The Gremlin in the Machine

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WHY THINGS BITE BACK:

Technology and the Revenge of Unintended Consequences.

By Edward Tenner. Knopf. 352 pp. $26

Technophilia is back. In truth, the return began in the early 1980s, after a decade of doubts and criticism sometimes bordering on technophobia. At about the same time that President Ronald Reagan declared that it was "morning in America," Tracy Kidder discovered *The Soul of a New Machine* and the Tofflers paddled out to meet *The Third Wave.* To be sure, the icons of the new technophiles are not the factories, automobiles, and airships of the messy "second wave"; rather, they are the personal computers, monitors, and modems of the Information Age.

Yet for all the new trappings, the technophilia of the late 20th century remains tied to the 19th-century assumption that technological progress is inevitable, linear, and benign. Like "the economy" or "the market," the "information highway" is now thought of as an autonomous force that drives change regardless of human preferences or social policies. "Ever kiss your baby goodnight ... from the airport? Ever go to a sales meeting ... in your bare feet?" asks AT&T. "YOU WILL!" (presumably whether you want to or not).

Not surprisingly, such an oversimplified view provokes a mirror-image response: apocalyptic jeremiads lamenting irreversible decline. Dreams of beneficent control on one side, nightmares of chaos on the other. The journalistic understanding of technological issues has become a melodramatic face-off between Dr. Pangloss and Cassandra.

Edward Tenner will have none of this. A former science editor at Princeton University Press, he has produced an illuminating meditation on technological change. *Why Things Bite Back* is a bracing critique of technological determinism in both its utopian and dystopian forms. Spuming the notion that technology constitutes an irresistible demiurge in human affairs, Tenner also debunks the managerial faith in predictability and control. He knows about everything from 19th-century railroad accidents to zebra mussels and graphic interfaces. He has a sharp eye for the telling detail and an uncommon ability to combine scientific with historical insight. No one who wants to think clearly about our high-tech future can afford to ignore this book.

Tenner's master idea is that technological developments often (indeed, nearly always) have "revenge effects": unforeseen consequences that create new problems or undo existing solutions to old problems. Tenner first developed this insight eight years ago in a prescient essay, "The Paradoxical Proliferation of Paper," in which he pointed out the obvious but unacknowledged fact that the computerized office was spewing forth far more printed documents than its low-tech and supposedly paper-cluttered predecessor.

Looking around, Tenner found mounting evidence that "revenge effects" have steadily increased over the last 100 years, as technical innovations have become part of "tightly coupled systems." Disasters are more easily averted and risks minimized in

"loosely coupled systems"—a crowded beach, for example, can be cleared by lifeguards when a thunderstorm approaches. But as Tenner explains, when the same number of people are packed into a stadium surrounded by gates, turnstiles, and other control devices, the possibilities for catastrophe increase. "The fall of a single person can panic a crowd, part of which is then crushed against some obstacle," he writes.

Our manmade environment is full of such tightly coupled systems. Their components have multiple links that can interact unexpectedly, says Tenner, "as when an airline coffeemaker heats concealed wires and turns a routine short circuit into a forced landing and near crash." It was the prevalence of such unexpected malfunctions that led the engineer Edward Murphy to conclude: "If there's more than one way to do a job and one of those ways will end in disaster, then somebody will do it that way." Murphy's Law is not a fatalistic prediction of disaster; it is a call for alertness, anticipation, and adaptation. It is also a challenge to complacent technophiles.

One of Tenner's major themes is the shift from tool use to tool management, which puts "human agency at greater and greater removes" from the task at hand. No one, least of all Tenner, would deny the benefits of distancing workers from hot, dirty, dangerous physical labor. But distance has its dangers. In the computerized office, it can trigger "the revenge of the body"; carpal tunnel syndrome and other cumulative trauma disorders challenge "the vulgar Platonism of computer studies that assumes a frictionless and disembodied world of information processing."
Tenner identifies the same problem in medicine, where the reduction of direct physical involvement can lead to an over-reliance on tests rather than old-fashioned hands-on diagnosis. For example, a student at Stanford University endured four weeks of horrific tests before the hospital finally acknowledged that his stomach pains were the result of a ruptured retrocecal appendix. Tenner reports that "a retired physician and family friend had recognized the symptoms at once, but the young doctors trusted tests above traditional judgment." About so-called automated treatment, Tenner warns that it "requires greater attention on the part of physicians, surgeons, nurses, and technicians, and increasingly of computer programmers and software developers." Unmonitored software can fail to signal dangerous conditions, send false alarms, deliver too much or too little medication, even administer fatal doses of radiation. In medicine, as elsewhere in our high-tech society, we see a departure from what anthropologists call "local knowledge" (wisdom patiently accumulated over years of experience) and a movement toward an intense, narrow focus on technical solutions to specific problems.

Rising expectations of a smoothly ordered existence are rooted in the managerial "illusion of control," which Tenner exposes most clearly in his discussion of the computerized office. "What-if software allows managers to simulate the consequences of various decisions. But growing evidence suggests that such model building does not improve decision making at all. Instead, the what-if-software feeds the fantasy that "we are making things happen when in reality they are chance events." In business, situations constantly arise "in which what-if questions are of limited value, in which

politics, distribution, the evolution of standards, and sheer bluff matter as much as technical excellence."

Tenner's universe, like William James's, is pluralistic and contingent. At the same time, everything is interrelated. In the field of public health, "we are awakening from the 19th-century dream of specificity." How can we go on fighting pitched battles against specific diseases when before our eyes bacteria are mutating into new, vaccine-resistant strains? "The boundaries between species and organisms are not as well defined as our ancestors believed," writes Tenner. "In only 50 years we have gone from the offense to the defense."

As a history of Murphy's Law in operation, Tenner's book reminds us that Nature has a way of undermining human schemes regardless of intent. When the owners of smelters and power plants built tall stacks to meet strict emission-control standards in the 1970s, the effect was to create acid rain hundreds of miles away. The suppression of natural fires by the Forest Service provoked "Smokey's Revenge": the growth of a "doghair thicket of young pines, white fir, incense cedar, and mature brush," which kindled a new type of forest fire that spread faster and burned hotter than previous conflagrations. During the Depression, the Department of Agriculture encouraged the planting of the east Asian kudzu vine all over the South in an effort to regenerate leached-out soil. Ever since, the kudzu has been pulling down telephone poles, obliterating traffic signs, and overwhelming stationary objects—including (if you believe folk wisdom) passed-out drunks. The best scientific minds have not been able to forecast the latent consequences of altering natural systems. In Tenner's apt phrase, undoing the effects of such tinkering can be "as impossible as unscrambling an egg."

Tenner does not counsel despair. He points out that "the real perils are not those we fear," while also noting that "the real benefits are usually not the ones we expected." He has faith in the "long term reverse revenge effects" of disaster, and he believes that "we have learned the limits of intensiveness." On a hopeful note, he suggests that "by replacing brute force with finesse, concentration with variety, and heavy traditional materials with lighter ones, we are already starting to overcome the thinking and habits that lead to many revenge effects."

The "we" in this sentence is, of course, the industrialized West. But what about the rest of the world? Tenner aptly observes that "what appears to be a technological question—how much of anything we really need —is in the end a social one." But when it comes to the social (and political and economic) questions. Tenner's thought can be surprisingly unfocused. Despite his deep distrust of technological determinism, he sometimes allows human beings to disappear from view. Writing of the desolation of resource-rich regions such as the Pennsylvania anthracite country, he admits that "absentee ownership" may have played a role. But the real source of the impoverishment, he says, was the resources themselves: "It was wealth that became an enemy of a vital diversity." Obviously, this leaves out the question of whether different human agents with different priorities—say, local entrepreneurs instead of outside investment capital — might have structured the regional economy in a less exploitative way.

The point is not to demonize the coal industry but to suggest that Tenner's analysis might have benefited from a larger conceptual framework. As part of recent corporate downsizing strategies, computers have been helping to create technological unemployment or underemployment for thousands of white-collar workers. This is not a revenge effect, as Tenner defines it. The computers may well be doing just what they were meant to do: cutting costs and increasing productivity. (For Tenner, a revenge effect would occur if the remaining employees were too few or too dispirited to perform productively, as often is the case.) Yet there is no question that the disappearance of job security can be seen, metaphorically at least, as a revenge effect resulting from a complex interaction of technology with concentrated power and dominant values. Likewise the deterioration of civil society, the loss of social tranquillity, and the decline of biological and cultural diversity.

Still, to sharpen the critique might be to weaken the case. In today's intellectual climate, critics must be exceptionally careful about challenging the bromides of technophiles, who, as Tenner observes, are "always ready to dismiss revenge effects as 'transitional.' " Only a handful of nuts (militiamen and unabombers, it is tacitly assumed) deny the beneficence of our corporate technostructure. Tenner's genteel language of "tastes and preferences" is probably more effective than rhetoric (however justified) about power and domination. And his skeptical, humane perspective makes it plain where his own values lie. "The open question," he writes, "raised during the upheavals of the 1970s and then forgotten during the boom of the 1980s, is whether cultural change can lead to new preferences that will in turn relieve humanity's pressure on the earth's resources." Thanks to Tenner, that question has just opened a little wider.

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