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The Compelling Tangle of Modernity and Technology

Thomas J. Misa

Schiphol Airport, November 21, 1999. I'm checking in, heading home, answering questions. "Please step this way, I have a few things to ask you. . . . Did you pack your own bags this morning? Has a stranger given you anything to carry? Where were you staying in the Netherlands? I *do* need to see your passport." I decide to give straight answers, even if the smiling young woman—officially, I suppose, with the full power of the Dutch nation-state behind her—soon enough goes way beyond the script of ensuring safe travel. "How many days did you stay? What were you doing here?" Stay calm, I think. This is no concrete-and-barbed-wire interrogation, even if she still has my passport. I'm on friendly and familiar terrain. Schiphol is an unmistakably human-made space, beautiful in its way. Bright painted steel-framed ceilings high overhead, a wall of windows spotless as only the Dutch can make them, the quiet hum of air conditioning, the periodic clunk of baggage conveyors, the pleasant babble of a thousand people on their journeys. Five minutes ago I arrived on a sleek electric train, whose bulb-nosed profile still calls to mind the classic shape of a Boeing 747. So Claire's next question—I've sneaked a peak at her name tag—takes me off-guard. "This workshop you were at, I don't understand, what *exactly* do you mean by 'modern' and 'technology'?" Well, I say, look around you.

Is there anything more assertively modern and more thoroughly technological than an airport? Airports—we might equally think of harbors, subways, skyscrapers, automobiles, telephones, or the Internet—are deeply implicated in the social and cultural formations deemed "modern" by the founding fathers of social theory. Can you imagine an anthropologist of any "traditional" society doing his or her fieldwork on some exotic ritual in which 300 strangers willingly line up to be crowded into a narrow cylinder-shaped space, placed in seats so close their shoulders touch, and strapped down for hours on end? And they *pay* for this privilege!

Yet the airport ritual is a common experience of contemporary life, and more to the point, it embodies and enacts certain key features of

modernity. It is not that airports are “new.” Airports provide a technologically mediated instance of the increased interpersonal contact and communication that Emile Durkheim deemed characteristic of modern society. For his contemporary Max Weber, increasing rationalization characterized modern society. Weber’s observations on German civil servants ring surprisingly true for airports.¹ Any sizable airport in the world has check-in counters, boarding passes, security and surveillance systems, indexical location schemes, English-language signs, and a high degree of time consciousness. Checking in at Portland, Oregon, one learns that Lagos, Nigeria, has failed its international safety inspection. The sign might as well say: you are entering a space of global standards.

As theorists of modernity, Marx and Engels shared with Weber a faith in the rationalization of society (in the sense of technological “progress” as well as growing social awareness of the process of change). Yet even though they misread the capacity of capitalism to avoid the cataclysms of revolution, Marx and Engels grasped the crucial point that modern economies, societies, and cultures are fundamentally about unremitting and unceasing *change*—in their memorable image, “all that is solid melts into air.”² This insight historicizes the “great divide” that theorists from Francis Bacon forward to Bruno Latour (1993) have used to separate the modern world from the premodern world that it supposedly supplanted.³ If you accept the divide and the terms used to describe it—traditional and modern, *Gemeinschaft* and *Gesellschaft*, lifeworld and system, Self and Net—you cannot help but put airports on the “modern” side.⁴ “Those marvelous flights which furrow our skies” were among the soul-inspiring “tangible miracles of contemporary life” identified and celebrated by the Italian Futurists, the primordial theorists of aesthetic modernism.⁵ Not bad for a painters’ manifesto penned within a year of Louis Blériot’s first cross-channel flight in 1909.

If one goal of this volume is to examine modernist icons such as airports, harbors, train stations, mechanical clocks, automobiles, pharmaceuticals, and surveillance and information technologies in the light of social theory, another goal is to consider them at the same time explicitly as technologies. In popular discourse technologies often appear as “black boxes,” fixed entities that irresistibly change society and culture. However, the contributors to this volume want to understand

them instead as embodiments of human desires and ambitions, as solutions to complex problems, and as interacting networks and systems. Social theories that assume static categories of “technology” and “society” or that presume technologies are always coercive structures are of scant help.⁶ Technologies interact deeply with society and culture, but the interactions involve mutual influence, substantial uncertainty, and historical ambiguity, eliciting resistance, accommodation, acceptance, and even enthusiasm. In an effort to capture these fluid relations, we adopt the notion of co-construction.⁷

In compelling ways, airports combine transportation, production, and consumption, activities that we usually think of as being conducted in railroads, factories, and stores.⁸ Think for a moment of your favorite airport not merely as a way of leaving town but as a rational factory with countercurrent flows of raw materials and products: departing and arriving passengers; food, beverages, and lavatory waste; jet fuel and pollution. Airports are in fact not only the location of electrical systems, ventilating systems, water systems, and communication systems, among others; they are also nodes in road and rail networks. Airports are created by, and in their day-to-day functioning depend on, the integration of these numerous systems. They are “systems of systems” or, as some theorists put it, second-order technological systems (Braun and Joerges 1994).

Solutions to the unique spatial problems of airports and other systems of systems often take novel forms and entail social and cultural changes. Sometimes what is important is a physical coupling of technologies; you can see this in the invention of jetways, which bridge the dangerous space between the check-in counter and the airplane’s door, and which emerged at Amsterdam’s Schiphol and Chicago’s O’Hare airports around 1960. Equally important are the nonphysical couplings that occur through a welter of communication and control systems guiding the flow of passengers, ground traffic, and airplanes. One might say, on an abstract level, that airports process information.⁹ Recently, as more and more airports have become display sites for luxury goods, they have displaced the shop windows of the metropolis and serve as a new site of modernism as consumption.

These transport, communication, and merchandising technologies have created a “modern” experience, and they serve as one long argument for

a technological framing of modernity. Airport authorities, like railroad companies before them, seem to understand their culture-making power intuitively and act on it instrumentally. The experience they create is not always, as the founders of the modern movement in architecture had hoped, spiritually satisfying. In our own time, what better display of a banal and homogenized global economy is there than a quick stroll through the enticements of “airport culture”? How can you decide (even if you are merely going to Cincinnati) between Motorola cell phones, Komatsu earth-moving equipment, or Mannesmann engineering? Perhaps you try to escape the blare of CNN by retreating to an authentic “local” airport bar?

The impossibility of escaping this tangle of technology and modernity is our volume’s point of departure.

Forget retreating to some mythical nontechnological past of small farms and happy peasants. Modern society—whether aspiring East or industrialized West, wealthy North or resentfully poor South—is constituted, in varied ways, through technological systems and networks. These systems and networks not only are the “connective tissues and the circulatory systems” of the modern economy,¹⁰ they also constrain and enable social and cultural formations. Birthing babies, educating children, exercising citizenship, going to work, eating and drinking, visiting with distant friends and family, maintaining health or combating sickness, even dying—these human experiences are all mediated by technology. We cannot responsibly escape this condition of modernity, and we need ways to confront it constructively.

In this respect most existing approaches to the “problem of technology” leave much to be desired. Habermas’s elegant opposition of “lifeworld” and “system,” and the legion of philosophers, critics, and commentators who have followed his lead, takes you straight to dead ends or to despair. As humans we identify deeply with lifeworld, but as inhabitants of a modern world we are enmeshed in systems. As scholars and citizens we have no choice but to wrestle with the cultural formations and technological systems that together constitute modern society. “Our fate is worked out here as surely as on Heidegger’s forest paths,” as Andrew Feenberg phrases our contemporary dilemma (Feenberg 1999a: p. 197). Our volume takes up this pressing task.

Proposal One: The concepts “technology” and “modernity” have a complex and tangled history.

For more than a century “modernity” has been a key theoretical construct in interpreting and evaluating social and cultural formations. What it means to be “modern,” however, is by no means clear. The term is bound up with overlapping and controversial notions about the imperatives of change and progress, of rationality and purposeful action, of universal norms and the promise of a better life.

Let us start at the present and dig down through the layers of sedimented meaning. In common speech, “modern” is often a synonym for the latest, and it is assumed inevitably the best, in a triumphant progression to the present. Contemporary designers, as Herbert Muschamp has recently observed, imaginatively draw a modernist veil over such varied products as computers, personal organizers, so-called designer drugs, cyber-prosthetics, and interior designs. “As expressions of The New, these products have inherited the myth of progress, modernity’s defining legend.”¹¹ The legend of progress through a parade of technologies, which has especially deep roots in American culture, forms a stock-in-trade for contemporary advertising.

The tie between modern technology and social progress was much in the minds of “modernists” in the early twentieth century. In Thomas Hughes’s (1989) formulation, Americans invented modern technology in the early twentieth century, while European artists and architects, inspired by Americans’ electric systems, automobile factories, and managerial organizations, theorized the “modern” movement. For Walter Gropius and Le Corbusier no less than for Frederick Taylor or Henry Ford, the values of order, regularity, system, and control constituted modernism. Inspired by the creative possibilities of new technologies such as electricity, automobiles, and mass-produced steel and glass, avant-garde artists and architects argued that modern forms were an authentic expression of the new machine age, and a necessary agent for progressive social change.

Among the well-known icons of modernism theorized by Europeans were the Futurists’ city planning schemes and “dynamic” art, Le Corbusier’s rational “machine for living,” and the sleek rectilinear International Style architecture of Mies van der Rohe and Walter Gropius.

These early twentieth century modernists were “technological fundamentalists” who embraced a messianic vision of societal transformation and spiritual redemption through the embrace of technology. In effect, they floated their aesthetic modernism on the deeper currents of socio-economic modernization (Banham 1986; Smith 1993; Trommler 1995).

Modernism in literature and poetry also drew on the technological dynamism of the age, especially the urban experience and the cinema, although its theorists were less likely to admit explicitly technical inspiration (Berman 1982; Tichi 1987; Charney and Schwartz 1995; Charney 1998; Harootunian 2000b).¹² Another expression of these mythic ideas was modernization theory in social science, which posited a deterministic link between technology, industrial growth, and desirable social and cultural changes (see later discussion).

Digging deeper, we can locate alternative and complementary conceptions in the various revolutions of the seventeenth and eighteenth centuries that were deemed to have ushered in the modern age: the scientific revolution, the Enlightenment, the consumer revolution, and the industrial revolution.¹³ For Francis Bacon in 1620, it was printing, gunpowder, and the compass “which were unknown to the ancients” and which had “changed the appearance and state of the whole world.”¹⁴ Along with the physical embodiments of progress, rationality, and science in iconic technologies such as steam engines, laboratories, factories, and prisons, the habits of mind associated with mechanical metaphors are key interpretive notions. In this vein Lewis Mumford (1934) famously argued that the defining symbol of the industrial age was not the steam engine but the mechanical clock, while Otto Mayr (1986) contrasted continental Europeans’ preoccupation with clock metaphors with British preferences for feedback mechanisms in politics and technologies. Recently, a small scholarly industry has grown up relating science, standards, and state formation in early modern Europe.¹⁵ Some, delving yet deeper, find a defining departure from traditional society in the acquisitive economy of the early modern town.¹⁶ For that matter, declaring a “modern” period in history was a polemical act that defined who was “in” and who was “other.”

On balance, the single most influential touchstone for modernity theorists is the Enlightenment, with its affinity for rationality and social

progress. Miles Ogborn, in *Spaces of Modernity*, writes: “[A]gainst the backdrop of the Enlightenment, modernity is associated with the release of the individual from the bonds of tradition, with the progressive differentiation of society, with the emergence of civil society, with political equality, with innovation and change. All of these accomplishments are associated with capitalism, industrialism, secularisation, urbanisation and rationalisation.”¹⁷ (In like measure, postmodern critics target these very same articles of faith.) In various ways, to conjure up “modernity” is to summon a noisy carnival of historical actors and images.

Technology also cannot be defined statically since its nature and meaning have shifted over time. In etymology, “technology” refers to a body of knowledge about the useful arts. It was this sense that prevailed, in the physical form of handbooks and written knowledge about the useful arts, from the Renaissance well into the industrial era. Even Jacob Bigelow, the Harvard professor whose *Elements of Technology* (1831 [1829]) is typically cited as introducing the term into popular English, used “technology” mostly in the sense of the useful arts or accumulated knowledge. “We traverse the ocean in security, because the arts [sic] have furnished us a more unfailing guide than the stars,” he wrote, “We accomplish what the ancients only dreamt of in their fables; we ascend above the clouds, and penetrate into the abysses of the ocean.” (In his chapters Bigelow described such “useful arts” as writing, printing, painting, sculpture, modeling, and casting as well as materials, machines, and processes.)¹⁸ Technology, as a *set* of devices, a complex of industries, or as an abstract force in itself, had yet to appear.

Other modernist key words, including “scientist,” “socialism,” and “capitalism” were coined around the 1830s, and as Raymond Williams has observed, such loaded terms as “industry,” “class,” and “culture” emerged in the surrounding decades. Put another way, Karl Marx’s famous observation that the culture of the working class was a product of modern technology and industry could not have been expressed, at least in English, before the mid-nineteenth century. The word “technology” took on something like its present meaning—abstract and culture-changing, systemic and symbolic—only after midcentury. “Technology” as Bigelow himself told his audience in 1865 at the newly founded and aptly named Massachusetts Institute of Technology (MIT), “in the

present century and almost under our eyes . . . has advanced with greater strides than any other agent of civilization.”¹⁹

Proposal Two: Technology may be *the* truly distinctive feature of modernity.²⁰

This volume takes up the task of reintegrating the close empirical study of technology with broader theoretical reflections on modernity. The drive to professionalize, itself a characteristic of the modern era, helps account for the enormous gap between empirical studies of technology and theoretical reflections on modernity that has persisted for a generation or more. No such gap can be found in writings by the founding fathers of social theory and technology studies. Marx’s scathing critique of the orthodox political economists of his day focused on their blind ignorance of the social processes of industrialization. And in Friedrich Engels, who for years actively managed and came to jointly own his father’s Manchester cotton factory, Marx had an unusually well-informed critical source on industrial capitalism. Weber similarly argued for a historically and empirically grounded analysis of society. Lewis Mumford, a founding father of technology studies, was deeply informed by his philosophical commitment to organicism. For all these authors, theoretical reflections are bound up with empirical studies.

Oddly enough, the “modern society” that has emerged in the writings of social theorists and philosophers in the past several decades has been a theoretical construct that is surprisingly devoid of technology. Theorists of modernity frequently conjure a decontextualized image of scientific or technological rationality that has little relation to the complex, messy, collective, problem-solving activities of actual engineers and scientists.²¹ Technology, abstractly, dominates humans. In representative formulations Heidegger writes of “enframing” (*Gestell*) and Horkheimer emphasizes “the domination of instrumental rationality.” Ellul in his work floated the notion of a boundless, omnipotent, and deterministic “technique.” And Habermas, as Feenberg (chapter 3 in this volume) writes, “has elaborated the most architectonically sophisticated theory of modernity without any reference at all to technology.”

These theorists of modernity invariably posit “technology,” where they deal with it at all, as an abstract, unitary, and totalizing entity,

and typically counterpose it against traditional formulations (such as lifeworld, self, or focal practices). Heidegger followed such an abstract, macro-level conception of technology and concluded that the rationalization of modern society (inescapably) leads to humans being caught in technology's grip. "Agriculture is now the mechanized food industry, in essence the same as the manufacturing of corpses in gas chambers and extermination camps, the same as the blockade and starvation of nations, the same as the production of hydrogen bombs," he wrote in 1949. In the end, he famously despaired, "only a god can save us now" from this technology-driven juggernaut.²²

Yet one central finding of this volume is that such despair, however elegantly arrived at, is certainly misplaced. Whether modernist or, as discussed later, postmodernist, these overaggregated approaches cannot help us discern the *varieties* of technologies we face and the *ambiguities* in the technologies that we might exploit.²³ Abstract, reified, and universalistic conceptions of technology obscure the significant differences between birth control and hydrogen bombs, and blind us to the ways different groups and cultures have appropriated the same technology and used it to different ends. To constructively confront technology and modernity, we must look more closely at individual technologies and inquire more carefully into social and cultural processes.

To be fair, empirical students of technology who have this detailed understanding have been instinctively antagonistic to the broad-scale interpretive schemes offered by social theory and philosophy, including reflections on modernity. The 1970s were something of a watershed. At more or less the same historical moment that postmodern theorists boldly asserted that information, media, and communication technologies had brought about a new, postmodern society, most empirical students of technology took hostile aim at all such "technological determinist" schemes.

In their detailed empirical studies, historians, sociologists, and many anthropologists of technology aimed to deconstruct the process by which a given technology supposedly imposed its logic on society. An early target was Marx's famous line in *The Poverty of Philosophy* (1847, chap. 2): "The hand-mill gives you society with the feudal lord; the steam-mill society with the industrial capitalist." In combating such technological determinist arguments, the empirical students' chosen

method was to reconstruct in great detail the social and political choices that conditioned how technologies were invented, chosen, or deployed. The “logic of technology” invoked by modernist and postmodern theorists alike simply vanishes in these detailed micro-level accounts.²⁴

A concise way of making the same point is to say that while philosophers and social theorists asserted the “technological shaping of society,” historians and sociologists countered with the “social construction of technology.” For years, these groups just talked past each other.²⁵ One can see, of course, that these rival positions are not logically opposed ones. Modern social and cultural formations are technologically shaped; try to think carefully about mobility or interpersonal relations or a rational society without considering the technologies of harbors, railroad stations, roads, telephones, and airports; and the communities of scientists and engineers that make them possible. At the same time, one must understand that technologies, in the modern era as in earlier ones, are socially constructed; they embody varied and even contradictory economic, social, professional, managerial, and military goals. In many ways designers, engineers, managers, financiers, and users of technology all influence the course of technological developments. The development of a technology is contested and controversial as well as constrained and constraining.

The central aim of this volume is to grasp both perspectives—the social construction of technology and the technological shaping of society—and to develop new intellectual frames by which to comprehend them. Indeed, we argue that theories of modernity at the macro level must engage the detail, ambiguity, and variety of technology evident at the micro level of empirical analysis. Theories of modernity that lack a reasonable and robust account of technology are hopelessly hollow. At the same time, we take seriously the criticism that empirical work on technology too often offers little more than instances of messy complexity without a larger aim in sight.²⁶ In proposing the *co*-construction of technology and modernity as our methodological point of departure, we emphatically reject the idea that either technology or modernity alone can be used as a template to “explain” the other. In different ways, the chapters in this volume problematize both “modernity” and “technology.”

Proposal Three: Modernization theory missed what was modern about technology.

Some readers may inadvertently assume that we wish to revive the social-scientific “modernization theory” that was popular in the 1950s and 1960s. Quite the contrary. Advocates of modernization theory, under the sway of rationalistic and universalistic models, sought to define and measure a single path leading from traditional societies to modern ones. Modernization theorists with a flair for policy advice capitalized on the political context of the Cold War, as the two superpowers competed for the hearts and minds of the developing world (recall that Walt Rostow’s famous *Stages of Economic Growth* [1960] was subtitled *A Non-Communist Manifesto*). Historical indexes of industrial production, education, literacy, and other “factors” deemed important in the successful industrialization and modernization of North America and western Europe were quickly transformed into policy targets for the developing world. Unfortunately, what appeared to work for England in the nineteenth century was often a disaster for many developing countries in Asia, Africa, and Latin America in the later twentieth century. Modernization theory can be a compelling object of study, but it offers few useful tools for understanding technology and modernity.²⁷

As I noted earlier, the word “technology” took on its contemporary meaning—in the twin sense of a complex of industrial systems and a dynamic force bringing about social change—well into the industrial era. Leo Marx (1994) suggests that it was the railroad systems and the elaboration of other complex mechanical and industrial systems in the late nineteenth century that gave rise to something approximating our contemporary understanding of technology. Ruth Oldenziel (1999) also locates the emergence of our contemporary understanding of the term in the two decades before and after 1900, focusing on the male identity of the American engineering community. In these decades, it was continent-spanning railroads; electric lighting and communications; immense bridge, dam, and skyscraper constructions; and sprawling factory complexes like Henry Ford’s that captured the public’s imagination and seemed to change culture. In the middle of the twentieth century, synthetic chemicals, mass automobility, and atomic power ushered in a new era. Today, such heavily hyped visions as pervasive computing, wireless

communication, genetic engineering, or nanotechnology capture the imagination and, at least for their visionary promoters, promise an endlessly better future. These culture-changing technologies have been at the core of modernity because their presence and their promoters' promises have seemingly offered proof of the modernist storyline that society is incessantly changing, ever progressing, transcending frontiers without an end in sight.

Yet, then as now, the symbol-making technologies, and the set of culture-changing expectations their promoters create, are only part of the modern story. Like the users of most technological systems, as travelers we hardly notice the dozens of technologies knitted together at an airport. They are unexamined black boxes whose internal characteristics we notice only when they fail.²⁸ This apparently smooth, silent functioning of networks of networks, or systems of systems, constitutes an infrastructure of daily life, choreographing the members of modern societies in an intricate routine. Technology, then, in its relations with modernity, is not only symbol making and culture changing but also, in the infrastructure of daily life, society constituting.²⁹

Proposal Four: Postmodernism no less and no more than modernism is tangled up with technology.

For many writers, modernity refers to a specific historical period, beginning sometime during the succession of scientific, industrial, and political revolutions considered to usher in the modern age, and which lasted through at least the middle of the twentieth century. Some authors furthermore distinguish "classic," "high," "low," or "late" modernity (Harvey 1989; Lash and Friedman 1993; Scott 1998). Although their terminology is by no means clear, postmodern theorists argue that modern society has been superseded by a postmodern one. Postmodernism in architecture can be understood as a revolt from the formalism and minimalism of modernist, International Style architecture, and can be dated rather precisely with the publication in 1966 of Robert Venturi's *Complexity and Contradiction in Architecture*. While Mies van der Rohe preached that "less is more," Venturi's postmodern stance is that "less is a bore."

Postmodernism in social theory is similarly a revolt, from the project of Enlightenment. As Michel Foucault (2000: p.273) phrased the

dilemma, “the Enlightenment’s promise of attaining freedom through the exercise of reason has been turned upside down, resulting in a domination by reason itself, which increasingly usurps the place of freedom.” But while postmodern skyscrapers literally stand next to modernist ones, modernist and postmodernist writings are not easily compared. Many postmoderns deliberately deploy alternative narrative forms—rejecting as a point of principle linear cause-and-effect relationships, formal logic, and rational argument. Writers informed by poststructuralist sympathies, while not adopting a specific postmodern theory of society, often utilize nontraditional writing styles—rejecting the objective third person and taking up multiple narrative voices.³⁰

It is too little appreciated that most postmodern theorists repeat the modernist mistake of conceiving technology as a universalistic force. A defining distinction for many postmodern theorist-critics is that modern society has changed into a postmodern society with distinctive cultural forms. Yet looking closely at what brought about this cultural transformation, one finds a well-worn argument hinging on technology: post-Fordist manufacturing technology, media technology, communication technology, and especially computer and information technology. From this volume’s viewpoint, these technologically determinist theories—common to many modernists and postmodernists alike—simply miss the theoretical salience of technology. It is in the details of technology, and not its macro-level abstractions, that one can escape the (various) traps that Heidegger, Ellul, Lyotard, Borgmann, and others have set for themselves.

Given our media-saturated culture, it is alarming to find so little empirical discussion of modern media technologies. An apparent exception to this pattern of neglect, Jürgen Habermas’s media studies, turns out upon close inspection to be an analysis of an abstract concept of media. The gap between theories of media and empirical studies of media technology is all the more unfortunate in that Susan Douglas (1987, 1995, 1999), Lisa Gitelman (1999), and others have demonstrated that the *history* of media technologies really matters, not least in who dominated which media when—and where the media have served countervailing, even oppositional social formations. Even Foucault’s famous reading of Bentham’s Panopticon is hardly the last word on that historic technology.³¹

This volume is informed but not captured by the fractious debates in recent decades between modernists and postmodernists. All contributors take seriously the methodological problems raised by postmodernists (such as essentialism, foundationalism, and determinism), and many adopt poststructuralist sympathies. As noted earlier, however, the problematic of this volume—which departs from and extends this debate—is a focus on relating theories of modernity (and postmodernity) to empirical studies of technology. Until now, the work done on this problem has been suggestive but episodic.

Perhaps the most compelling use of postmodernist and modernist themes in technology studies is Sherry Turkle's exposition of rival computer aesthetics.³² In the mid-1990s she found that users of IBM-DOS personal computers (PCs) tended to use modernist images in their effort to understand and relate to their machines (Turkle 1995). These users wanted detailed understanding and absolute control over their machines. Far from being irritated by the need to set dozens of parameters just to plug in a modem, they praised their machines' operational transparency and conceptual openness.

By contrast, users of Apple Macintoshes often used postmodernist images in describing their machines. Early Macs were literally factory-sealed beige boxes that not only frustrated users eager to know what was "going on inside" (you needed a special factory tool just to open them) but also discouraged reductive understanding and detailed control. Whereas PC users found satisfaction in controlling their machines directly, by typing inscrutable computer codes at the "command line," few Mac users ever experienced this level of their machines. Instead of plumbing their machines' conceptual depths, Mac users surfed the conceptual "surface" of their machines with mouse clicks, windows, and icons. (Needless to say, Turkle's neat dichotomy is considerably clouded by the rise of mouse-enabled and windows-savvy PCs as well as transparent iMacs that show off their insides, not to mention the "command line" to Unix within Macintosh's latest operating system.)

Contributors to this volume come from several disciplines and theoretical traditions, but we all share a conviction that comprehending technology and modernity is a compelling theoretical, practical, and political problem. In moving from the international workshop we held

at the University of Twente, the Netherlands, in November 1999, to this volume, the editors have selected eight essays, commissioned four new ones, and asked each author to develop three levels of analysis. The volume as a whole, and nearly all the essays in it, suggests and exemplifies relations between theory, methodology, and empirical research. Our goal is not only to illuminate the co-construction of technology and modernity but also to develop ways of moving across various levels of understanding.

The papers in part I, “Modernity Theory and Technology Studies,” are methodological pieces concerned with description and analysis. Philip Brey, Andrew Feenberg, and Barbara Marshall take up various disciplinary angles (respectively, technology studies, philosophy, and sociology). Each of their essays reflects on the interactions between technology and either modern socioeconomic structures or modern notions of culture, ideology, or identity. Brey and Feenberg have a predominantly methodological orientation in that they focus on the question of how to combine modernity theory and technology studies, and how to deal with different levels of analysis. Marshall exemplifies a way of integrating feminist and critical theory with technology studies, while raising methodological issues.

Philip Brey’s chapter offers a wide-ranging interdisciplinary survey of theoretical and methodological issues in bringing together modernity studies (e.g. Marx, Weber, Habermas, Heidegger, Giddens, Beck, Latour, Castells) and technology studies (sociology and history of technology), including a perspective on postmodern theory (including Harvey, Jameson, Baudrillard, Lyotard). He develops the co-construction theme, which jointly problematizes modernity and technology, first by discussing disciplinary and philosophical obstacles to analyzing technology and modernity together, and then by developing methodological proposals for surmounting these obstacles. Feenberg aims similarly at “bridging the gap” by diagnosing the philosophical and methodological gaps and overlaps between technology studies and modernity theory. Using Thomas Kuhn and Karl Marx as exemplars of these two traditions, and gathering together complementary strands in their respective bodies of work, he then develops a synthetic “instrumentalization” theory, introduced in his recent *Questioning Technology* (Feenberg 1999a).

Barbara Marshall's chapter continues her work in combining critical theory with feminist theory (Marshall 1994, 2000). She surveys these theoretical constructs with an eye to developing methodological prescriptions for the empirical analysis of technology. Even more so than Feenberg and Brey, she combines her theoretical comments with detailed empirical discussion. Her illustrations of what she terms the "gender-technology-modernity nexus" include the feminist-inspired sexual assault evidence kit as a forensic technology and the pharmaceutical framing of erectile dysfunction with Viagra. "[T]here is no point at which technology and modernity are not joined in some way in the production of sexual bodies," she finds. While the conjunction of technology and human might call to mind Donna Haraway's postmodern notion of cyborg bodies, Marshall finds more compelling the "distinctively modernist framing shared by the scientists, pharmaceutical companies, physicians, and consumers."

Part II, "Technologies of Modernity," continues the methodological discussion with a focus on the co-construction theme. These essays, however, examine particular sociotechnical systems or technologies with prominent symbolic and material relations to modernity. These include the Internet, surveillance, infrastructures, and western technologies in China and Japan. Don Slater's essay deals with the Internet and its varied uses by Trinidadians to grapple with global modernity, while David Lyon's deals with the technologies of surveillance and their relation to modernist and postmodernist cultural formations. Paul Edwards, building on his work in computer history, proposes a wide-ranging interpretation of modernity and infrastructure technologies. Junichi Murata, drawing on contemporary Japanese philosophy, revisits and interprets the influx of western technologies into China and Japan during the late nineteenth and early twentieth centuries.

Don Slater's essay, drawing on his investigations of the Internet and Trinidad (Miller and Slater 2000), illustrates perfectly the co-construction theme. He insists that neither technology nor modernity can be taken as global, totalizing, or unitary. Even "context," if we assume it to be a fixed entity, may mislead: "the context of a technology is also partly a consequence of that technology; it is produced by the very 'thing' one is trying to put into it." As with much good ethnography, Slater's work challenges

and problematizes our conceptual categories. He asks, for instance, what is constant about the categories “modernity” and “technology” when Trinidadians use the Internet—itsself an amalgam of email, chat rooms, World Wide Web (WWW) sites, intranets, and e-commerce—to participate directly and actively in global modernity (by linking up and sharing technical capabilities with world-leading North American technology companies) but also use email to sustain traditional family functions (such as mothers nagging daughters, often at a significant physical distance, about staying out too late)?

Yet Slater’s chapter is not principally an exercise in category crashing, since he proposes reconstructing the “big picture” from his theoretically aware ethnography. To this end, he offers four “dynamics”—objectification, mediation, normative freedom, and positioning—as methodological heuristics which would make sense of both the Internet and modernity “in a wide range of different places,” and which might “allow us to ask intelligent questions about the similarities and differences in peoples’ responses to new communication possibilities.” His framework also has the valuable feature of highlighting actors’ agency in and perceptions of “modernity.”

“Modernity is in part constituted by surveillance practices and surveillance technologies,” observes David Lyon in his chapter. Lyon is concerned to show the deep historical relation of surveillance technologies and modern societies, with their functions of taxing, policing, and providing welfare, as well as producing and consuming goods and services linked to the state’s routine monitoring of individuals. Yet what most intrigues him about surveillance is the shift he discerns beginning in the 1960s with extensive computerization of surveillance in the capitalist workplace and modern nation-state. Equal in importance to new hardware, he emphasizes, are the practices of data matching between government departments as well as the outsourcing of government functions to private firms. These changes have brought about, not the centralized “Big Brother” that haunts the Orwellian imagination, but perhaps just as ominously, a decentralized network of databases that facilitates national and international flows of personal data.

For Lyon these shifts embody a shift away from classical modern society and toward a condition of “postmodernity . . . where some aspects of

modernity have been inflated to such an extent that modernity becomes less recognizable as such.” People are still under scrutiny, he observes, but less as citizens of the modern nation-state and more as workers and consumers, often in a globalized economy. (He notes that the Internet company Engage tracks the Web-surfing patterns of more than 30 million individuals.) Postmodernity as a social formation involves “widespread and deepening reliance on computers and telecommunications as enabling technologies, and an intensification of consumer enterprises and consumer cultures.”

Finally, anticipating the normative bent of part III, Lyon considers how co-construction itself is a technology-making process. Consider privacy advocates. “The ad hoc practices of organizations as well as the self-conscious political stances of those who question and resist encroaching surveillance are inextricable elements of that co-construction process,” he maintains. While lobbying the more-or-less centralized nation-state on privacy concerns has been an effective way of changing laws and thus altering surveillance technologies and practices, it is vastly more difficult to exert meaningful influence when confronting contemporary surveillance that is “networked, polycentric, and multidimensional.” In this way Lyon, while aware of practical limits to effecting change in a polycentric world, echoes Feenberg’s advocacy of democratic rationalization as a strategy for affecting sociotechnical change.³³

In directing our attention from “new” to mature technologies, Paul Edwards subtly enlarges the co-construction theme with his consideration of infrastructures. The order, regularity, predictability, and stability of modernity, he argues, “fundamentally depend on” the presence and mostly silent functioning of mature technological systems—cars, roads, municipal water supplies, sewers, telephones, railroads, weather forecasting, even most routine uses of computers. At the same time, he writes, the “ideologies and discourses of modernism have helped define the purposes, goals, and characteristics of those infrastructures.” Technology and modernity, to repeat the theme, are co-constructions.

Showing how these co-constructions occur, and developing a methodology for understanding these processes, are the goals of Edwards’ chapter. Reviewing the SAGE early-warning military system in the 1950s and the ARPANET/Internet system beginning in the 1970s, and retelling the

narratives from several perspectives, he shows how these infrastructures link varied scales of force, time, and social organization. Edwards, like Slater, finds that the “same” technology can seemingly possess contradictory characteristics, yet he goes beyond this telling observation by providing a method to grasp the varied effects of technologies. Edwards develops and illustrates a typology of scales ranging from the detailed micro, through intermediate meso, to the aggregated macro level. Then, to comprehend seemingly contradictory phenomena occurring at different scales, Edwards offers the concept of “mutual orientation.”

Junichi Murata’s chapter is deeper and more subtle than it may appear at initial approach. At first, his essay appears to be a straightforward discussion of the technology studies literature, essentialism in philosophy, and a comparison of modernization processes in Japan and China. One should appreciate, however, that Murata is seeking to engage technology studies with modern Japanese philosophy—an effort that Feenberg does for the critical theory tradition (see Feenberg 1986, 1995, 1999a, 2002). For both, as philosophers, the point is exploring the overlaps, contradictions, and extensions of the two (once-separate) literatures. To this end Murata offers an interpretation of the modern Japanese philosopher Nishida, focusing on his notions of the “otherness” of technology, an exposition of “reverse determination,” and a discussion of the natural and human worlds.

By embedding his discussion of empirical cases of modernization within Japanese philosophy, Murata arrives at results that will be at once familiar and fresh. The “otherness” of technology is not a takeoff on the feminist Other, but rather an exploration of the unplanned, often unforeseeable, noninstrumental and nonrational aspects of technology. (These “creative” aspects of technology are also a concern in Khan’s chapter.) The transformation of the Internet from a military tool to a commercial medium, or the reconception of automobiles as speed machines, are instances of creativity in the *use* of technology. Murata suggests that this feature should be called “creative” because “a new meaning for artifacts is realized.” That the results may go against the original intent of designers and producers agrees solidly with the “user heuristic” in technology studies (see Fischer 1992; Borg 1999; Oudshoorn and Pinch forthcoming).

Murata further develops his ideas through examples drawn from the wrenching modernization that Japan experienced in the years following the Perry mission in 1853. On the one hand, Murata fully grasps that Japanese elites saw little option but to import and master such western technologies as telegraphs, railroads, and military equipment—and to adopt western institutions and ways of life that were consonant with industrialization and modernization. All the same, as hinted by the slogans “Japanese spirit and western technology” and “Enrich the country, strengthen the army,” Japan thoroughly industrialized and modernized in these years, but did not clearly westernize. Murata provides tantalizing evidence for this proposition in a detailed comparison of western, Chinese, and Japanese mechanical clocks and the persistence of indigenous conceptions of time.

While the essays in parts I and II are mostly concerned with description and analysis of existing or historical conditions, the essays in part III, “Changing Modernist Regimes,” shift attention to practical and political matters. These chapters provide a normative critique of modernity and technology as unitary, totalizing, and universal by suggesting alternative modes of developing technology or, indeed, alternative modernities.³⁴ In their discussion of alternatives, the chapters in this section also offer original and substantial critiques of technology policy, medicine, environmental technology, and international development.

In his chapter, Johan Schot accepts the broad framework of modernization as a way to analyze the various structural changes in western societies since the eighteenth century, but uses it to criticize the “modernist technology politics” that developed during this era. While a classic modernist account might point at “progress” in dealing with social conflict about technology, or the increasing acceptance of technical rationality, or the emergence of an autonomous technical realm, Schot instead emphasizes that a modernist technology politics emerged under a continual cloud of contestation. In the early industrial era, there was little separation of “technical” criteria from broader social and cultural considerations; the Luddites in England, in his view, knew precisely that certain machines embodied a dangerous worldview and moved to destroy them. By comparison, he finds the discourse of technology dissent much impoverished by the early twentieth century. In a classic “men versus machines” set

piece—a two-year conflict over mechanizing the unloading of grain at Rotterdam Harbor—the working-class critics of the machines failed to find alternatives to mechanization while their socialist leaders even supported job-destroying mechanization.³⁵ Schot's diagnosis is that by accepting the terms of modernist technology politics, which has split a unified problem into separate "promotion" and "regulation" realms that are frequently in conflict, we have lost the ability to have reasoned discussion and dialogue on these vital matters.

Drawing on Beck and Giddens, Schot is guardedly optimistic about the prospects of a "reflexive modernization." He presents a case study of recent Dutch attempts to integrate technical and political decision making, which should be compared with Hughes's (1998) discussion of Boston's Central Artery project and Khan's discussion of a positive feedback loop innovation structure (see chapter 12). Critics of the grandiose expansion schemes of Schiphol Airport in the late twentieth century have succeeded in slowing and shifting the airport's grand march into the future by preemptively buying needed land and forcing the airport to build a state-of-the-art train station. However, a persistent divide between "promoters" and "critics" has poisoned dialogue between the parties, led to substantial mistrust, and left both sides disillusioned and angry. To go beyond this modernist stalemate, Schot proposes a fundamental reform of design processes using the criteria of anticipation, reflexivity, and social learning.³⁶

David Hess develops a broad three-part framework to explore the practical, political, and theoretical implications of the rise of "complementary and alternative" medical therapies. His long-term viewpoint, informed by the anthropology-inspired frameworks of cultural ecology, cultural values, and political economy, and his claim that the political economy of technology and modernity needs to be situated far beyond the past 500 years, will challenge readers presuming a "recent" view on modernity. He contrasts orthodox allopathic, science-based medicine with alternative therapies such as acupuncture, herbal remedies, and chiropractic, and finds a conceptually puzzling (if practically popular) result. In a simple narrative of the "triumph" of modern science in medicine, bitter conflict "ought" to occur between alternative therapies, which are often based on belief systems antithetical to "modern"

reductionist science, and orthodox medical practices. But something more intriguing has happened. While orthodox medical doctors have been “surprisingly” open to alternative therapies—after all, the therapies frequently work, even if their underlying biomedical mechanisms are unclear—at the same time the mainstreaming of alternative therapies has brought about their acceptance through insurance payments and licensing rights.

Hess departs from a conventional technology-studies framing of these issues (for instance as alternative rationalities) with his insistence on a “broader terrain of shifts in environmental consciousness and disease ecology.” As with Mol’s chapter that follows, Hess takes Beck’s “risk society” seriously. He also considers the understudied notion of “technological pluralism,” a parallel to medical pluralism, as a way to conceptualize the tensions between the local and the global, patterns of domination and resistance, and relations between “normal” and “alternative” technologies.³⁷ Yet these analytical or methodological observations, important in themselves, are a means for Hess to spotlight the “deep normative question about the kind of global material-social world that should be co-constructed.” These problems, he concludes, “require both empirical research and normative debate.” He proposes sustainability, equality, and community as “three major criteria that provide viable points of reference for a general discussion of technological and social redesign.”

Arthur Mol’s chapter on ecological modernization focuses attention on how modernity is understood and deployed by *actors* in the realm of politics and policy making. In the environmental field, the understandings of modernity and the actions based on them are changing, he reports. For decades, environmentalism was antimodern; to be an environmentalist was to be against capitalism, industrialism, modern science and technology, and the bureaucratic nation-state. In the past 15 years, however, the landscape of “green” philosophical positions has become far more complex and decidedly less hostile toward modernity. Mol surveys four positions in these environmental debates—neo-Marxists, demodernization or counterproductivity theorists, postmodernists, and reflexive modernization advocates—but his underlying concern is to situate the rise of “ecological modernization” as both

a philosophy and a set of political and policy-making strategies (see Mol 1995; Hajer 1996).

As a theory, ecological modernization has deep affinities with Beck's and Giddens' writings on reflexive modernization and the risk society (see Beck 1992; Beck et al. 1994). Both ecological and reflexive modernization are philosophies positing the imperative of fundamental change in society (to deal with the environmental and risk crises, respectively) absent a requirement for radical social transformation. Specifically, the advocates of ecological modernization view the "institutions of modernity, not only as the main causes of environmental problems but also as the principal instruments of ecological reform." Scientific researchers, technology developers, industrial corporations, and the nation-state are at once part of the problem and part of the solution, and are themselves changing in response to environmental problems. For example, in the growing "autonomy" of the environmental sector (where environmental functions are institutionalized within and across governments, businesses, and nongovernment organizations, or NGOs), itself a classic symptom of modernization, the role of the nation-state is transformed. And while changes in the content of the sciences, for instance "soft chemistry," have thus far been more speculative than practical, changes in business have been substantial, meaningful, and fundamental. Businesses, especially in the European chemical sector Mol reviews, are using environmental criteria to shape their business strategies, to prioritize technological choices, and to relate to environmentally conscious consumers.

Yet Mol's objective is not to lay out a "global" theory, as Beck is sometimes criticized for attempting. Rather, he uses ecological modernization to evaluate both sectoral and regional variations in business and society. Surveying how this highlights environment-induced transformations in modern social practices and institutions, Mol enumerates five key heuristics of ecological modernization—for example, the contributions of science and technology to environmental reform, the increasing importance of market dynamics and economic agents, and the transformations of the modern "environmental state," along with the rise of new ideologies, practices, and discourses for the environmental movement. These heuristics, while valuable in framing research for analysts, are also used by policy actors as "normative paths for change."

Focusing principally on Europe, he reviews and evaluates changes in the chemical industry over the past 15 years as the industry has introduced new environmental management functions and activities, new products, and new relationships among its members and with governments and NGOs. As Mol observes, from the viewpoint of ecological modernization, “all ways out of the ecological crisis will lead further into modernity.”

The entwined “path dependence” of modernity and technology is also a central concern for Haider Khan. Khan’s chapter begins with a careful and critical discussion of “methodological aspects of connecting theories of modernity with empirical approaches in the context of technology and development.” Yet for Khan, as for Schot, the principal concern is to identify the limits imposed by a modernist framing of technology and development and to explore a rigorous conceptual model for moving forward and beyond the modernist impasse. Indeed, both of their chapters use Beck and Giddens’ rather abstract notion of reflexive modernization as an entry point for their real-world discussions.

Khan’s principal aim is to critique the modernist framing of development policy and to develop his own, holistic model (a POLIS). Targeting the modernist framing of development, especially the influential national innovation systems (NIS) model, which has focused narrowly on economic measures, he advocates instead a multidimensional “capabilities” approach (drawing on the work of Amartya Sen and Martha Nussbaum), insisting that human capabilities should be understood as enhancing a “complex” notion of freedom and that technology developments are central in realizing human capabilities. While “technology as freedom” is too often loosely theorized,³⁸ Khan’s specified criteria and constructive stance make it clear that he is seeking a fundamental change in development policies and practices. In a stance that resonates with Feenberg’s democratic rationalization and Mol’s ecological modernization, Khan is embracing technology as a powerful means to enhance societal development.

Stories of development schemes gone awry are, alas, common enough. Instead, Khan critically analyzes one of the “success” stories, Taiwan, and especially its top-down, modernist, national-innovation-system model of development. Even though the country succeeded beyond its planners’ wildest dreams in the worldwide export of computer components, Khan nonetheless finds Taiwan lacking in a range of fundamental

human capabilities. The corporate economy boomed while democracy, among other human capabilities, languished. The path-dependent paradox is that the country's "very success in exports may have forced the Taiwanese companies to seek a closure that largely excludes their domestic constituencies." In the end, Khan inquires into the conditions at the national, regional, and city levels that might bring about an alternative POLIS model of development that is "cognizant of the complex interactions among technology, economy and polity . . . [and] emphasizes the teleological desideratum of equalizing social capabilities as the end of development."

Still at Schiphol Airport, my fellow travelers have long gone to their gates. "OK, yes, I can see the point about technology and modernity now. I've been working here at Schiphol only a few months, and it is quite a place. Sounds like a nice workshop. Is there a chance you can send me the papers?" Yes, of course, I tell Claire. At long last she explains that she is a Ph.D. student in medieval history, and that she works part-time as a security guard in the airport to make ends meet. Working in both a premodern field of history and a thoroughly modern airport, she is making her own journey through the compelling tangle of modernity and technology. Finally I see the point of her questions. "Can you give me your address?" I ask. "I'll send you the essays. But I need to go now, my flight home is leaving soon." "Of course. Have a pleasant journey. Here's your passport."

Acknowledgments

I am grateful for specific comments on this essay from Mikael Hård, Nil Disco, Henk van den Belt, and the MIT Press reviewer of this volume. More generally, this essay serves as a long-term reflection on a Mumford-cluster seminar on technology and modernity at the University of Twente that I had the good fortune to co-organize with Johan Schot and Pieter Tijmes during the spring of 1997. I appreciate feedback on earlier versions from the Center for Science and Technology Studies at Trondheim, Norway, and the Humanities Colloquium at Illinois Institute of Technology.

Notes

1. For studies of technology and modernization processes directly inspired by Durkheim and Weber, respectively, see Fischer (1992) and Hård (1994). For

studies adopting a loosely theorized “agents of modernity” approach, see Rose (1995), Tobey (1996), and Kline (2000).

2. For expositions of modernity *as* change, see Berman (1982), Lash and Friedman (1993), and Charney (1998).

3. A parallel argument is made by Adas (1989), who observes that Europeans’ perceptions of cultural superiority over African, Indian, and Chinese peoples were a product of the technical superiority they believed opened up in the course of industrialization.

4. Similar binary opposites figure prominently in recent discussions on the latest manifestation of “global modernity,” i.e., globalization: Jihad and McWorld (Benjamin Barber), Lexus and olive tree (Thomas Friedman). Of course, one need not accept any “great divide” and the modernist assumptions it entails. In fields as diverse as science studies, history of technology, and the “new” (post-Chandler) business history, scholars in the past two decades or so have adopted a determinedly skeptical approach to the very core of the modernist paradigm: facts and rationality. The solid “facts” of science, technology, and capitalist business, it turns out, are not so solid and indeed are shot through with contingencies and compromises. For this reason, these scholars tend to reject (or ignore) any formulation (like Habermas’s) separating system and lifeworld, science and society, rationality and practice. For examples of the “new” business history, see Scranton (1997) and Sabel and Zeitlin (1997). The field of technology studies is addressed later as well as by Brey and Feenberg in this volume.

5. Umberto Boccioni et al., “Manifesto of the Futurist Painters,” at <www.futurism.org.uk/manifestos/manifesto_02.htm> (13 July 2002). On “technological fundamentalism,” see Trommler (1995) and Todd (2001).

6. For criticism of social theorists’ approaches to technology that are essentialist, reified, or deterministic, see Feenberg (chapter 3) and Brey (chapter 2). For social theories with a more interactive and fluid conception of technology and society, see Bourdieu’s notion of *dispositif* and Giddens’ notion of the duality of agency and structure: Bourdieu and Wacquant (1992) and Giddens (1979, 1984). I thank Mikael Hård for the latter suggestion.

7. For recent studies exploring the co-construction of technology and modern culture in a variety of settings, see Mayr (1986), Overy (1990), Nye (1990), Nolan (1994), Misa (1995), Edwards (1996), Alder (1997), Brooks (1997), Charney (1998), Hecht (1998), Schatzberg (1999), Gitelman (1999), Slaton (2001), and Allen (2001).

8. For the historical evolution and multifunctionality of Schiphol Airport, see Mom et al. (1999).

9. As if to underscore its role as an information processor, Chicago’s O’Hare Airport just retired a signature artifact of the mid twentieth century, a three-bladed DC-6 propeller whose springiness and surface texture you could physically engage. The airport filled the space occupied by the propeller with a bank of pay-by-the-minute Internet-linked computer workstations.

10. See Edwards' essay in this volume.
11. Herbert Muschamp, "A Happy, Scary New Day for Design," *New York Times* (15 Oct. 2000). <www.nytimes.com/2000/10/15/arts/15MUSC.html> (17 Oct. 2000).
12. The modernity of cities, city life, and city planning, from St. Petersburg to New York, and from Brasília to Chandigarh, is a prominent theme of Berman (1982), Ward and Zunz (1997), Scott (1998), Driver and Gilbert (1999), and many other authors.
13. There are varied approaches to modernity in the seventeenth and eighteenth centuries; for science, see Whitney (1986), Toulmin (1990), and Iliffe (2000); on consumption, see Clunas (1999); and for the economy, see de Vries and Woude (1996).
14. Francis Bacon, *Novum Organum* (1620), aphorism 129, cited in Eisenstein (1983: p. 12).
15. On science, standards, and state formation, see Porter (1995), Wise (1995), Alder (1997), and Scott (1998).
16. Conceptions of modernity can be located much earlier in human history; see Hess's chapter in this volume.
17. Miles Ogborn, *Spaces of Modernity* (p. 10), quoted in Porter (2000: p. 488, note 10).
18. I consulted Bigelow's second edition of 1831 (Jacob Bigelow, *Elements of Technology*, Boston: Hilliard, Gray, Little and Wilkins, 1831; 2nd ed., p. 4.) First printed in 1829.
19. For discussions of Bigelow and "technology," see Segal (1985: pp. 74–97, quote on p. 81) and Oldenziel (1999: pp. 9–26). Oldenziel argues forcefully that technology took on its modern sense, as an abstract and gender-bound concept, only in the years after 1865. She cites (p. 195, note 8), for instance, the founding of institutes and colleges of "technology" e.g., Massachusetts (1861), Stevens (1870), Georgia (1885), Clarkson (1896), Carnegie-Mellon (1912), and California (1920).
20. I think this volume comes close to operationalizing Leo Marx's call (in an exchange with Mel Kranzberg in *Technology and Culture*, vol. 33 [1992]: 407), "Why not start with the intuitively compelling idea that technology may be *the* truly distinctive feature of modernity? . . . The aim would be to understand all of the ways that technological knowledge, processes, and behaviors in fact distinguish modernity from other ages—other societies and cultures."
21. For a recent evaluation of technological rationality by a well-informed historian of technology, see Constant (2000).
22. Heidegger, quoted in Feenberg (2000a: p. 297, note 3).
23. Discerning these varieties in technologies and exploiting their ambiguities for alternative social formations is the goal of Feenberg's "subversive" or "democratic" rationalization; see Feenberg (1995). Douglas Kellner (2000: p. 236)

also appreciates the pressing need for theoretical approaches that can discern “some of the more positive, but also more ambiguous and enduring features of modernity” and technology.

24. For analysis of technological determinism, see MacKenzie (1984), Sherwood (1985), Misa (1988), Adler (1990), Smith and Marx (1994), and Edgerton (1998). For a well-regarded exemplar attacking technological determinism, see Noble (1984). For Marx’s “handmill” quote <www.marxists.org/archive/marx/works/1847/poverty-philosophy/ch02.htm#s2> (23 April 2002).

25. For apposite instances of Thomas Kuhn’s incommensurability thesis, compare Russell (1986) with Pinch and Bijker (1986) and Winner (1993) with Pinch (1999). In criticizing social constructivism, Langdon Winner (2001: p. 15) states that “the scholarly community in STS is so inward looking that it seems not to notice the glaring disconnect between its own favored theories and the visions of run-away technology that prevail in society at large.”

26. “Putting on boots” is how one of my Dutch philosopher colleagues refers to doing empirical work, which is something like wading through the muck in a cow barn; for his work, he prefers a book-lined study.

27. For historical critiques of modernization theory and development, see Adas (1989: pp. 402–418), Moon (1998), Scott (1998), and Engerman (2000).

28. When I wrote these lines some months before September 11, 2001, I had in mind such “failures” as lost baggage and missed connections. The multiple system failures evident on that day (airport security at Boston, Newark, and Dulles; the tracking systems that lost American Airlines flight 77 en route to the Pentagon; the faulty antihijacking transponders), which substantially contributed to the success of the attacks, have indeed forced the scrutiny of many technologies and practices taken for granted. Conversely, we have heard far less about the striking successes of the air traffic control system, which quickly and effectively shut down U.S. airspace in short order on that date, or the stairwells of the World Trade Center towers that enabled thousands to save themselves. Personally, I can no longer forgive the Futurists’ architectural dictum that “the stairs—now useless—must be abolished.”

29. See Edwards (chapter 7, this volume).

30. For this distinction I am indebted to Barb Marshall, who in her contribution to this volume tries to sort out postmodernism and poststructuralism.

31. On Benthamite reforms in London, see Hamlin (1998) and Linebaugh (1992: pp. 371–401).

32. For other suggestive modern and postmodern readings of technologies, see Rosen (1993) on the global bicycle industry, Duncombe (1997) on IBM and SONY, Marshall (chapter 4, this volume) on sexual technologies, and Lyon (chapter 6, this volume) on surveillance.

33. Feenberg (1995) suggests the notion of a “subversive” or democratic rationalization to encourage would-be reformers to engage rationalization processes, including technological change, and to strive to bend them toward

more democratic outcomes. Rationalization, for Feenberg, can favor dominant power structures and systems, but approached critically, rationalization processes can also enhance nondominant values.

34. The generous notion of “alternative modernities” (see Feenberg 1995; Lash and Friedman 1993; Lash 1999) is more complex than it first appears. While Feenberg uses “alternative” in the specific sense of *opposition to* the dominant (capitalist) rationalization processes (and in favor of a “subversive” rationalization), Lash uses “alternative” in the sense of *neither* the “high” modernists’ embrace of the Enlightenment tradition *nor* the postmoderns’ rejection of the Enlightenment (and in favor of a “reflexive” rationalization). Yet adopting a loose notion of “alternative” drains modernity of its emancipatory and universalizing potential; this has been a contentious issue within feminist scholarship, human-rights debates, and development thinking, as well as in environmental reform (see the chapters by Marshall and Mol in this volume). From a different angle, Harootunian (2000a: p. 163, note 4) firmly declares his opposition to “more fashionable descriptions, such as ‘alternative modernities,’ ‘divergent modernities,’ ‘competing modernities,’ and ‘retroactive modernities,’ that imply the existence of an ‘original’ that was formulated in the ‘West’ followed by a series of ‘copies’ and lesser inflections.” He demonstrates (Harootunian 2000b) that intellectuals in interwar Japan, just as their western counterparts, wrestled with the cultural implications of modern life, including capitalism, cities, and industrialization.

All the same, modernity as a totalizing force should not be overdrawn. Historians studying the industrial revolution have piled up a huge literature on alternative paths to industrial revolution (Sabel and Zeitlin 1985, 1997). Essays in Hård and Jamison (1998) show empirically that in the formative years of the early and mid twentieth century, Europeans did not experience modernity as a single phenomenon; rather, each country absorbed and reinterpreted a global notion of modernity in a nation-specific tradition of discourse.

35. For a detailed treatment of the Rotterdam conflict, see van Lente (1998a,b).

36. On reflexivity and social learning in technology, see Rip et al. (1995: chaps. 2, 7–10).

37. Hess hints at the prescriptive sense of “normal” (rather than in the “mundane but deadly” sense used by organizational sociologist Charles Perrow [1984]). A similar point has been argued by John Staudenmaier (1985: p. 200): “A technological style can be defined as a set of congruent technologies that become ‘normal’ (accepted as ordinary and at the same time as normative) within a given culture. They are congruent in the sense that all of them embody the same set of overarching values within their various technical domains. For example, it can be argued that the United States, beginning with the U.S. Ordnance Department’s 1816 commitment to the philosophical ideal of standardization and interchangeability, gradually adopted a set of normal technologies that incorporate that ideal. From this point of view many distinct technological developments—the machine tool tradition, the growth of standardized and centrally

controlled rail systems, the centralization and standardization of corporate research and development, the use of consumer advertising to program individual buying habits, the increasing centralization and complexity of electricity and communications networks, etc.—can be interpreted as participating in a single style, embodying a specific set of values within a specific world view.”

38. For a loose formulation of “technology as freedom,” see Tobey (1996). Sen (1999) provides a more rigorous formulation of “development as freedom.”