pendence upon technical artifacts; that technical forms impose a stringent discipline; that there is a tendency for technical means to redefine ends; that sophisticated technologies lead to a transformation of consciousness; and finally that

> technical artifice as an aggregate phenomenon dwarfs human consciousness and makes unintelligible the systems that people supposedly manipulate and control; by this tendency to exceed human grasp and yet to operate successfully according to its own internal makeup, technology is a total phenomenon which constitutes a "second nature" far exceeding any desires or expectations for the particular components.

In the course of the discussion these points are explained and defended, and a number of writings are insightfully reviewed. Among these are works by Don K. Price and J. K. Galbraith, and also Mary Shelley's *Frankenstein*. However, the work of Jacques Ellul, as represented in *The Technological Society* (French original 1951, translation 1964), is central to Winner's argument; I shall concentrate on it here. It is no discredit to say that Winner's main scholarly achievement has been to rescue Ellul's deep analysis by making it less idiosyncratic and more plausible in the present-day American context.

Ellul has proclaimed his enthusiasm for Marx, but it seems to me that his vision really starts with an insight of German academic sociology: the rise of "scientific rationality," replacing the thought-style of a traditional, agrarian society. In this world of ours, means are calculated narrowly for the best achievement of ends, and (most important) the ends themselves are of a narrow, calculated sort. Fun, generosity, spontaneity, and honor have no place in the culture of what Max Weber described as the "ascetic bourgeois" who created the spirit of capitalism. And it is in such a world that "rationalized" technological systems are most easily adopted.

Ellul makes a bold move beyond this well-known position, at two levels. First, he sees "*la technique*," which he almost personifies, as becoming the master, with man the slave; he portrays how it has shaped our thinking and being, inexorably and perhaps irreversibly. The meaning of this event for human history is then implicitly supplied by Ellul's religious perspective; Winner notes the functional analogy between *la technique* and the state of sin, or the action of Satan, as described in Ellul's other works.

Winner brings Ellul down to earth most successfully in a creative interaction with Marxism. He inquires into the long-standing and apparently permanent scandal of the socialist economies, in which workers are effectively deprived of their elementary rights, being permitted neither to choose their bosses nor to go on strike against them. Winner reminds us how unexpected this was by quoting from Lenin's *State and Revolution* on socialist workplace democracy. How to explain this calamitous betrayal? Invoking foreign hostility or apologizing for aberrant individuals is to evade the Marxist approach to political economy in this crucial case.

The relations between the "means," "mode," and "social relations" of production (in the Marxist terminology) are beautifully explicated by Ellul's analysis for high-technology society. The size, complexity, and vulnerability of the productive machine entail requirements for order, discipline, and "scientific rationality." The Marxists themselves have perceived and praised factory production for these features, while failing to notice the contradiction with their political ideals. And such a total system then further molds institutions and people for its smooth functioning. Hence we find the "convergence" of the capitalist and socialist economies, the merging of state and private institutions in the former, and also the loss of any chance of genuinely democratic control anywhere. Thus a Marxist analysis shows the obsoleteness of Marx's own model, and consequently of all the political action deriving from it.

To the extent that it holds, the Ellul-Winner thesis has depressing implications. A real restoration of control over technology would seem to require actions far more radical than citizens' participation campaigns against this or that new industry. Winner himself makes a rather general suggestion for "epistemological Luddism": personal experiments in seeing what it is like to kick the habit of some aspect of our enveloping technology. However, he does not spurn political efforts, provided that they avoid the fallacious assumption that technology is an inert system waiting to be legislated and recognize that technology *is* politics. He even offers some criteria for "good" technology, along generally alternative/intermediate lines.

What of the strength of Winner's main thesis? The detailed evidence he adduces for his sweeping assertions is fragmentary and unconvincing. He cites a few cases (and some of those dubious) from war, where "small is beautiful" never did apply anyway. But it may be that theses so general as this are not capable of strict testing. A deep change in our thought-styles cannot easily be seen from the outside, either in the temporal dimension or in the imagination. The possibility of genuine counterexamples is nearly precluded by the phenomenon itself.

This study is therefore best seen as contributing a radical insight on our technological society. Considered as describing a tendency rather than an accomplished fact, it serves as a warning and a guide. Its value is established by its explanatory power, as in the case of the socialist economies.

As a source for readings and reflections on the problem, the book is rich and rewarding, containing a more varied selection than this condensed review could survey. If it has a practical lesson, it is that of awareness: only by recognizing the boundaries of our socially constructed scientific-technological reality can we transcend them in imagination and then achieve effective human action.

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Potential Hazards

The Zapping of America. Microwaves, Their Deadly Risk, and the Cover-Up. PAUL BRODEUR. Norton, New York, 1977. xvi, 344 pp., illus. $11.95.

In his 1960 Godkin Lectures at Harvard C. P. Snow warned, "Some of the most important choices about a nation's physical health are made, or not made, by a handful of men, in secret, and, again in legal form, by men who normally are not able to comprehend the arguments in depth." The intense wartime development of electromagnetic radiation for radar, which was the subject of Snow's lectures, accelerated a pattern of well-known historical events. Maxwell formulated his equations of electromagnetics in 1864, and in 1888 Hertz first transmitted an electromagnetic signal using a spark-gap radiator. Marconi followed with radiotelegraphy, and in 1915 speech was first transmitted. With the first commercial radio broadcast in 1920, a proliferation was under way.

Less well known than this history are the questions about biological effects of radio-frequency and microwave radiation that soon developed, which ultimately grew into the controversies described in this book. Unlike x-rays, radiation at these lower frequencies lacks sufficient photon energy to break organic molecular bonds, and its effects were initially believed to be limited to tissue heating. By the 1930's, however, con-

troversy had developed over the possible existence of subtler, nonthermal effects. Such effects were not conclusively demonstrated, though, and military concerns during World War II generated explosive development of the technology. Subsequent spin-offs resulted in an enormous expansion of military and commercial use of radio-frequency and microwave radiation in higher-powered radars, radio and television broadcasting, industrial heating processes, and domestic ovens.

Not until the 1950's did the military begin in earnest to fund research examining the biological effects of microwaves. Meanwhile, the U.S. Department of Defense provisionally enacted a personnel exposure limit of 10 milliwatts per square centimeter based purely on considerations of thermal effects (such as hyperthermia and the formation of cataracts at exposures of 100 mW/cm^2 or more). In 1961, finding itself unconvinced of lower-level effects, the Defense Department decided to keep the 10 mW/cm^2 standard. Shortly thereafter it became known that the Soviet Union had promulgated its own standard, limiting continuous occupational exposure to 0.01 mW/cm^2. This was based on considerations of low-level nonthermal effects, including the possibility that microwaves might act directly on the central nervous system. Though many Western scientists have complained of a lack of experimental detail in Eastern reports, the controversy has continued unabated.

The Zapping of America is the first book-length attempt to bring the controversy before a nonspecialist audience, a clearly desirable goal. The central theses of the book are that exposure to low-level radio-frequency and microwave radiation does have hazardous biological effects and that the Defense and State departments have misled the public concerning their knowledge of these effects. Both points merit consideration.

Brodeur discusses the substantial volume of research on nonthermal effects done in the West over the past decade and the recently increased East-West scientific contact, which has led to improved exchange of information on the subject. Taken together, recent developments have substantially complicated the initial, thermal picture. There are numerous reports of effects on hematopoiesis in animals, including lymphocytosis, chromosomal aberrations, and even an increased incidence of leukemia. Reports abound of central nervous system effects in animals, including increased cerebral Ca^{2+} efflux, blood-brain barrier alterations, and changes in electroencephalogram pattern. Some of these observations have been experimentally reproduced, others have not; some were made at exposure levels of 10 mW/cm^2 or less. Still, the effects of low-level exposure are usually reversible, and their significance for human health is often unclear. Several comprehensive surveys of the animal research literature have been published, though they are absent from Brodeur's references. Data on humans are very sparse, but there are studies suggesting a microwave-induced "neurasthenic" syndrome (in East European occupational groups), and increases in chromosomal aberrations, as well as cataract formation at high levels of exposure. Brodeur also notes several specific cases of accidental human exposure with subsequent pathology, but often implies causal relations without obvious grounds for doing so. It is undeniably important to recognize the considerable uncertainty surrounding this issue and the overwhelming need for additional research bearing on it—we ignore these matters at our own peril. Unfortunately, one often gets the impression that Brodeur is presenting firm knowledge, not matters of uncertainty.

In expounding his second thesis, Brodeur makes much use of such Watergate terms as "stone-walling," "smoking gun," and "cover-up." Brodeur accuses the Defense Department of a cover-up of ignorance rather than of information, of unwillingness to admit possible error in setting exposure standards, and of using its influence to limit independent investigation. He suggests that the department has been motivated by fear of litigation from exposed persons, by the enormous expense of lowering (military and civilian) exposure to microwave radiation from classified Defense Department sources, and by the department's putative possession of secret microwave weapons. The individual reader must decide whether the charges have been proven. The State Department is criticized for not informing its Moscow embassy employees of their irradiation by Russian microwave beams and for delaying protective measures. It was later claimed that levels were too low for concern. Yet Brodeur notes that the State and Defense departments and the Central Intelligence Agency were concerned enough to begin clandestine animal research on biological effects of microwaves, though the results of the research were apparently inconclusive. (An unclassified epidemiological study of Moscow embassy employees is now under way at Johns Hopkins University.)

Brodeur is a resourceful journalist advocating a definite viewpoint; he makes little pretext at evenhandedness. He cites a mountain of reports (some recently declassified) detailing telling aspects of government decision-making. There are some technical errors in the book (for example, the startling statement that the electromagnetic spectrum ends at about 10 Hz), but these are rarely significant. More disconcerting is Brodeur's willingness to impute motives. He frequently proffers dramatic speculation, undocumented allegation, and even innuendo.

Regrettably, there is no way to connect citations in the text with the references listed. Moreover, the use of cited materials is sometimes careless. For example, the Czech scientist Karel Marha is reported as having stated that some of a set of effects (including headaches, sleeplessness, and fatigue) were observed at exposures of 0.1 mW/cm^2. Actually, the reference shows that Marha assigned no particular level to these effects; he later stated that some effects he did not specify were observed at 0.1 mW/cm^2. Brodeur makes considerable use of newspaper articles, secondary sources at best and of uneven reliability (the newspapers range from the *New York Times* to the *National Enquirer*). He also tends to overlook information that is detrimental to his thesis. For example, the auditory perception of microwave energy is cited as a direct effect on the central nervous system without mention of numerous studies implicating thermomechanical stimulation of the cochlea. Elsewhere, in attempting to link the lack of Western epidemiological studies with a Defense Department cover-up, Brodeur dwells on the department's lack of cooperation with a follow-up study of congenital anomalies in children born at Fort Rucker, Alabama, an Army flight-training base with numerous radars. Though Brodeur discusses positive and negative findings from the initial study the reader is not told that the final report quoted the researchers as concluding that "in net terms, and on the basis of available retrospective data, there are no strong indications that the incidence of congenital anomalies in the Fort Rucker, . . . area is higher than normal."

Brodeur does draw attention to some important issues, among them the potentially high occupational exposure from radio-frequency plastic sealers and the lack of Western epidemiological studies of the effects of microwave exposure,

which has been noted often by others. Unfortunately, such information is buried in a plethora of speculation.

Discussing the early history of the issue, Brodeur notes that "in the absence of scientific work, . . . a whole folklore, based on a mixture of intuition, observation and apprehension, grew up around the biological effects of shortwaves and microwaves." It is debatable whether Brodeur has improved the situation or made it worse.

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The Acceptance of Contraception

From Private Vice to Public Virtue. The Birth Control Movement and American Society since 1830. JAMES REED. Basic Books, New York, 1978. xvi, 456 pp. + plates. $17.95.

From Private Vice to Public Virtue is a broadly conceived and admirably executed study of the American birth control movement from the publication of *Fruits of Philosophy* (1832) by Charles Knowlton, an eccentric Yankee physician and freethinker, to the discovery and popularization of hormonal methods of inhibiting ovulation. Reed insists that such a history has to analyze several factors: the role of technology, the contributions of leaders, changing popular conceptions of marriage and sexuality, and broad shifts in social thought. Although his account of scientific innovators such as Gregory Pincus, whose work on hormones led to development of the contraceptive pill, is both subtle and gripping, Reed does not believe that such innovations are the crux of the issue. Rather, he stresses that a wide range of birth control techniques from coitus interruptus to condoms and douches were available during the 19th century and were, relative to contemporary medical information on other matters, reliable. The obstacle to wider acceptance of contraception was less technological than psychological. The psychological "availability" of contraception during the 19th century was restricted by the prevalent assumption that sexual gratification had to be held in check. Similarly, Reed argues that the development of the pill and the intrauterine device owed more to changes in social values than to technological opportunity. These contraceptives were accepted because they offered a way to a biological economy of low death rates and low birth rates at a time of fears of world overpopulation. A generation earlier "the pill would have been dismissed as a dangerous interference with natural processes; the IUD would have been banned as an abortifacient" (p. 376).

Reed's emphasis on the role of social values is reflected in his discussion of Margaret Sanger. Her success was partly due, Reed argues, to the decline during the second and third decades of this century of the idea that sexual gratification within marriage had to be held in check. Greater material abundance and the growth of advertising spurred hedonistic attitudes even on issues of sexuality. But attitudinal change was not always a liberalizing force. Even as Victorian inhibitions waned, rising fears generated by the differential fertility of native- and foreign-born parents encouraged opposition to birth control. During the 1920's immigration restrictionists, Roman Catholics, and most physicians (who associated birth control with quackery) formed a powerful alliance against birth control. The case for birth control long had to be made through "mixed metaphors and twisted analogies" (p. 63); proponents of birth control had to follow an oblique rather than a straight line of attack.

Because social values pertinent to family limitation were often in conflict, the role of leaders was vital to the success of the movement. Reed provides extensive and insightful biographical sketches of figures such as Robert Latou Dickinson, Clarence Gamble, and Katherine Dexter McCormick, but Margaret Sanger is the protagonist of his story and the subject of some of his most penetrating comments. He takes issue with David Kennedy's censorious biography, *The Career of Margaret Sanger* (1970). Kennedy portrayed Sanger as abandoning her radical associates during the 1920's and fostering a new cult of domesticity by affirming that birth control could increase amative gratification in marriage. Reed argues that Sanger was never an apologist for marriage, but merely broadened her base of support during the 1920's. He sees her as the perfect pragmatist, making concessions where necessary to the self-conscious professionalism of doctors such as Dickinson in order to recruit the trained personnel for a national system of birth control clinics.

The diversity of types drawn to the birth control movement reflected Sanger's desire for a broad base. Sanger herself represented the aspirations of a variety of clubwomen, feminists, and working women. Dickinson, her first important link to the medical profession, was a religious man who thought that birth control was necessary to insure the viability of the monogamous family. Others such as Clarence Gamble, the Ivory

A 19th-century handmade rug. [Sophia Smith Collection, Smith College; reproduced on the dust jacket of *From Private Vice to Public Virtue*]