborgs at large: interview with Donna Haraway. Technoculture. C. Penley and A. Ross. Minneapolis, University of Minnesota Press: 1 - 20.

Haraway, D. J. (1993). The bio-politics of a multicultural field. The "Racial" economy of science : toward a democratic future. S. G. Harding. Bloomington, Indiana University Press: 377 - 397.

Haraway, D. J. (1999). Modest_Witness@Second_Millennium. The social shaping of technology. D. A. Mackenzie and J. Wajcman. Philadelphia, Open U P: 41 - 49.

Haraway, D. J. (2004). A manifesto for cyborgs: science, technology, and socialist feminism in the 1980s. The Haraway reader. New York, Routledge: 7 - 45.

Harding, S. G. (1991). Whose science? Whose knowledge? : thinking from women's lives. Ithaca, N.Y., Cornell University Press.

Harding, S. G. (1993). The "Racial" economy of science : toward a democratic future. Bloomington, Indiana University Press.

Hayden, C. (2003). When nature goes public : the making and unmaking of bioprospecting in Mexico /

Cori Hayden. Princeton, Princeton University Press.

Hayden, C. (2005). "Bioprospecting's Representational Dilemma." Science as Culture 14 (2): 185 - 200.

Hecht, G. (1998). The radiance of France : nuclear power and national identity after World War II. Cambridge, MA, MIT Press.

Heilbroner, R. L. (1967). "Do machines make history?" Technology and Culture 8: 335-345.

Hodges, A. (2000). Alan Turing : the enigma. New York, Walker.

Hughes, T. P. (1969). "Technological Momentum in History: Hydrogenation in Germany 1898-1933." Past and Present 44: 106 – 132.

Hughes, T. P. (1983). Networks of power : electrification in Western society, 1880-1930. Baltimore, Johns Hopkins University Press.

Hughes, T. (1987). The evolution of large technological systems. The Social construction of technological systems : new directions in the sociology and history of technology. W. E. Bijker, T. P. Hughes and T. J. Pinch. Cambridge, Mass., MIT Press: 51 - 82.

Hughes, T. (1991). Technological momentum. Does technology drive history? L. Marx and M. R. Smith. Cambridge, MA, MIT P: 101 - 114.

Jasanoff, S. (1990). The fifth branch : science advisers as policymakers. Cambridge, Mass., Harvard University Press.

Jasanoff, S. (1995). Science at the bar : law, science, and technology in America. Cambridge, Mass., Harvard University Press.

Jasanoff, S. (2002). "Citizens at risk: Cultures of Modernity in the US and EU." Science as Culture 11 (3): 363 - 380.

Jasanoff, S. (2004). States of knowledge : the co-production of science and social order. London ; New York, Routledge.

Jasanoff, S. (2005). Designs on nature : science and democracy in Europe and the United States. Princeton, N.J., Princeton University Press.

Jenkins, H. (2004). "The Cultural Logic of Media Convergence." International Journal of Cultural Studies 7 (1): 33-43.

Klawiter, M. (2008). The biopolitics of breast cancer : changing cultures of disease and activism. Minneapolis, University of Minnesota Press.

Kleinman, D. L. (2000). Science, technology, and democracy. Albany, State University of New York Press.

Kroker, A. (1996). Virtual capitalism. Technoscience and cyberculture. S. Aronowitz. New York, Routledge: 167 - 180.

Kroker, A. and M. A. Weinstein (1994). Data trash : the theory of the virtual class. New York, St. Martin's Press.

Kuhn, T. S. (1962). The structure of scientific revolutions. Chicago, University of Chicago Press.

Latour, B. (1987). Science in action : how to follow scientists and engineers through society. Cambridge, Mass., Harvard University Press.

Latour, B. (1993). We have never been modern. Cambridge, Mass., Harvard University Press.

Latour, B. (1999). Pandora's hope : essays on the reality of science studies. Cambridge, Mass., Harvard University Press.

Latour, B. (2004). "Why has critique run out of steam? From matters of fact to matters of concern." Critical Inquiry 30: 225-248.

Mackenzie, D. A. (1984). "Marx and the machine." Technology and Culture 25: 473 - 502.

Mackenzie, D. A. (1987). Missile accuracy: a case study in the social processes of technological change. The Social construction of technological systems : new directions in the sociology and history of technology. W. E. Bijker, T. P. Hughes and T. J. Pinch. Cambridge, Mass., MIT Press:

195 - 222.

Mackenzie, D. A. (1990). Inventing accuracy : an historical sociology of nuclear missile guidance. Cambridge, Mass., MIT Press.

MacKenzie, D. A. and J. Wajcman (1985). The Social shaping of technology : how the refrigerator got its hum. Milton Keynes ; Philadelphia, Open University Press.

MacKenzie, D. A. and J. Wajcman (1999). The social shaping of technology. Buckingham [Eng.] ; Philadelphia, Open University Press.

Martin, E. (1991). "The Egg and the Sperm: How Science Has Constructed a Romance Based on Stereotypical Male-Female Roles." Signs: Journal of Women in Culture and Society 16 (3): 485 - 501.

Martin, E. (1994). Flexible Bodies Tracking Immunity in American Culture from the Days of Polio to the Age of AIDS. Boston, Beacon Press.

Marx, L. (1964). The machine in the garden; technology and the pastoral ideal in America. New York,, Oxford University Press.

Marx, L. (1988). The pilot and the passenger : essays on literature, technology, and culture in the United States. New York, Oxford University Press.

Marx, L. (1995). The idea of 'technology' and postmodern pessimism. Technology, pessimism, and postmodernism. Y. Ezrahi, E. Mendelsohn and H. P. Segal. Amherst, University of Massachusetts Press: 11 - 28.

Mattelart, A. (2000). Networking the world, 1794-2000. Minneapolis, University of Minnesota Press.

Misa, T. J. (1988). " How machines make history, and how historians (and others) help them to do so." Science, Technology, and Human Values 13: 308 - 311.

Misa, T. J., P. Brey, et al. (2003). Modernity and technology. Cambridge, Mass., MIT Press.

Monk, R. (1990). Ludwig Wittgenstein : the duty of genius. New York, Free Press : Maxwell

Macmillan International.

Noble, D. F. (1977). America by design : science, technology, and the rise of corporate capitalism. New York, Knopf.

Nye, D. E. (1990). Electrifying America : social meanings of a new technology, 1880-1940. Cambridge, Mass., MIT Press.

Nye, D. E. (1994). American technological sublime. Cambridge, Mass., MIT Press.

Nye, D. E. (1997). Narratives and spaces : technology and the construction of American culture. New York, Columbia University Press.

Nye, D. E. (2003). America as second creation : technology and narratives of new beginnings. Cambridge, MIT Press.

Nye, D. E. (2006). Technology matters : questions to live with. Cambridge, Mass., MIT Press.

Penley, C. and A. Ross (1991). Technoculture. Minneapolis, University of Minnesota Press.

Pinch, T. J. (1981). "The Sun-Set: The Presentation of Certainty in Scientific Life " Social Studies of Science 11 (1): 131-158.

Pinch, T. J. (1997). "Kuhn - The Conservative and Radical Interpretations: Are Some Mertonians `Kuhnians' and Some Kuhnians 'Mertonians'?" Social Studies of Science 27: 465 - 482.

Pinch, T. (2001). Does science studies undermine science? Wittgenstein, Turing, and Polanyi as precursors for science studies and the science wars. The one culture? : a conversation about science. J. A. Labinger and H. M. Collins. Chicago, University of Chicago Press: 13 - 26.

Pinch, T. and W. Bijker (1987). The social construction of facts and artifacts: or how the sociology of science and the sociology of technology might benefit each other. The Social construction of technological systems : new directions in the sociology and history of technology. W. E. Bijker, T. P. Hughes and T. Pinch. Cambridge, Mass., MIT Press: 17 - 50.

Rapp, F. (1981). Analytical Philosophy of Technology. Dordrecht, R. Reidel.

Reardon, J. (2005). Race to the finish : identity and governance in an age of genomics. Princeton, Princeton University Press.

Redfield, P. (2000). Space in the tropics : from convicts to rockets in French Guiana. Berkeley, University of California Press.

Rheingold, H. (1993). The virtual community : homesteading on the electronic frontier. Reading, Mass., Addison-Wesley Pub. Co.

Rip, A. (2006). "Folk Theories of Nanotechnologists." Science as Culture 15 (4): 349 - 365.

Rose, N. S. (2007). The politics of life itself : biomedicine, power, and subjectivity in the twenty-first century. Princeton, Princeton University Press.

Rouse, J. (1987). Knowledge and Power: Toward a Political Philosophy of Science. Ithaca, Cornell U P.

Sarewitz, D. (2000). Human well-being and federal science - what's the connection? Science, technology, and democracy. D. L. Kleinman. Albany, State University of New York Press: 87 - 102.

Shapin, S., S. Schaffer, et al. (1985). Leviathan and the air-pump : Hobbes, Boyle, and the experimental life : including a translation of Thomas Hobbes, Dialogus physicus de natura aeris by Simon Schaffer. Princeton, N.J., Princeton University Press.

Shiva, V. (1993). Colonialism and the evolution of masculinist forestry. The "Racial" economy of science : toward a democratic future. S. G. Harding. Bloomington, Indiana University Press: 303 - 314.

Simon, B. (2002). Undead science : science studies and the afterlife of cold fusion. New Brunswick, N.J., Rutgers University Press.

Sunder Rajan, K. (2006). Biocapital : the constitution of postgenomic life. Durham, Duke University Press.

Svensson, F. (1979). The Technological Challenge to Political Theory. The History and Philosophy of

Technology. G. Bugliarello and D. B. Doner. Urbana, U of Illinois P: 294-308.

Swyngedouw, E. (2006). "Circulations and Metabolisms: (Hybrid) Natures and (Cyborg) Cities." Science as Culture 15 (2): 105 - 121.

Thompson, J. (1995). The Media and Modernity: a social theory of the media. Stanford, Calif., Stanford University Press.

Tomlinson, J. (2002). Globalization and cultural identity. Global transformations reader: an introduction to the globalization debate. D. Held and A. G. McGrew. Malden, MA, Polity: 270-277.

Traweek, S. (1988). Beamtimes and lifetimes : the world of high energy physicists. Cambridge, Mass., Harvard University Press.

Traweek, S. (1993). Cultural differences in high-energy physics: contrasts between Japan and the United States. The "Racial" economy of science : toward a democratic future. S. G. Harding. Bloomington, Indiana University Press: 398 - 407.

Traweek, S. (1996). When Eliza Doolittle studies 'Enry 'Iggins. Technoscience and cyberculture. S. Aronowitz. New York, Routledge: 37 - 56.

Treichler, P. A. (1991). How to have theory in an epidemic: the evolution of AIDS treatment activism. Technoculture. C. Penley and A. Ross. Minneapolis, University of Minnesota Press: 57 - 106.

Turkle, S. (1995). Life on the screen : identity in the age of the Internet. New York, Simon & Schuster.

Turkle, S. (1999). "Looking toward cyberspace: Beyond grounded sociology - Cyberspace and identity." Contemporary Sociology-a Journal of Reviews 28 (6): 643-648.

Turkle, S. (2005). The second self : computers and the human spirit. Cambridge, Mass., MIT Press.

Turkle, S. and S. Papert (1990). "Epistemological Pluralism: Styles and Voices within the Computer Culture." Signs: Journal of Women in Culture and Society 16 (1): 128 - 157.

Weber, M. (1946). Science as a Vocation. From Max Weber: Essays in Sociology. H. H. Gerth and C.

W. Mills. New York, Oxford U P: 129-156.

Webster, F. and R. Blom (2004). The information society reader. London ; New York, Routledge.

Winner, L. (1977). Autonomous technology : technics-out-of-control as a theme in political thought. Cambridge, Mass., MIT Press.

Winner, L. (1986). Do artifacts have politics? The whale and the reactor : a search for limits in an age of high technology. Chicago, University of Chicago Press: 19 - 39.

Winner, L. (1986). The whale and the reactor : a search for limits in an age of high technology. Chicago, University of Chicago Press.

Winner, L. and Society for Philosophy and Technology (U.S.) (1992). Democracy in a technological society. Dordrecht ; Boston, Kluwer.

Winner, L. (1996). "Shattered alliances in science and technology studies." Social Text(46/47 - Science Wars): 81 - 91.

Wittgenstein, L. and A. Kenny (2006). The Wittgenstein reader. Malden, MA ; Oxford, Blackwell Pub.

Zabusky, S. E. (1995). Launching Europe : an ethnography of European cooperation in space science. Princeton, N.J., Princeton University Press.

Zuboff, S. and Dr. Aliza Kolker Collection. (1988). In the age of the smart machine : the future of work and power. New York, Basic Books.