The Invention of "Technology"

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When the Enlightenment project was being formulated, after 1750, the idea of "technology" in today's broad sense of the word did not yet exist. For another century, more or less, the artifacts, the knowledge, and the practices later to be embraced by "technology" would continue to be thought of as belonging to a special branch of the arts variously known as the "mechanic" (or "practical," or "industrial," or "useful")—as distinct from the "fine" (or "high," or "creative," or "imaginative")—arts. Such terms, built with various adjectival modifiers of "art," then were the nearest available approximations of today's abstract noun "technology"; they referred to the knowledge and practice of the crafts. By comparison with "technology," "the practical arts" and its variants constituted a more limited and limiting, even diminishing, category. If only because it was explicitly designated as one of several subordinate parts of something else, such a specialized branch of art was, as compared with the tacit uniqueness and unity of "technology," inherently belittling. Ever since antiquity, moreover, the habit of separating the practical and the fine arts had served to ratify a set of overlapping and invidious distinctions: between things and ideas, the physical and the mental, the mundane and the ideal, female and male, making and thinking, the work of enslaved and of free men. This derogatory legacy was in some measure erased, or at least masked, by the more abstract, cerebral, neutral word "technology." The term "mechanic arts" calls to mind men with soiled hands tinkering with machines at workbenches, whereas "technology" conjures up images of clean, well-educated technicians gazing at dials, instrument panels, or computer monitors.

These changes in the representation of technical practices were made in response to a marked acceleration in the rate of initiating new mechanical or other devices and new ways of organizing work. During the early phase of industrialization (ca. 1780–1850 in England, ca. 1820–1890 in the United States), the manufacturing realm had been represented in popular discourse by images of the latest mechanical inventions: water mill, cotton gin, power loom, spinning jenney, steam engine, steamboat, locomotive, railroad "train of cars," telegraph, factory. The tangible, manifestly practical character of these artifacts matched the central role as chief agent of progress accorded to instrumental rationality and its equipment. Thus the locomotive (or "iron horse") often was invoked to symbolize the capacity of commonsensical, matter-of-fact, verifiable knowledge to harness the energies of nature. It was routinely depicted as a driving force of history. Or, put differently, these new artifacts represented the innovative means of arriving at a socially and politically defined goal. For ardent exponents of the rational Enlightenment, the chief goal was a more just, more peaceful, and less hierarchical republican society based on the consent of the governed.

As this industrial iconography suggests, the mechanic arts were widely viewed as a primary agent of social change. These icons often were invoked with metonymical import to represent an entire class of similar artifacts, such as mechanical inventions; or the replacement of wood by metal construction; or the displacement of human,

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animal, or other natural energy sources (water or wind) by engines run by mechanized motive power; or some specific, distinctive feature of the era ("the annihilation of space and time," "The Age of Steam"); or, most inclusive, that feature's general uniqueness (the "Industrial Revolution"). Thus, when Thomas Carlyle announced at the outset of his seminal 1829 essay "Signs of the Times" that, if asked to name the oncoming age, he would call it "The Age of Machinery," he was not merely referring to actual, physical machines, or even to the fact of their proliferation. He had in mind a radically new kind of ensemble typified by, but by no means restricted to, actual mechanical artifacts. "Machinery," as invoked by Carlyle (and soon after by many others), had both material and ideal (mental) referents; it simultaneously referred to (1) the "mechanical philosophy," an empirical mentality associated with Descartes and Locke and with the new science, notably Newtonian physics; (2) the new practical, or industrial, arts (especially those using mechanized motive power); (3) the systematic division of labor (the workers as cogs in the productive machinery); and (4) a new kind of impersonal, hierarchical, or bureaucratic organization, all of which could be said to exhibit the power of "mechanism." Carlyle's essay is an early, eloquent testimonial to the existence of a semantic void and to the desire to fill it with a more inclusive, scientistic, and distinctive conception of these new human powers than was signified by the most inclusive term then available, "the mechanic arts."

During the nineteenth century, discrete artifacts or machines were replaced, as typical embodiments of the new power, by what later would come to be called "technological systems." It is evident in retrospect that the steam-powered locomotive, probably the nineteenth century's leading image of progress, did not adequately represent the manifold character or the complexity of the mechanic art of transporting persons and goods by steam-powered engines moving wagons over a far-flung network of iron rails. To represent such complexity, that image of a locomotive was no more adequate than the term "mechanic art." As Alfred Chandler and others have argued, the railroad probably was the first of the large-scale, complex, full-fledged technological systems. In addition to the engines and other material equipment (rolling stock, stations, yards, signaling devices, fuel supplies, the network of tracks), a railroad comprised a corporate organization, a large capital investment, and a great many specially trained managers, engineers, telegraphers, conductors, and mechanics. Because a railroad operated over a large geographical area, 24 hours a day, every day of the year, in all kinds of weather, it became necessary to develop an impersonal, expert cohort of professional managers, and to replace the traditional organization of the family-owned and -operated firm with that of the large-scale, centralized, hierarchical, bureaucratic corporation.

Between 1870 and 1920 such large complex systems became a dominant element in the American economy. Although they resembled the railroad in scale, organization, and complexity, many relied on new nonmechanical forms of power. They included the telegraph and telephone network; the new chemical industry; electric light and power grids; and such linked mass-production-and-use systems as the automobile industry (sometimes called the "American" or "Fordist" system), which involved the ancillary production of rubber tires, steel, and glass and which was further linked with the petroleum, highway-construction, and trucking industries. In the era when electrical and chemical power were being introduced, and when these huge systems were replacing discrete artifacts, simple tools, or devices as the characteristic

material form of the "mechanic arts," the latter term also was being replaced by a new conception: "technology."

The advent of this typically abstract modern concept coincided with the increasing control of the American economy by the great corporations. In Western capitalist societies, indeed, most technological systems (save for state-operated utility and military systems) were the legal property of—were organized as—independently owned corporations for operation within the rules, and for the purposes, of minority ownership. Thus, most of the new technological systems were operated with a view to maximizing economic growth as measured by corporate market share and profitability. At the same time, each corporation presumably was enhancing the nation's collective wealth and power. Alan Trachtenberg has aptly called this fusion of the nation's technological, economic, and political systems "the incorporation of America." By the late nineteenth century, Thorstein Veblen, an exponent of instrumental rationality, ruefully observed that under the regime of large-scale business enterprise the ostensible values of science-based technology (matter-of-fact rationality, efficiency, productivity, precision, conceptual parsimony) were being sacrificed to those of the minority owners: profitability, the display of conspicuous consumption, leisure-class status, and the building of private fortunes. But the abstract, sociologically and politically neutral (one might say neutered) word "technology," with its tacit claim to being a distinctive, independent mode of thought and practice like "science," is unmarked by a particular socio-economic regime.

Although the English word "technology" (derived from the Greek *teckhne,* "art" or "craft") had been available since the seventeenth century, during most of the next two centuries it had referred specifically and almost exclusively to technical discourses or treatises. In view of the way historians now routinely project the word back into the relatively remote past, it is surprising to discover how recently today's broad sense of "technology" achieved currency. It was seldom used before 1880. Indeed, the founding of the Massachusetts Institute of Technology in 1861 seems to have been a landmark, a halfway station, in its history; however, the *Oxford English Dictionary* cites R. F. Burton's use of "technology" in 1859 to refer to the "practical arts collectively" as the earliest English instance of the inclusive modern usage. (It is important to recognize the exact nature of this change: instead of being used to refer to a written work, such as a treatise, about the practical arts, "technology" now was used to refer directly to the arts—including the actual practice and practitioners—themselves.)

That this broader, modern sense of "technology" was just emerging at the middle of the nineteenth century is further indicated by the fact that Karl Marx and Arnold Toynbee, who were deeply concerned about the changes effected by the new machine power, did not use the word. At points in his influential lectures on the Industrial Revolution (composed in 1880–81) where "technology" would have been apposite, Toynbee, an economic historian, relied on other terms: "mechanical discoveries," "machinery," "mechanical improvements," "mechanical inventions," "factory system." Yet within 20 years Veblen would be suggesting that the "machine technology" was the distinguishing feature of modernity. My impression is, however, that "technology" in today's singular, inclusive sense did not gain truly wide currency until after World War I, and perhaps not until the Great Depression.

The advent of "technology" as the accepted name for the realm of the instrumental had many ramifications. Its relative abstractness, as compared with "the

mechanic arts," had a kind of refining, idealizing, or purifying effect upon our increasingly elaborate contrivances for manipulating the object world, thereby protecting them from Western culture's ancient fear of contamination by physicality and work. An aura of impartial cerebration and rational detachment replaced the sensory associations that formerly had bound the mechanic arts to everyday life, artisanal skills, tools, work, and the egalitarian ethos of the early republic. In recognizing the mastery of various technologies as a legitimate pursuit of higher learning, the universities ratified that shift from the craft ethos to the mechanic arts to the meritocratic aspirations of the engineering and management professions. The lack of sensuous specificity attached to the noun "technology," its bloodless generality, and its common use in the more generalized singular form make the word conducive to a range of reference far beyond that available to the humdrum particularities of "the mechanic arts" or "the industrial arts." Those concrete categories could not simultaneously represent (as either "technology" or, say, "computer technology" can and does) a particular kind of device, a specialized form of theoretical knowledge or expertise, a distinctive mental style, and a unique set of skills and practices.

Perhaps the crucial difference is that the concept of "technology," with its wider scope of reference, is less closely identified with—or defined by—its material or artifactual aspect than was "the mechanic arts." This fact comports with the material reality of the large and complex new technological systems, in which the boundary between the intricately interlinked artifactual and other components—conceptual, institutional, human—is blurred and often invisible. When we refer to such systems, as compared with, say, carpentry, pottery, glass-making, or machine-tool operating, the artifactual aspect is a relatively small part of what comes before the mind. By virtue of its abstractness and inclusiveness, and its capacity to evoke the inextricable interpenetration of (for example) the powers of the computer with the bureaucratic practices of large modern institutions, "technology" (with no specifying adjective) invites endless reification. The concept refers to no specifiable institution, nor does it evoke any distinct associations of place or of persons belonging to any particular nation, ethnic group, race, class, or gender. A common tendency of contemporary discourse, accordingly, is to invest "technology" with a host of metaphysical properties and potencies, thereby making it seem to be a determinate entity, a disembodied autonomous casual agent of social change—of history. Hence the illusion that technology drives history. Of all its attributes, this hospitality to mystification—to technological determinism—may well be the one that has contributed most to postmodern pessimism.

. . . As the first complex technological systems were being assembled, and as the new concept of technology was being constructed, a related change was occurring within the ideology of progress. It entailed a subtle redescription of the historical role of the practical arts. Originally, as conceived by such exponents of the radical Enlightenment as Turgot, Condorcet, Paine, Priestley, Franklin, and Jefferson, innovations in science and in the mechanic arts were regarded as necessary yet necessarily insufficient means of achieving general progress. To the republican revolutionaries of the Enlightenment (especially the radical *philosophes*), science and the practical arts were instruments of political liberation—tools for arriving at the ideal goal of progress: a more just, more peaceful, and less hierarchical republican society based on the consent of the governed.

The idea of history as a record of progress driven by the application of science-based knowledge was not simply another idea among many. Rather it was a figurative concept lodged at the center of what became, sometime after 1750, the dominant secular world-picture of Western culture. That it was no mere rationale for domination by a privileged bourgeoisie is suggested by the fact that it was as fondly embraced by the hostile critics as by the ardent exponents of industrial capitalism. Marx and Engels, who developed the most systematic, influential, politically sophisticated critique of that regime, were deeply committed to the idea that history is a record of cumulative progress. In their view, the critical factor in human development—the counterpart in human history of Darwinian natural selection in natural history—is the more or less continuous growth of humanity's productive capacity. But of course they added a political stipulation, namely that the proletariat would have to seize state power by revolution if humanity was to realize the universal promise inherent in its growing power over nature. To later followers of Marx and Engels, the most apt name of that power leading to communism, the political goal of progress—of history—is "technology."

But the advent of the concept of technology, and of the organization of complex technological systems, coincided with, and no doubt contributed to, a subtle revision of the ideology of progress. Technology now took on a much grander role in the larger historical scheme—grander, that is, than the role that originally had been assigned to the practical arts. To leaders of the radical Enlightenment like Jefferson and Franklin, the chief value of those arts was in providing the material means of accomplishing what really mattered: the building of a just, republican society. After the successful bourgeois revolutions, however, many citizens, especially the merchants, industrialists, and other relatively privileged people (predominantly white and male, of course), took the new society's ability to reach that political goal for granted. They assumed, not implausibly from their vantages, that the goal already was within relatively easy reach. What now was important, especially from an entrepreneurial viewpoint, was perfecting the means. But the growing scope and integration of the new systems made it increasingly difficult to distinguish between the material (artifactual or technical) and the other organizational (managerial or financial) components of "technology." At this time, accordingly, the simple republican formula for generating progress by directing improved technical means to societal ends was imperceptibly transformed into a quite different technocratic commitment to improving "technology" as the basis and the measure of—as all but constituting—the progress of society. This technocratic idea may be seen as an ultimate, culminating expression of the optimistic, universalist aspirations of Enlightenment rationalism. But it tacitly replaced political aspirations with technical innovation as a primary agent of change, thereby preparing the way for an increasingly pessimistic sense of the technological determination of history.

The cultural modernism of the West in the early twentieth century was permeated by this technocratic spirit. (A distinctive feature of the technocratic mentality is its seemingly boundless, unrestricted, expansive scope—its tendency to break through the presumed boundaries of the instrumental and to dominate any kind of practice.) The technocratic spirit was made manifest in the application of the principles of instrumental rationality, efficiency, order, and control to the behavior of industrial workers. As set forth in the early-twentieth-century theories of Taylorism and Fordism, the standards of efficiency devised for the functioning of parts within machines

were applied to the movements of workers in the new large-scale factory system. The technocratic spirit also was carried into the "fine" arts by avant-grade practitioners of various radically innovative styles associated with early modernism. The credo of the Italian Futurists; the vogue of geometric abstractionism exemplified by the work of Mondrian and the exponents of "Machine Art"; the doctrines of the Precisionists and the Constructivists; the celebration of technological functionalism in architecture by Le Corbusier, Mies Van der Rohe, and other exponents of the international style—all these tendencies exemplified the permeation of the culture of modernity by a kind of technocratic utopianism.

Architecture, with its distinctive merging of the aesthetic and the practical, provides a particularly compelling insight into the modern marriage of culture and technology. The International Style featured the use, as building materials, of such unique products of advanced technologies as steel, glass, and reinforced concrete; new technologies also made it possible to construct stripped-down, spare buildings whose functioning depended on still other innovative devices (the elevator, the subway system, air conditioning). This minimalist, functional style of architecture anticipated many features of what probably is the quintessential fantasy of a technocratic paradise: the popular science-fiction vision of life in a spaceship far from Earth, where recycling eliminates all dependence on organic processes and where the self-contained environment is completely under human control.

Do Artifacts Have Politics?

LANGDON WINNER

In controversies about technology and society, there is no idea more provocative than the notion that technical things have political qualities. At issue is the claim that the machines, structures, and systems of modern material culture can be accurately judged not only for their contributions of efficiency and productivity, not merely for their positive and negative environmental side effects, but also for the ways in which they can embody specific forms of power and authority. Since ideas of this kind have a persistent and troubling presence in discussions about the meaning of technology, they deserve explicit attention.

Writing in *Technology and Culture* almost two decades ago, Lewis Mumford gave classic statement to one version of the theme, arguing that "from late neolithic times in the Near East, right down to our own day, two technologies have recurrently existed side by side: one authoritarian, the other democratic, the first system-centered, immensely powerful, but inherently unstable, the other man-centered, relatively weak, but resourceful and durable." This thesis stands at the heart of Mumford's studies of the city, architecture, and the history of technics, and mirrors concerns voiced earlier in the works of Peter Kropotkin, William Morris, and other nineteenth century critics of industrialism. More recently, antinuclear and prosolar energy movements in Europe and America have adopted a similar notion as a centerpiece in their arguments. Thus environmentalist Denis Hayes concludes, "The increased deployment of nuclear power facilities must lead society toward authoritarianism. Indeed, safe reliance upon

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