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Cultural Origins and Environmental Implications of Large Technological Systems

The Argument

This essay argues that a prime source of contemporary technological pessimism is the loss of place that accompanied the conquest of space through the construction of large technological systems of transportation and communication. This loss may involve physical destruction, or it may involve the more subtle withdrawal of economic, political, and cultural meaning and power from localities in favor of these far-flung systems.

The argument proceeds in five stages. First, key terms are defined, notably "environmental damage" and "technological system." Second, the origins of the modern ideology of circulation are traced in the development of a capitalist world-economy, and in the historical theories of Enlightenment *philosophes* (with special attention to Turgot and Condorcet). Third, possible relations between that ideology and nineteenth-century systems-building are briefly sketched. Fourth, the ambiguous political character of these systems — at once liberating and constraining — is noted. Finally, the cultural challenge of overcoming spatial alienation is described with reference to some late nineteenth-century writers who sought to trace new pathways both spatially and linguistically.

> We erect our structure in imagination before we erect it in reality.
> Karl Marx, *Capital,* cited in Harvey 1989, 345

Environmental Damage as a Source of Technological Pessimism

A major source of "technological pessimism" today is the sense that we live in a ruined world. We are all aware of the scientific evidence that environmental systems are being altered in potentially dangerous ways — for example, the

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ever-enlarging ozone hole over the poles or the one-half degree Celsius rise in global temperature over the last century. For many of us, though, the most troubling indications of environmental damage lie not in the abstractions of scientific data but in the more visible evidence of personal experience. Any American of the 1990s has watched the relentless encroachment of office parks, malls, houses, and highways on familiar fields and pastures. The intrusion of the machine into the garden has been followed by that of the syringe on the beaches, the smog in the valley, the sewage in the river. Few of us well understand, much less empathize with, environmental models. We apprehend nature not as a system but as a place — and the ruin of beloved places tells us, in images more powerful than any data, that we live in a fallen world.

To be sure, this sense of living in a ruined world is by no means new. Medieval Europeans viewed their earthly home through the lens of the Christian conviction that the natural world, like natural man, is tainted by sin. As late as the 1680s, in his *Sacred Theory of the Earth,* Thomas Burnet described how the once paradisiacal earth had been transformed by human disobedience into a "hideous ruin," "a dirty little planet." We think of ourselves as moderns, but our "environmentalism" often echoes such despair. We too perceive our worldly home as ruined and desecrated, and we too assume there is a connection between our fallen nature and nature's fall. As we survey our planetary home, we see everywhere the marks of our failures and crimes. What we call "technological pessimism" is far more than a bad mood. It is a profound spiritual crisis, as we see in the landscape the consequences of our own sin.

In what sense, though, is this pessimism "technological"? How is technology implicated in the modern fall of nature? Is environmental ruin an accidental and therefore correctable by-product of technological development, or is it an inherent and inevitable result? Are we pessimistic about mistakes of technology or, in a much more fundamental way, are we pessimistic about technology itself?

To address these questions we must begin by distinguishing two types of environmental damage: pollution and development. Pollution is chemical or physical degradation that damages the ecosystem so it becomes less supportive of human and other forms of life, although this damage may be invisible. Pollution may therefore be considered an unintended and correctable consequence of technological change. There may be disagreement about levels of risk to life forms, but in principle the risks can be measured objectively and addressed through scientific and technological means.

Development, on the other hand, while it may not render any physical or chemical damage to the ecosystem, alters the visible landscape in a significant way. Unlike pollution, the effects of development are not in principle measurable by scientific standards; they are always mediated by culture. A highway that for one person is an emblem of modernity seems to another a gash on the landscape. As a consequence, while pollution is in principle correctable through technological means, development is not. Technology cannot correct a problem if it is itself

perceived as the problem. (See the vigorous discussion of the concept of development in Berman 1982.)

When we talk about environmental problems, we habitually lump together pollution and development — a conflation that can lead to confusion in politics and policy.[1] For the purposes of this paper, however, the two are distinguished. The prime importance of the distinction is to clarify our thinking about technology as a source of environmental damage. In matters of pollution, nature is considered an environmental system; in matters of development, a visible landscape. These two views of the environment are in turn related to two different types of technological systems, which also tend to be confused and also need to be distinguished.

In the past decade or so, historians of technology have increasingly relied on the concept of the *system*, rather than that of the *machine* or the *invention* (or *inventor*) as the central category of analysis. Because much of the theorizing about technological systems has been done by social scientists, these systems are often defined as sociological models, as systems "socially constructed" to transform energy and materials into goods and services for human consumption. In this context, human labor, with the aid of machinery, "consumes ecosystemic energy flows in the process of performing physiological and mechanical work" (Cronon 1990). A classic example is the "American system" or, more narrowly, the "Fordist system" of automobile production. The definition of such manufacturing systems includes much of what used to be called "social context" — management techniques, modes of labor control, even techniques of mass consumption (Harvey 1989, chap. 8, 125–40). Even natural "actors" may be considered part of the system in three ways: as resource, as sociologized actor ("cooperating in" or "resisting" its role), and as dumpsite (see Langdon Winner's critique of the "social construction of technology" approach in Winner 1991).

Besides manufacturing systems, however, there are also connective systems of technology, organized not for primary production but for the circulation of goods, ideas, or people. To be sure, in the economic process there are no firm boundaries separating production, circulation, and consumption. Connective systems are obviously interdependent with manufacturing ones, since the latter require the former (e.g., the railways that carried steel to Ford plants and the phone lines that carried orders there), while communication may fruitfully be interpreted as a form

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[1] Contemporary public discourse about environmental problems focuses on pollution, and the rhetoric is consequently of global models, scientific evidence, and invisible but insidious threats. On the other hand, private discourse often laments the loss of beloved places — the meadow turned into a mall, the city neighborhood cut through by an expressway. Being based on an assumption of property rights, the American legal system recognizes the public discourse of pollution but not the private discourse that may value beauty and community over property rights. As a result, the quasi-scientific discourse of pollution regularly has to be used in legal efforts to resist development that may be unwanted primarily for cultural reasons. The construction of a shopping mall may be fought in court on the basis of the pollution of groundwater caused by runoff from the parking lot, when the more compelling objection to it has to do with the desecration of the meadow.

of production (Williams 1980, 50–63). Still, the distinction points to the existence
of two broadly different types of engineering practice — mechanical and civil
engineering — and two broad types of engineering products — machines and
structures.[2]

Furthermore, the distinction highlights two rather different ways of thinking
about engineering. The concept of manufacturing systems, as we have seen, is
often treated as a sociological construct in which a number of radically different
entities — technological, human, and biological — are related as abstract social
actors. From this perspective, nature is "denatured" by being assimilated into what
is fundamentally a social system. The language of biology may be used to describe
"inputs," "outputs," and "flowthroughs," but these are used as metaphors in
reference to a fictitious superorganism, the system.[3]

The concept of connective systems on the other hand is primarily
phenomenological rather than sociological. These constructions are tangible
structures existing in geographical space, and their components are related
primarily in physical rather than in social terms. When engineering involves the
creation of such structures, it looks more like a "mirror twin" of landscape
architecture or of urban planning than of science. Technological systems of
connection therefore bear a markedly different relationship to nature than do
manufacturing systems. In the creation of structures, nature is understood
primarily as *space,* and the system as a *means of organizing space.* Nature is not a
means to the creation of a product, unless one interprets the "product" in this case
as the creation of a second nature, of a cultural landscape from the given physical
one. "In the cultural landscape man 'builds' the earth, and makes its potential
structure manifest as a meaningful totality" (Norberg-Schulz [1979] 1980).[4] In
analyzing technological systems of connection, then, the language of cultural
geography is more appropriate and useful than the vocabulary of sociology.

According to cultural geographers, the main elements of the cultural landscape
in both the rural and the urban environment are *centers* or settlements of differing
scale (houses, villages, cities) and *pathways* connecting the settlements (ibid., 10,

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[2] David P. Billington has complained that historians of technology have been preoccupied with
machines — devices that are often short-lived, relatively mobile and ubiquitous, and largely
independent of their environmental context — at the expense of constructions, which are highly
visible, massive, permanent, slow to evolve, and site-specific. As examples of machines, Billington
mentions pumps, turbines, television sets, and motors; structures are roads, bridges, terminals, dams,
harbors, waterworks, power plants, office towers, and public housing blocks (Billington 1974, cited in
Borgmann 1984, 66; see also Billington 1978, esp. pp. 149–53).

[3] According to Carolyn Merchant, "The dominant paradigm in ecology draws heavily on economic
metaphors such as producers, consumers, productivity, yields, and efficiency. Nature is cast as a
computerized network of energy inputs and information bits that can be extracted from the
environmental context and manipulated according to a set of thermodynamic equations." The value
of instrumental reason, the need for unimpeded circulation, the need for expertise — all these
now-familiar themes are currently being applied to natural systems as well as to technological ones
(Merchant 1989, 9).

[4] The term "second nature," derived from Hegel and Marx, is revived by William Cronon in
Cronon 1991.

52).[5] Heidegger put it even more succinctly when he said that the two basic constructions are dwellings and bridges (Heidegger 1971, 152–53). The category of technological structures thus includes two distinct subsets: architectural structures (skyscrapers, for example) that organize space by creating settlements or places, and connective structures that organize space by creating pathways, which are actual or metaphorical roadways.

The outstanding feature of the modern cultural landscape is the dominance of pathways over settlements. In the city, the central element in modern urban organization is the street or highway, as opposed to the square, market, forum, or particular buildings. Outside the city, the dominant element of organization is the roadway — whether actual roads such as "strips" or interstate highways, or other transportation and communication networks such as railway lines and electric power lines (Jackson 1980, 122). Engineering the landscape — like any act of engineering — is a process that both reflects and defines human values and relationships. What human values and relationships are represented in the cultural landscape of the late twentieth century, especially in the dominance of pathways over settlements?

Many students of American history and culture would argue that the high value placed on mobility — freedom of movement for people, goods, and ideas — is particularly and prototypically American. In his opening chapter to *Brooklyn Bridge,* Alan Trachtenberg reminds us that the oldest of all the ideas associated with America was that it was a road to elsewhere — a passage to India. "To many, roads fulfilled fervent dreams of the West as a new Garden of Eden, as the long-sought passage to the Orient." From the early days of the republic, the theme of "manifest destiny" was linked to roadways. While Hamilton and Jefferson may have had different visions of their purpose — Jefferson hoping they would protect the agrarian republic, Hamilton expecting they would promote manufacturing — the two statesmen shared the ideal of "opening up" the West and binding it to the East. Trachtenberg concludes that "not the land, not the garden, but the road, from Jefferson's own national turnpike to the latest superhighway, has expressed the essential way of American life" (Trachtenberg 1965, 9, 21; see also pp. 10–12).[6]

The idea of a "passage to India" may be uniquely associated with America, but the search for that passage, after all, emerged from European culture — as did the Enlightenment values expressed by both Jefferson and Hamilton. The main element of American exceptionalism is not the high value put on mobility but the particular pattern in which mobility was conceptualized. The main lines of the mental map of Americans ran from east to west, the eastern seaboard being

[5] Norberg-Schulz credits Paolo Portoghesi for the term "field," and further explains that a center generates a field when, for example, "a circular *piazza* is surrounded by a concentric system of streets. The properties of a 'field' are hence determined by the center, or by regular repetition of structural properties" (p. 61).

[6] As Trachtenberg notes on p. 15, it was Henry Nash Smith who referred to the passage to India as "the oldest of all ideas associated with America."

identified with the built environment and the West with unfilled open space (Marx 1990, esp. p. 5). Europeans, on the other hand, used a mental map more like a grid, with criss-crossing lines linking capital cities with hinterlands and Europe with the rest of the world. The difference in spatial patterns, while significant, is still less important than the shared, powerful cultural assumption that it is the destiny of the West to promote circulation through technological systems-building.

Tracing the sources of that pervasive cultural assumption is extremely complex, but this essay will attempt to develop some lines of inquiry. One of its primary goals is to demonstrate the significance of the Enlightenment in shaping modern patterns of technological development. "The Enlightenment is known to us primarily as an intellectual and cultural revolution, a breaking of the fetters of religious superstition and ancient dogma," Albert Borgmann has written. "It is generally accepted that [the Enlightenment] had reverberations beyond the realm of culture and the intellect, but these are almost exclusively seen in the political area." Yet it is in the Enlightenment that "the promise of technology" was first formulated — not "at the center of attention" but as "the obvious practical corollary of intellectual and cultural liberation" (Borgmann 1984, 35).

I would go further than Borgmann to argue that Enlightenment *philosophes* were technological determinists, because they assumed that the progress of civilization depended on the construction of technological systems of connection. Most interpretations of the Enlightenment stress the temporal dimension of the idea of progress — that is, progress as a sequence of historical stages culminating in a utopian, or semiutopian, future. In the eighteenth century, it is said over and over, utopia ceased being defined as another place (the distant island, the lost valley) and instead became another time — the future.[7] "In time we shall have utopia"(Manuel and Manuel 1979, 120). But "the Enlightenment project"(Jurgen Habermas' useful term) also has a crucial spatial dimension. The *philosophes* identified the spread of enlightenment with the diffusion of ideas in space through the proliferation and intensification of global systems of communication. Social progress was assumed to depend on construction of connective systems: communication and transportation grids, layer upon layer of roadways for the circulation of people, goods, and ideas. The Enlightenment vision of progress rests upon a powerful *ideology of circulation.*

To be sure, the eighteenth-century concept of progress should not be reduced to that ideology. The *philosophes* understood progress more broadly, as the rational control of nature for human ends; they assumed that such control involved the organization of manufacturing as well as the facilitation of connections (Alder 1991). An ideology of productivity has always complemented that of circulation. In the case of productivity, the capitalist flavor of the ideology is evident. In the case of circulation, however, the relation of the ideology to capitalist economics may be less obvious, but it is no less significant.

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[7] "With Turgot and Condorcet, *eutopia* becomes *euchronia.*" See Kumar 1987, 45.

Circulation: From Economics to Ideology

In a capitalist economy, profit ultimately derives not from the production of goods but from the mobility of money (Braudel [1979] 1982, 138–48). As Karl Marx understood so clearly, the single unitary principle underlying all the changes and insecurities of capital is that of "'value in motion,' or, more simply, the circulation of capital restlessly and perpetually seeking new ways to garner profits" (Harvey 1989, 107). The constant imperative of capitalism, its "elementary determinism," is to increase the rate of circulation (Braudel [1979] 1982, 582). The rate can be increased in time (by reducing the period required to complete the economic circuit) or in space (by extending the net of circulation and therefore increasing the flowthrough). In the early modern period, as a capitalist economy was taking shape, movement in space (rather than location in place) became the key to social reproduction.

The importance of these principles was well understood by early capitalists. The concept of an economic circuit was firmly established in the seventeenth century, when merchants habitually thought of trade routes as completed circuits (Dockès 1969, 424–25). The simplest circuit was the round trip: the journey out, the journey back. Other circuits were more complicated, such as the famous "triangle trade" comprising a voyage from a European port to the coast of Africa, to the Caribbean, and back to Europe. Immanuel Wallerstein has estimated that the circuits of the sixteenth-century European world economy could be completed in about sixty days, using the best available means of transport (Wallerstein 1976, 16). Any technological improvement that could reduce that time, or that would allow a trader to cover more space in sixty days, was highly prized and would yield significant competitive advantage. The "elementary determinism" of capitalism therefore strongly favored technological development in these directions.

Wallerstein's *Modern World System* ([1974] 1976) and subsequent publications are of particular importance in understanding how the spatial arrangements of capitalism differ from those of other, earlier economic systems. The world empires of antiquity were primarily political units. As a means of economic domination they were inefficient because their centralized political structure required a large bureaucracy, which tended to absorb profits. In modern capitalism, however, economic space is distinct from political space. Rather than being organized around one political center, capitalism is organized around a multiplicity of economic centers. With no damage to the overall system, geographical connections can be strengthened or left to decay as the changing flow of capital warrants. Economic surpluses are efficiently directed to the geographic core from peripheral areas without the wastefulness of a cumbersome political superstructure.

Wallerstein's analysis suggests ways in which many modern technological systems differ in their purpose from ancient systems they may resemble externally; for example, Roman roads or aqueducts were built primarily to enforce political authority, not to facilitate the flow of capital. Such systems were impressive but

rigid. In an empire where "all roads lead to Rome," the political core cannot change without the fall of the empire. In modern systems, in contrast, technological construction is less dependent on political boundaries, purposes, and fortunes. To be sure, in the spatial arrangements of the modern world there is constant tension between the political **and economic** organizations of space — between tentacular lines of economic power connecting cores and peripheries, as opposed to blocks representing political power (see the discussion of this tension in Harvey 1989, 109). The "distinctive historical geography" (ibid., 343) of capitalism involves the coexistence of these two types of organization, with the blocks ultimately being subordinated to the lines.

Philosophes such as Turgot and Condorcet emphasized the circulation of ideas rather than of capital — but in its overall structure, the cultural geography of Enlightenment looks the same as the "distinctive historical geography" of capitalism: networks of tentacular lines superimposed on political blocks. As we shall see, Enlightenment *philosophes* considered political boundaries relatively unimportant compared to the lines connecting cultural centers with peripheries. They also stressed the importance of quickening the pace of circulation and of extending its reach through the construction of technological systems. Above all, their ideology of circulation depended on economically based assumptions about knowledge and communication. With some exceptions (most notably Rousseau), the *philosophes* assumed that scientific knowledge is capable of being circulated in the same way as capital: it consists of ideas that are universal counters, the same in all places, independent of personality. As a consequence, they thought of communication as a form of transportation. Knowledge, like merchandise, could be accumulated and bundled in one place, transported to another, and consumed there without any alteration in its essential character.

Fernand Braudel reminds us that "cultures . . . are ways of ordering space just as economies are" and adds the warning, "The cultural map and the economic map cannot simply be superimposed without anomaly" (Braudel [1979] 1982, 65). What is striking about the era of Enlightenment is the way the dominant economic map — "the octopus grip of European trade," in Braudel's words (Braudel [1979] 1982, caption to map on p. 29)[8] — also became the dominant cultural map. The "octopus grip" became both a description of economic reality and also a cultural ideal. In the eighteenth century extended lines replaced the enclosed garden as the dominant image of utopia.

Observing a structural similarity does not explain it: there is no automatic (or semiautomatic) process by which economic practices become represented on a cultural level. An economic system can organize and produce space, but it cannot by itself organize and produce meaning. The production of meaning is the role of culture, and more specifically of ideology. One crucial function of the ideological process is to articulate the meaning of economic practices in terms that give those

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[8] See his general comments on the reception of Wallerstein, pp. 68–69.

practices broad and persuasive social significance. Enlightenment *philosophes* extrapolated an ideology of circulation from the economic sphere to express it as a general theory of historical progress. But in proposing a cultural geography that mirrored the geography of capitalism, Turgot and Condorcet were not only articulating a defense of capitalist practices; they were simultaneously expressing a critique of them, because the cultural map, for all its similarities, was not identical with the economic one. These *philosophes* highlighted the transmission of ideas rather than of goods and emphasized communicative relationships that were not necessarily instrumental in character. While confirming the historical geography of capitalism, they also set forth a vision of social and intellectual liberation that might not coincide with capitalist practices. In this ambivalent and complicated way, Turgot and Condorcet provide the ideological link between the trade routes of early capitalism and the large technological systems of late capitalism.

Circulation and Progress: Turgot

Anne Robert Jacques Turgot (1727–81) has three claims to historical significance: as an economic thinker identified with the Physiocrats; as an administrator, first as an *intendant* in Limoges and later, in his brief (1774–76) but ambitious tenure as minister of finance under Louis XVI; and finally as author of what is "by general agreement the first important statement in modern times of the ideology of progress" (Kumar 1987, 43) — the *Discours sur les progrès successifs de l'esprit humain* (A philosophical review of the successive advances of the human mind) — a speech delivered by Turgot at the Sorbonne in 1750, when he was only twenty-three (Manuel and Manuel 1979, 468; see also pp. 467–81 for a helpful discussion of "Turgot on the future of mind").

Turgot's emphasis on circulation as the engine of progress derives from his economic principles as a Physiocrat. While Turgot always demonstrated a good deal of independence in interpreting those ideas, he did accept the Physiocrats' fundamental emphasis on the unique productivity of land. More specifically, he accepted the belief that land is the only form of production capable of yielding a disposable surplus over necessary costs, and therefore of yielding taxable income (see the helpful discussion by Ronald L. Meek in Meek 1973, 14–27, esp. 26–27; see also Dockès 1969, 295). These principles led Turgot and other Physiocrats to place great emphasis on economic circulation. Precisely because all economic value comes from one source — agriculture — commercial and industrial classes were essentially "paid" by agricultural ones, and as a result the wealth created by agriculture had to be cycled through the entire society as efficiently as possible.[9]

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[9] In his *Tableau économique,* for example, François Quesnay (1694–1774) carefully analyzed various ways of shortening the circuits of revenue from the productive class to proprietors, then to the

With the Physiocrats, then, we can already discern links between an economic theory of circulation, a more general theory of social progress, and a technological program of system building. The Physiocrats thought of economic circuits not as abstract patterns but as physical connections in geographical space. The city-country circuit, being the shortest, was the most important to nurture. The Physiocrats particularly urged the improvement of rural roads that would spread wealth in areas around cities, rather than the construction of roads linking large cities. Leaders of the school such as François Quesnay and Pierre Samuel Dupont de Nemours (who eventually edited Turgot's papers) also urged the state to take a more active role in creating a dense network of canals (Dockès 1969, 277–78, 286).

In his 1750 *Discours,* Turgot extends the principle of circulation from economics to history in general, and from regions and states to the entire globe. He begins by presenting a startlingly novel definition of history. First, history is global: it is the story of "the human race," which to the "eye of a philosopher" appears "as one vast whole." Second, history is intellectual. What really matters are not transient political events (motivated by "self-interest, ambition, and vainglory") but the gradual and enduring enlightenment of the human mind. Turgot connects the spatial and temporal dimensions of history by stating that the slow process of enlightenment proceeds to the extent that "separate nations are brought closer together" (cited in Meek 1973, 40–41).

The rest of the *Discours* elaborates on the civilizing process by which groups of human beings become more enlightened in proportion to their contacts with other groups. Turgot's historical starting point is the original diaspora, the great dispersal of human societies after the failure to construct the Tower of Babel. During the long centuries that followed, human progress depended on spatial contact, as more civilized groups came into contact with less civilized ones, whether through military, economic, or cultural exchanges. Turgot repeatedly uses the language of fluid dynamics — ebb and flow, overflowing rivers, underground streams, deluge and irrigation — to describe the turbulent interactions of these groups.

As Peter Gay points out, for a so-called optimist, Turgot's discourse is notably uncheerful, with its "startling" emphasis on the costs and difficulties of progress (Gay 1969, 110). Again and again, humanity gets stuck in routine and repetition, to be pulled back to the infinitely repeating cycles of nature. Genius appears in one group only to disappear beneath waves of migration. The Greeks enjoy a splendid age but then succumb to internal vices and to invading warriors from the Middle East (Meek 1973, 50). Rome extends the boundaries of the civilized world but then "Roman liberty is extinguished in waves of blood" (ibid., 52). The pattern keeps

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s alaried classes, and back to the cultivators. In the view of Quesnay and other Physiocrats, two things above all were necessary to facilitate the circulation of grain: the suppression of taxes on trade (both internal and external taxes: the Physiocrats were ardent free traders) and the improvement of roadways and canals. Quesnay advised proprietors and local officials as well as the king to use tax revenues on projects that would reduce the price of transport and open new areas to production. He argued that these projects, while initially expensive, would pay off handsomely by providing new markets for rural areas and thus by raising farm prices. See Dockès 1969, 277–78, 286.

repeating: genius emerges in one place, thanks to nature's random distribution of talents, and then "circumstances either develop these talents or allow them to become buried in obscurity; and it is from the infinite variety of these circumstances that there springs the inequality in the progress of nations" (ibid., 43).

The turning points in history are ones that have decisively changed "circumstances" so that humanity could not only innovate, but also accumulate its innovations. These turning points are technological ones — great inventions. The first and greatest, which Turgot mentions at the very beginning of his speech, is language: "The arbitrary signs of speech and writing, by providing men with the means of securing the possession of their ideas and communicating them to others, have made of all the individual stores of knowledge a common treasure-house, which one generation transmits to another, an inheritance which is always being enlarged by the discoveries of each age" (ibid., 41).

Next, the discovery of writing, which "unites places and times," meant that genius, until then at the mercy of local oblivion, could reach a global audience and therefore achieve immortality. "Priceless invention! — which seemed to give wings to those peoples who first possessed it, enabling them to outdistance other nations" (ibid., 44). The climactic invention, of course, was that of printing — and again Turgot uses the image of flight to describe its historical significance. "What new art is suddenly born, as if to wing to every corner of the earth the writings and glory of the great men who are to come? ... At once the treasures of antiquity, rescued from the dust, pass into all hands, penetrate to every part of the world, bear light to the talents which were being wasted in ignorance, and summon genius from the depths of its retreats" (ibid., 57). With this ode to the printing press, Turgot concludes his discourse. The scientific revolution would never be safe in one country alone; thanks to printing, it is so widely diffused that its survival is ensured. "If each day adds to the vast extent of the sciences, each day also makes them easier, because methods are multiplied with discoveries, because the scaffolding rises with the building" (ibid., 59). Progress depends on circulation. Enlightenment in time depends on its extension in space. Only great inventions have made it possible for civilizations to keep from sliding back into cycles of repetition. If progress is now self-sustaining, if further discoveries are now ensured, it is not because genius appears more often than before; it is because key inventions have reorganized space so that henceforth discoveries will accumulate, never again to be buried in unmarked, isolated graves. Turgot is a technological determinist.

Circulation and Progress: Condorcet

If Turgot's 1750 discourse marks the beginning of the age of Enlightenment, the death in 1794 of Marie Jean Antoine Nicolas Caritat, marquis de Condorcet (b. 1743) marks its end. Condorcet had been a pilgrim to Ferney to visit the aging Voltaire (he wrote a biography of Voltaire in 1787) and a friend and protégé of

Jean d'Alembert, who convinced him to contribute to the *Encyclopédie*. But his most important friend, mentor, and model was Turgot. For the brief but decisive period when Turgot was minister of finance, Condorcet devoted himself to promoting Turgot's reforms (Baker 1976, xi). In despair when Turgot fell from power, Condorcet wrote a biography of his master (published in 1786) and even developed some of Turgot's unpublished sketches (Manuel and Manuel 1979, 459). After the deaths of Turgot, Voltaire, and d'Alembert, the younger Condorcet saw himself as carrying on their intellectual and political legacy. This was the mission he expressed in the most famous and influential statement of the Enlightenment idea of progress, the *Esquisse d'un tableau historique des progrès de l'esprit humain* (Sketch for a historical picture of the progress of the human mind), composed in 1793 while in hiding from the Jacobins.

Like Turgot's *Discours*, Condorcet's *Esquisse* defines history as the global extension of scientific knowledge among humanity as a whole. The 1793 essay, however, has a sense of urgency, a breathlessness, not found in Turgot's speech delivered almost a half-century earlier (ibid., 504). "Everything," he writes in the introduction, "tells us that we are now close upon one of the great revolutions of the human race" (Condorcet [1795] 1955, 12). Much of that urgency, of course, came from his knowledge that time was running out for him. (Suspecting that his hiding place was being watched, he fled to search for another, was captured, and was found dead the next day, apparently a suicide.)

Another reason for Condorcet's impatience, however, is more intrinsic to his historical vision. For Turgot, the main danger to progress had been inertia, routine, passivity. Condorcet sees a far more active and therefore more dangerous opponent: the oppressive, mystifying class of priests. From the very first stage of human development, this "institution . . . has had contrary effects upon human progress. . . . I refer to the separation of the human race into two parts; the one destined to teach, the other made to believe." The main reason error has proved so tenacious through history is the "crude cunning" of imposters on the one hand and the "credulity" of dupes on the other (ibid., 17–18).

In achieving social control, the priests' most powerful tool has been a linguistic one. Condorcet proposes that early in the age of agriculture, priestly castes developed a double language — a primitive, allegorical, image-laden language that they reserved for their dealings with the common people, and an abstract, nonallegorical language that they used among themselves. Accordingly, Condorcet explains, when the priests "used some expression and meant by it a quite simple truth, the people understood by it heaven knows what absurdity" (ibid., 37). Condorcet's conspiracy theory is an important reminder of the political agenda behind the Enlightenment ideology of circulation. The diffusion of scientific knowledge is a heroic struggle to overcome priestly error: the conquest of space is necessary to destroy the place-based power of the clergy. Condorcet's theory of two languages foreshadows twentieth-century critical theories of false consciousness, which also propose that a calculating elite maintains social power

by hypnotizing the credulous masses with powerful imagery (see Gay's rather jaundiced view of Condorcet's anticlerical conspiracy theory, Gay 1969, 112–22).

Condorcet therefore concludes — like Turgot, but with even more force — that the key to progress in time is diffusion of scientific information in space. Condorcet explicitly distinguishes intensive progress — that is, progress within a particular science — from the extensive kind, "which is to be measured partly in terms of the number of people who are familiar with the more obvious and important truths and partly in terms of the number and nature of these truths." Intellectual revolution will never be safe in one country alone. Because progress is assured only when it is extensively disseminated, it depends on technological invention (ibid., 120; see Manuel and Manuel 1979, 501).

The titles of the ten chapters of the *Esquisse* correspond to what Condorcet understands as the major steps in technological progress, beginning with the invention of the alphabet. Once spoken language could be reproduced as enduring and transportable signs, the "progress of the human race [was assured] forever" (Condorcet [1795] 1955, 7). Still, there were many obstacles along the way. For example, Condorcet argues that the progress of the Greeks was "lost to later nations" because they lacked means of communication and thus succumbed to the tyrannical domination of Rome (ibid., 178). The eighth chapter of the *Esquisse* describes the momentous effects of the invention of printing, when for the first time the human mind was truly freed from spatial limitations: "Men found themselves possessed of the means of communicating with people all over the world.... The public opinion that was formed in this way was powerful by virtue of its size, and effective because the forces that created it operated with equal strength on all men at the same time, no matter what distances separated them" (ibid., 100).

In the chapter on the tenth epoch, Condorcet reaffirms Turgot's conviction that progress will now continue indefinitely, because for the first time in history technical innovations prevent historical regression. "The strength and the limits of man's intelligence may remain unaltered; and yet the instruments that he uses will increase and improve, the language that fixes and determines his ideas will acquire greater breadth and precision and, unlike mechanics where an increase of force means a decrease of speed, the methods that lead genius to the discovery of truth increase at once the force and the speed of its operations" (ibid., 185).

According to these *philosophes*, then, the historical record traces the evolution of an intellectual world system, based on rational thought, that transcends local and national boundaries. This system has a hierarchical, though dynamic, arrangement of cores and peripheries, linked together in tentacular fashion by lines of transportation and communication. While the cores of civilization change over time (for example, Rome succeeds Greece as the cultural core), the constant tendency is for the global system to incorporate more and more of the world's surface into these networks. A second tendency is for the rate of circulation to become increasingly rapid and easy. The basis of Enlightenment is language,

defined as the clear, nonmetaphorical articulation of universally valid information. The most important innovations are ones that facilitate the transmission of this information: writing, the alphabet, the printing press. Techniques that disseminate this language are the necessary tools of universal Enlightenment. Technological innovation determines cultural progress.

Technical Reifications of the Ideology of Circulation

France, the home of Enlightenment philosophy, is also the home of systems engineering, and both emerged during the eighteenth century. Economic and technological historians have finally ceased to puzzle over the nonproblem of "France backwardness,"which was fostered by a far too exclusive focus on British industrial practice as a model. If the focus is not on manufacturing systems but on systems of connection — on structures rather than machines — it is clear that French military and civil engineers have long excelled at the latter. In a comprehensive overview, Cecil O. Smith has traced the continuity of the civil engineering tradition in France "from the highway system built by the Corps [des Ponts et Chausées] in the eighteenth century through the waterways and railroads of the nineteenth century to electric power and economic planning in the twentieth." Ever since the birth of the Corps in the eighteenth century, "French state engineers have promoted the complementary notions of rational public administration in the general administration and planning on a national scale" (Smith 1990, 658–59). [10]

Kenneth Alder has forcefully argued that even in the realm of mechanical engineering, French practitioners led the world in adopting a systems approach. He focuses on military engineering — specifically, the manufacture of artillery carriages and muskets — to demonstrate the extent to which French military engineers of the late eighteenth century were thinking in terms of developing technological systems, including the development of rational systems of language. In elucidating the origins of the systems approach, Alder argues the need to connect what he so happily calls the "high Enlightenment" of intellectual and political leaders with the "low Enlightenment" of engineering practice (Alder 1991).

The coincidence between Enlightenment philosophy and the systems approach in engineering practice is striking; the problem is to explain it. Alder's research

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[10] Smith presents a picture of a struggle in France between enduring, if not eternal, spirits of engineering: politically rational, centralized statism, and economically liberal, antistatist decentralization. The statist centralizers have largely prevailed in directing policy, however, except for the period between the 1880s and World War II. In Harvey's terms, the two groups represent the tension between the political and the economic organizations of space. It would be a mistake, however, to present this tension as one between those who wanted to build systems and those who did not. As Smith demonstrates, the arguments were rather about which type of systems should be built and who should pay for them.

suggests that French systems engineers saw their work as part of a radical republican program: Smith, on the other hand, emphasizes the origins of the systems approach in civil engineering sponsored by the "enlightened despotism" of the eighteenth-century French monarchy. Future work in this area should seek to reconcile this apparent contradiction by illuminating the political context of French engineering in the tumultuous half-century framing the Revolution. However, both Alder's and Smith's interpretations present a puzzle: How is it that a systems-oriented engineering tradition, whether "the creature of enlightened despotism" (Smith's words) or of radical republicanism, not only survived but flourished after the fall of both the despotism and the First Republic? Smith describes the continuity in the French national style of engineering rather than explaining it. Alder says that the systems approach did go out of favor as the republic turned into the empire, but he does not explain how it would later be revived (Smith 1990; Alder 1991).

The problem of historical continuity is less perplexing if we interpret the construction of technological systems as a means of spreading enlightenment, a goal that could be identified either with the monarchy or with republicanism but that was understood to transcend any national political system. Such a connection between the "high" and "low" Enlightenments is evident when we consider that Turgot and Condorcet themselves were systems builders as well as historical and economic theorists. As Louis XVI's minister of finance, Turgot in 1776 introduced the famous Six Edicts, which among other things abolished the *corvée* (the traditional, but inefficient method of getting roads repaired by commandeering peasant labor) in favor of a general tax to support better road repair service (Dockès 1969, 277; for the state of the road system in eighteenth-century France, see esp. pp. 206–13).[11] Turgot also asked Condorcet — then his unofficial science adviser — to undertake hydrodynamic experiments to arrive at engineering principles for canal construction, and initiated studies to evaluate the feasibility of building canals in various areas (Baker 1976, xi). After his fall from grace, when he was no longer able to command the resources for expensive civil engineering projects, Turgot became more involved with conceptual rather than physical systems of communication. In particular, he "toyed with inventions of cheap processes for the reproduction of writing, in order to multiply communications and extend progress among those elements in society which were still beyond its pale" (Manuel and Manuel 1979, 479).

Condorcet followed a similar pattern in his career. Besides helping Turgot plan canal construction, he aided the minister's efforts to reform and standardize weights and measures on a scientific basis (Baker 1976, xi). After his mentor fell from power, Condorcet too became more and more deeply involved with projects

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[11] It is also true that the intendants who directed *corvée* labor tended to use it to repair major roads between cities instead of the smaller, less noticeable — but to the Physiocrats more important — local routes connecting rural areas with neighboring towns (see Baker 1976, xi).

to establish a common language for moral and physical sciences based on the calculus of probabilities. In 1791 he was a member of a committee of academicians proposing a decimal-based system of scientific measurements; the work of this committee played a key role in the establishment of the metric system. Even after he had fallen out of favor with the Jacobins, Condorcet continued to seek means of establishing a standardized scientific language. At the very end of the *Esquisse* he proposes in some detail the creation of a universal language that could be used to express a scientific theory or the invention of a procedure. The language would be learned along with science itself — "the sign . . . at the same time as the object" — so that all people, not just a few, could understand it (Condorcet [1795] 1955, 198). In Alder's words, Condorcet was deeply involved in devising "a language of the machine age" (Alder 1991, 403–97, also pp. 16, 30–33).

The key link, however, between eighteenth-century ideas of systems and subsequent French engineering is Claude Henri de Rouvroy, comte de Saint-Simon, a disciple of Condorcet's. Much more work needs to be done on the intellectual and political genealogy linking Turgot, Condorcet, Saint-Simon, and the latter's disciples, collectively known as the Saint-Simonians.[12] The Saint-Simonians were the first coherent group of engineers to propose, and in some cases actually to build, the technological systems Turgot and Condorcet had described as necessary means to global Enlightenment. Saint-Simon himself gave a more romantic, less rationalistic cast to the model of global circulation. Whereas Turgot and Condorcet had stressed the circulation of ideas, Saint-Simon emphasized the circulation of feelings — the gradual spread of associationism, the gradual retreat of antagonism. In short, with Saint-Simon the diffusion of love replaced that of scientific reasoning, and universal enlightenment was recast as universal association.[13]

Saint-Simon, however — like any engineer of genius — combined a fertile imagination with intense practicality. He understood that financing was an integral part of the creation of a large technological system. He proposed a bank at the center of the industrial mechanism to permit overall accounting of incomes and debits, and a central planning agency to consider the credit needs of all branches of industry and development. The Saint-Simonians thus reconnected the cultural ideal of circulation with its economic origins in the circulation of capital. They

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[12] Although the Saint-Simonians are famed for their role in promoting some of the most ambitious engineering projects of the nineteenth century, Smith scarcely mentions them, and then only to minimize their influence in awakening French administrators to the importance of railway building. The reason, I would guess, is that the Saint-Simonians do not conform to Smith's argument that there is an enduring tension in French engineering between economic liberalism and state-sponsored centralization. The Saint-Simonians did not fit easily into either category (Smith 1990, 667).

[13] As with Condorcet and Turgot, Saint-Simon assumed that the progress of enlightenment would take place in geographical space; the difference was that he defined enlightenment in affective rather than intellectual terms, emphasizing "progressions of love" rather than "successive advances of mind." "World history thus became the study of the general diffusion of love and the contraction of antagonism." The key historical process was the gravitation of humanity toward universal association (Manuel and Manuel 1979, 626–27).

extended the vision of the *philosophes* in two seemingly opposite directions: toward passion and toward finance (Rabinow 1989, 29–30).[14]

Saint-Simon is conventionally described as a utopian; but with relatively minor changes — namely, dropping the more romantic, especially sexual theories of the cult — his disciples readily made the transition from utopian fervor to the business realities of mid-century France. Consider, for example, Michel Chevalier, who began his chequered career by controlling the funds and administering the affairs of the Saint-Simonians. After serving some months in prison under the July Monarchy, he began a speedy rehabilitation by conducting a mission of inquiry into the administration of public works in the United States and Mexico, and he eventually became a prominent senator of the Second Empire and main organizer of the Crédit Mobilier, the most important development bank of the time (Manuel and Manuel 1979, 638).

Backed by these financial resources and those of the Pereire brothers, the Saint-Simonians of the mid–nineteenth century pushed two main lines of technological development. First, they were the major promoters of railroad building in France (they were responsible for merging smaller companies into the dominant Paris-Lyons-Marseilles organization) and on the Continent generally. Second, they were the prime organizers behind the construction of the Suez Canal, a project they pursued with enormous tenacity and vigor (Zeldin 1973, 1:431).

The Saint-Simonians thus incarnate what Kenneth Clark has called the "heroic materialism" of the nineteenth century, when cubic tons of earth were moved to dig canals, railroads, tunnels, roadways, electrical power networks, and the like. These systems of connection — the pathways of modern life — transformed the natural landscape in ways that were immediately visible and often dramatic. But they also reorganized space in ways that were less obvious but equally significant. Let us now look at some of those ways and consider the cultural and political implications of this vast reorganization.[15]

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[14] It was Saint-Simon who proclaimed — using a metaphor drawn no doubt from his military service — "It is we, artists, who will serve you as avant-garde. What a most beautiful destiny for the arts, that of exercising over society a positive power, a true priestly function, and of marching forcefully in the van of all the intellectual faculties in the epoch of their greatest development!" (quoted in Bell 1978, 35). Saint-Simon proposed a three-chambered parliament: a Chamber of Inventions, dominated by engineers and artists, which would be the central planning agency, and would "arrive at a master plan for public works, emphasizing circulation"; a Chamber of Review, comprised of pure scientists, which would examine these projects; and a Chamber of Deputies, an executive body of industrialists, which would coordinate and finance them (Manuel and Manuel 1979, 630–31).

[15] A grand overview of systems of connection built since the beginning of the nineteenth century reveals a gradual process of dematerialization. Beginning with telegraph lines, the construction of connective systems began to become decoupled from massive civil engineering projects. Although one should not minimize the physical effect of telegraph wires strung across the landscape, it is still considerably less than the effect of laying a railway line. A similar point could be made about electrical and telephone lines. The process of decoupling became much more pronounced with the advent of radio and other uses of electromagnetic radiation, which travel across space with minimal disruption of the earth's surface. In more recent times, large-scale computer networks have been built that are nearly invisible to most observers because they are so often piggy-backed onto existing telephone links. As with so many major shifts in capitalism, the radical dematerialization of connective systems

Conquest of Space, Devaluation of Place

The Enlightenment ideology of circulation proclaims the revolutionary liberation of humanity from place. Until the eighteenth century, the fixed position of most human beings in a geographic locality — so closely related to their fixed position in the social order — was accepted as an inevitable part of human destiny. Enlightenment *philosophes* understood that physical mobility was closely related to social and intellectual mobility, and few of us in the late twentieth century would want to return to any such state of fixity. As Langdon Winner reminds us, however, "Each technically embodied affirmation may also count as a betrayal, perhaps even self-betrayal" (Winner 1991, 19). From the vantage point of the late twentieth century, we can see how the "conquest of space" has had unintended but significant costs in the loss of place.

Obsessed, by his own admission, with spatial metaphors, Michel Foucault is the most famous critic of the modern relationship linking power, knowledge, and space (Harvey 1989, 205; Rabinow 1989, 14). In analyzing the micropolitics of power in modernity, Foucault devoted special attention to physical layouts that imprison the body — the ultimate irreducible fact of human existence — in spaces of social control. In these spaces, bodies either submit to authority (by no means necessarily state authority) or manage to carve out spaces of resistance and freedom, however limited, in this repressive world (Harvey 1989, 213). According to Foucault's analysis of the Enlightenment, the power of the *ancien régime* was overturned "only to be replaced by a new organization of space dedicated to the techniques of social control, surveillance, and repression of the self and the world of desire" (ibid.). Prisons, asylums, and factories were all examples of totalitarian institutions — spaces designed to function as "containers" of social power — that were established during the Enlightenment and that represented its pervasive drive for ever more efficient social control. They are all variations on the paradigmatic model of spatial control, the panopticon, the Bentbamite "model prison," where the efficient technology of a central cockpit permitted an unrelieved and comprehensive one-way gaze from the seat of power. Despite the rhetorical emphasis on individual freedom, the Enlightenment therefore subjected individuals to forms of social control more systematic and thorough than the apparently crueller but limited and arbitrary premodern techniques.

The systems of connection described in this essay are quite different in quality from a panopticon. They are primarily routes, not buildings — systems, if you will, not devices. However, these spatial arrangements too permit a high degree of social control. This is not the control of surveillance, and no one is forced into the systems. Instead, people "choose" to use the systems because they are the fastest, most efficient, most "rational" way of circulating ideas and goods. To borrow the

can be dated from around 1973 — the time when comprehensive computer links began to be established and also when the great era of interstate highway building drew to a close in the United States.

terminology of Anthony Giddens, these structures are both enabling and constraining. They overcome "distanciation" (which Giddens defines as "simply a measure of the degree to which the friction of space has been overcome to accommodate social interaction") and simultaneously commit the user to the discipline of the grid (ibid., 222).[16] Once the choice has been made, one is constrained to use the system as it has been organized. In the case of communications, for example, this means framing the message in a way that conforms to the technical features of the system.

Thus systems of connection may be even more efficient modes of social control than prisons, because they maintain discipline without cumbersome arrangements of surveillance and forced incarceration. Furthermore, these systems are highly effective means of discipline, because they reduce (if not eliminate) the possibility of place-based resistance. You can imagine taking over a prison, but how do you seize control of an entire highway system? Local rebellion becomes impossible, and general revolution necessary, when protest against systems requires the construction of other systems.

In focusing on discrete "containers of power" modeled on the panopticon, then, Foucault diverts attention from another, more diffuse form of spatial discipline: technological systems of connection based on an ideology of circulation. As the Age of Enlightenment faded into the Age of Improvement, the spatial basis of Western society began to be reorganized along ever-extending networks of transportation and communication, which were also networks of economic, political, and intellectual power. As the physical networks continued to be laid down in the nineteenth and twentieth centuries, in layer upon expensive layer, they legitimated themselves in a self-reinforcing cycle of hegemony. The pathways of modern life are also corridors of power, with power being understood in both its technological and political senses. By channeling the circulation of people, goods, and messages, they have transformed spatial relations by establishing lines of force that are privileged over the places and people left outside those lines.

The project of conquering space inherently and inevitably entails the devaluation of place. That devaluation has three dimensions: economic, political, and intellectual. In economic terms, a place without connection is a place without value, because it remains outside the market system. Leo Marx has reminded us that this is the point of John Locke's famous statement in the *Second Treatise on Civil Government* that "in the beginning, all the world was America." Locke was referring not to the lack of settlement in America but to the fact that land there was economically worthless until it acquired the status of a commodity in the marketplace (Marx 1990, 6).

In political terms, power relations became based on access to connective systems rather than on local sources of power. The Enlightenment ideology of circulation was specifically framed to challenge the locality-based power of priests and

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[16] A prototypical study of "the discipline of the grid" might be Schivelbusch [1977] 1986.

aristocrats and to legitimate instead the political power of the bourgeoisie that "knew no place." For the *philosophes*, the ideal, utopian community was not based on geographical contiguity, which they considered an inherently reactionary arrangement, but was a community without boundaries connected by "technologies without boundaries" (de Sola Pool 1990, see esp. chap. 11). There were two models for such noncontiguous communities, both of them dating from the seventeenth century. One was the "universal class" (Wallerstein's term) of capitalist merchants controlling the circulation of capital; the other, the international fraternity of natural philosophers, or "scientific community" as it would now be called, controlling the circulation of scientific ideas. In both cases community members were united by relationships that "disembedded" them (as Giddens defines the term) from the natural landscape. They were united instead by common values, language, and information — specifically, since the Enlightenment, by the shared discourse of universal and instrumental reason, which was assumed to be the same everywhere, just as the laws of nature were the same everywhere.

In theory, everyone has access to that discourse. In practice, access differs radically depending on race, sex, income, education, and other factors. (For example, both the merchant and the scientific communities were overwhelmingly male.) While *philosophes* like Turgot and Condorcet were committed to revolutionary republicanism, they were incorrect in forecasting that the development of systems of connection would necessarily have a democratizing effect. Those systems can readily (if not inevitably) have a differential effect, by creating new hierarchies. The dynamic organization of space is closely linked to the investment of power in a meritocratic elite (Rabinow 1989, x). Conversely, those who remain settled may be disempowered, because traditional communities — social organizations gathered in space and developed over time — are devalued. People may be deprived of a place-based neighborhood when social and economic resources are directed away from settlements to networks.

At the same time local knowledge is also devalued. Significant knowledge comes to be defined as information that can be circulated on technological systems, as opposed to that which can be communicated only face-to-face. Types of discourse that do not fit the information model became devalued as "emotional" and "feminine." Truth becomes identified with information that is mobile, universal, contextless. In sum, technological systems of connection both incarnate and reinforce an ideology that accords economic, political, and intellectual power to the global market, to a meritocratic elite, and to information.

Cultural Responses to Destruction of Place

Destruction of place is therefore not a regrettable side effect but a central outcome of modernity. This includes not only destruction in the obvious, visible sense but also in the less obvious sense of a general withdrawal of economic, political, and

intellectual meaning. By the late nineteenth century, destruction of place in Europe in both senses was evident and troubling. The proliferation of large technical systems — a proliferation that practically defines "the second industrial revolution" of that epoch — was rapidly transforming both the urban and the rural landscapes. This transformation was far more complicated than a shift in balance between city and country, for the proliferation of technological systems renders that distinction obsolete. On the one hand, those systems permitted the country to "invade" the city, as country dwellers migrated to the metropolis in huge numbers. On the other hand, systems originating in the metropolis extended further and more effectively into formerly rural areas. Thus rural pathways extended into the city as well as the reverse.[17]

In the arts of late nineteenth-century Europe, response to the destruction of place was expressed in two reciprocal metaphors: technological systems were seen as endowed with vitality, while places disconnected from those systems were perceived as moribund. Just as the construction of technological systems renders obsolete any sharp distinction between city and country, so does it blur the distinction between organic and mechanical. This blurring is inevitable when circulation, rather than production, becomes a technological ideal, for the concept of circulation comes from biology. (It was introduced in the first half of the seventeenth century, as a result of William Harvey's discovery of the circulation of the blood, published in 1628.) In France, furthermore, the term "network" (*réseau*) was first used to refer to organisms, then to river patterns, and only then to canals and later to railways.[18]

In late nineteenth-century European culture, these organic images became highly conscious and elaborated. The most common metaphor was to describe networks of any kind — roads, railroads, power lines — as "tentacles" that enmeshed and sucked the lifeblood of the countryside. This image suggests a sort of technological animism that both expresses and protests the fetish of circulation.[19]

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[17] In relating material and cultural change I have tried to avoid the model of a technological base and cultural superstructure, especially by emphasizing the cultural origins of technological systems in Enlightenment ideology. Instead I have suggested substituting a layered model of coexistent grids by stressing the similarity in geographic pattern between the capitalist world picture and the historical world picture of Enlightenment *philosophes*. This pattern of tentacular networks was reified in the construction of large technological systems. But we can again layer the technological grid with a cultural one by using the same pattern to select and interpret cultural events of late nineteenth-century Europe. The technological systems of that epoch provide a "grid of intelligibility" (Rabinow's expression), or a theoretical framework, on which to site cultural examples by relating them to the reorganization of space. David Harvey has demonstrated persuasively how changes in the spatial and temporal qualities of human experience provide a common ground where technological changes may be related to cultural ones (Harvey 1989, 89).

[18] In a paper given at the International Conference for the History of Technology in Paris in July 1990, André Guillerme mentions that the term was used in medicine before being applied to rivers; then it was used to refer to the water supply system for Paris, before being applied to canals — at which point the transition from organic to technological frames of reference was complete (Guillerme 1990).

[19] In the terminology of Horkheimer and Adorno, nature and technology trade places (see for example Horkheimer and Adorno [1944] 1972, 12, 149).

It is therefore misleading to think of "systems" and "life world" as opposites, as Habermas (borrowing the vocabulary of phenomenology) typically does. Systems too have a life, and at the center of mechanism beats the heart of the superorganism. Much of what we think of as "technological determinism" derives precisely from this attribution of vitality to technology: its growth cannot be stopped.

On the other hand the vitality of these systems could also be celebrated. The early works of Jules Verne — the poet laureate of Saint-Simonianism — awakened generations to the thrill of circling the world in eighty days, or of speeding through the oceans at twenty thousand leagues below the waves. Somewhat later Jules Romains announced the birth of a new social organism, the *unanime,* from the ebb and flow of urban traffic, and lauded the extension of *unanimiste* consciousness into the countryside through highways and telegraph lines. As for the futurists, they could be collectively described as Enlightenment *philosophes* on speed. They developed new aesthetic practices from their fascination with systems and with the vehicles on them, and they expressed new experiences where environment and object merge in fields of force, where the mind becomes a control panel and the body rides surges of power (Virilio 1985, 1986).

It is one of the contradictions of modernism that other European artists at the same moment were lamenting the loss of place. These laments go deeper than reactionary mourning over the uprooting of the peasantry. Indeed, some of the most powerful expressions of grief are found in the lines of Belgian poet Émile Verhaeren, a fervent socialist. The very titles of his trilogy of the 1890s express his anguish: *Les Campagnes hallucinées* (The hallucinated fields) (1893), *Les Villages illusoires* (The illusory villages) (1895), and *Les Villes tentaculaires* (The tentacular cities) (1896). Verhaeren's poetry forcefully illustrates Anthony Giddens' observation that when "the truth of experience no longer coincides with place," places are perceived as dead, infertile, deserted, void, phantasmagoric.[20] These are the metaphors that obsessively recur in Verhaeren's work and, though often less vividly, in the work of countless other writers of that time and place (for example Romains, who experienced the countryside as "dead nature" except for the roadways and telegraph lines running through it). The land had become unreal in part because people who lacked a productive relationship with it could no longer understand or interpret it. Those who visited the countryside only on Sundays and holidays had no "local knowledge" to draw on in "reading" the landscape.

Since the city was also being spatially transformed, there too the visible environment seemed mysterious and opaque because "the truth of experience no longer coincides with place." Over and over the city is described as a puzzle, a labyrinth, a maze. Whether in urban or rural surroundings, then, a major cultural project of the late nineteenth century was to comprehend these new relationships

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[20] Giddens continues, "The primacy of place in pre-modern settings has been largely destroyed by disembedding and time-space distanciation. Place has become phantasmagoric because the structures by means of which it is constituted are no longer locally organised" (Giddens 1990, 108).

to space and, by extension, to economic, political, and cultural power. The construction of technological systems, even when they did not transform the landscape in a direct way, created a pervasive sense of homelessness, of disconnection from earthly surroundings. The cultural challenge was to overcome this spatial alienation.[21]

One method was the deceptively simple activity of taking a walk. Thanks to the work of two generations of cultural geographers (notably Kevin Lynch and his disciples), walking has come to be appreciated as a potentially significant act of cognition, in which knowledge is created from the active involvement of the entire body.[22] What looks like a grid to the *philosophe* loftily surveying humanity as a whole, is experienced by the individual on the ground as a pathway. Tracing these "felt paths" can be a means of understanding the spatial organization of the grid (Bamberger 1991). The Romantics'"sublime" walks in the mountains, the *flânerie* of late nineteenth-century dandies on urban boulevards, and turn-of-the-century Sunday strolls in the park may all be interpreted as acts of learning, as efforts to construct a new cognitive map of modern times.

Accordingly, there is a close relationship between the creation of spatial knowledge and literary creation. Walking in space and constructing a narrative in time are both efforts to organize knowledge through sequential arrangement. As modes of learning they both resemble ritualistic or musical acts. Countless nineteenth-century narrations, whether in poetry or in prose, trace "felt paths" at once spatial and linguistic. By interpreting literary narratives as cognitive acts, we can understand more clearly their role as efforts to overcome spatial dissonance. Both writing and walking were active means of creating new forms of local knowledge.

In recent years postmodernists such as Pierre Bourdieu and Michel de Certeau have interpreted walking not only as a cognitive act but also as a political one. If, as Foucault asserts, the body is the irreducible element in social organization, then carving out an unpredictable, individual trajectory through the creation of an alternative pathway is an implicit act of defiance. De Certeau emphasizes the

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[21] One of the clearest descriptions of spatial alienation is found in E. M. Forster's seminal short story "The Machine Stops." The imaginary society of that story dwells largely underground — an environment that permits little sense of direction or distance. The hero Kuno explains to his mother how he prepared for a journey to the surface of the earth: "You know that we have lost the sense of space. We say 'space is annihilated' but we have annihilated not space, but the sense thereof. We have lost a part of ourselves. I determined to recover it, and I began by walking up and down the platform of the railway outside my room. Up and down, until I was tired, and so did recapture the meaning of 'near' and 'far.' 'Near' is a place to which I can get quickly *on my feet*, not a place to which the train or the air-ship will take me quickly. 'Far' is a place to which I cannot get quickly on my feet; the vomitory is 'far,' although I could be there in thirty-eight seconds by summoning the train. Man is the measure. That was my first lesson. Man's feet are the measure for distance, his hands are the measure for ownership, his body is the measure for all that is lovable and desirable and strong" (Forster [1909] 1928, xx).

[22] See the eloquent argument of Bruce Chatwin in *The Songlines* (1987), esp. "From the Notebooks," pp. 163-206. For summaries of the literature in cultural geography, see the bibliographies in Gould and White [1974] 1986, 165-68; Downs and Stea 1977, 264-72.

defiance of nomadism, when a pedestrian deliberately jumps off the beaten path. Instead of submitting to "the technological system of a coherent and totalizing space," walkers erect a "pedestrian rhetoric" of paths with "a mythical structure," narrating "a story jerry-built out of elements taken from common sayings, an allusive and fragmentary story whose gaps mesh with the social practices it symbolizes." Thus de Certeau refutes Foucault's pessimistic assessment of the disciplinary imperatives of modernity. Walking, says de Certeau, is an example of a popular practice with liberating potential existing "at the heart of the contemporary economy"(de Certeau 1984, cited in Harvey 1989, 214). In the same spirit, in his seminal article "Postmodernism, or the Cultural Logic of Late Capitalism," Fredric Jameson draws on Kevin Lynch's studies in urban topography to argue for the possibility of a "practical reconquest of a sense of place." Jameson proposes that this reconquest might result from the activity of "cognitive mapping," which he defines as the "construction or reconstruction of an articulated ensemble which can be retained in memory and which the individual subject can map and remap" (Jameson 1984, 89; Jameson 1988).

The cognitive mapping praised by de Certeau and Jameson (as well as Bourdieu) is part of the larger postmodernist emphasis on localism, particularity, and difference. Yet a certain despair lies beneath this postmodern celebration. The burden of creating freedom is placed on individual human beings — specifically, on their imaginative capacities — because the possibility of reshaping human surroundings in a physical way has been so largely abandoned. Human beings may retain their flexibility and creativity, but the landscape is set in concrete, as the saying goes. The infinite circulation of linguistic codes, the endless game of establishing connections between cultural artifacts, is seductive when other patterns of circulation seem beyond intervention. The freedom to deconstruct in linguistic terms is highly valued when freedom to deconstruct in any physical sense seems so remote. The freedom to reject the grand narrative systems of the past seems more important when the freedom to reject the technological systems seems so limited. The central form of protest is no longer political but aesthetic — the capacity to apprehend differently, to create a different cognitive map.

The seeds of this technological pessimism underlying postmodernism exuberance were sown in the technological optimism of the Enlightenment. Its central *humanistic* goal, the diffusion of Enlightenment, now needs to be detached from the twin assumptions that knowledge is information and that information is best disseminated by large technical systems. Jurgen Habermas and Raymond Williams have argued that instead of abandoning the Enlightenment project, we should seek to understand why its goals have not been fulfilled and should continue the struggle to fulfill them (see the helpful summary of the debate in Brantlinger 1990, 185–88). Both Habermas' "theory of communicative action" and Raymond Williams' "long revolution" affirm the Enlightenment project of establishing increasingly complex and efficient communicative relationships. When Williams defines communication, however, he does so not in terms of exchanging

bits of information but in terms of "describing, learning, persuading and exchanging experiences" (Williams 1962, 18, quoted in Brantlinger 1990, 185, cf. p. 59). While both Habermas and Williams are keenly aware of the new technological possibilities for enhancing such relationships, they keep their focus on the whole range of communication and do not equate it with the construction of particular technological systems.

Immense damage has been done to human beings and nonhuman nature alike by envisioning our globe as empty space across which to string systems for the circulation of capital, goods, and information. Yet we must also recall what motivated the Enlightenment vision of global circulation: an awareness of the immense suffering caused when human minds and bodies are trapped in one place, and when fierce ethnic conflicts erupt because human identity is so dependent on its relation to particular places. Is there a way to reaffirm the value of locality without falling into a reactionary trap of blood and soil? Answering this question is a central challenge of the postmodern age.

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