

## High-Tech Tantalus

The arrival in the American workplace of the computer and other high-tech marvels was supposed to give a strong boost to the U.S. economy. So far, it hasn't. The cause of frustration is a band of obstinate gremlins—what Edward Tenner here describes as “revenge effects.” Unless we confront them with better organization, Tenner argues, we will continue to be tantalized.

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*by Edward Tenner*

**T**he tragic god of the industrial West was once Prometheus, who still holds the place of honor at the Rockefeller Center skating rink. If a statue for the year 2000 is needed, it perhaps should be of King Tantalus, son of Zeus, who according to one account brought secrets—information rather than fire—from the gods to humanity. For this theft he was cruelly punished in the netherworld: The water in which he was condemned eternally to stand would recede whenever he leaned over to drink, and a bough of fruit that dangled above him would be blown beyond his grasp whenever he reached for it.

The 1980s was a tantalizing decade. Computers seemed to transform the workplace. They did not, as feared, throw millions out of work. But neither did they, as hoped, make many workers feel less harassed or more creative. They increased

productivity least in services, the sector of the economy that was growing fastest.

There are success stories to the contrary. Thanks to computer-based exploration geophysics, America's estimated recoverable reserves of oil have declined little during a decade of three-billion-barrel annual production. Authors' electronic files and conversion software have helped some book publishers reduce production costs and hold down prices. But will these be typical experiences? Many people, still tantalized, are wondering.

In 1987 the Labor Department reported that the rate of productivity growth outside manufacturing had fallen significantly since the beginning of office automation in the early 1970s. The pre-computer postwar average of 2.3 percent declined to 0.5 percent annually between 1973 and 1981 and was still only 0.7 percent by the mid-1980s. In the professions, the record has been even worse: two-

tenths of one percent annually. Government fared no better. The U.S. Postal Service has spent \$526 million on automated equipment in the last year yet still runs a \$1.6 billion deficit and has actually increased its mail-processing work force to handle all those bar codes and nine-digit zips.

In 1988 Robert H. Flast, vice president for technology strategy at American Express, told a meeting of the New York Academy of Sciences that the costs of making computer systems work have "more than offset the savings from work transferred to the machines." Stephen Roach, a Morgan Stanley & Co. economist, declared to the *Wall Street Journal*: "Fifteen years into the 'high-teching' of America, the U.S. is still trapped in a quagmire of low-productivity growth." Since the great majority of new jobs in the 1990s will be in the service sector, the recent record is an enigma.

What we have discovered the hard way, and will continue to find, are revenge effects: unintended and ironic consequences that apparently neutralize the benefits of technology. Everyone has his own favorite revenge effect. Parkinson's Law, that work expands to fill the time available for its completion, is a cautious executive's revenge effect. The unmanageable growth of traffic on new highways that were built to lower the old level of congestion is an environmentalist's. A recent book on long-term accident rates in developed countries by John Adams of the University of London argues that total casualties changed remarkably little from 1900 to 1975; Heinz Wolff, another British academic, has used Adams's data to suggest that people are "buying back danger," taking new risks that cancel the benefits of safety measures. Automatic teller ma-



*Tantalus tantalized.*

chines, originally an alternative to long banking lines, now have queues of their own: revenge again. At home, as the historian Ruth Schwartz Cowan has shown, "labor-saving" appliances have redirected rather than reduced time spent on housework. And all that oil recovered by new techniques may lead only to more sprawl and longer commutes.

A revenge effect is not necessarily bad. It may simply reflect a consumer priority. To some people, rural life or a better job may be worth a fatiguing drive to work. Access to cash at all hours may matter more than shorter waiting times. Clean underwear daily may be worth a sacrifice of leisure time, especially if it's that of another family member. Speed may be val-

ued above safety. If we were consistently conscious about our preferences, we might not perceive revenge effects as problems. But forecasters and marketers influence our expectations. When they are not met, we are tantalized.

We expect, for example, that technology will give us an advantage over competitors; but of course the competition has or gets technology of its own. Martin Neil Baily, an economist at the Brookings Institution in Washington, has pointed out that "much of information processing is used as a tool in the effort to move customers from one company to another." If slick laser printing influences even tough-minded biomedical researchers to rank some scientific materials higher than others, as a recent study suggests, no wonder so much computer power goes into persuasion rather than production. But these advantages seldom last. The first users, whether of hot-air balloons, carrier pigeons, real-time stock quotations, or cellular telephones, have a temporary advantage that disappears as rapidly as the technology spreads. In the long run, arms races help mainly the armorers.

Even where we appear to gain real productivity, we are tantalized because we can't estimate the price we will have to pay in learning time. Digital Equipment Corporation estimated in 1987 that it presented more classroom hours each year than Harvard, Yale, and Princeton combined. The technical manuals for a single car can cost a repair shop \$1,600 a year, and mechanics may need two days to study one new electronic transmission. Computers themselves will continue to be simpler to use; yet as their capabilities grow, there will be more to study. There seem to be between one and two pages of documentation per dollar of retail price for most popular applications software, not to mention entire bookstore sections devoted to the information and techniques the producers left out. Organizations in the

1990s will have to look much harder at learning costs—theirs, their customers', and third parties'.

In principle, this learning time is an investment that should lead to higher pay for the employee as well as more profit for the firm. In fact, the benefits aren't necessarily appearing. A recent survey of desktop publishing managers suggests that impressive gains in the productivity of their systems often haven't affected their salaries. And technology is also shifting work within organizations without necessarily increasing output. While some workers are eliminated or downgraded, others have the double burden of learning new systems and making up for the work of the displaced. In one recent study of a small midwestern manufacturing company, the "protected" employees chosen to operate the new systems frequently cited job stress and 60-hour workweeks. In offices, skilled employees may take hours from their real jobs to guide coworkers with new equipment. No wonder a current cynical definition of productivity is "fewer people working longer."

Even where staffing isn't changed, speed doesn't necessarily bring more productivity. Spreadsheet software should be able to free managers' time for more creative work. But some managers armed with financial and statistical software may demand and produce more data more often, with no net saving of time. As the computer consultant Paul Strassmann has pointed out: "If a secretary types 300 lines of mostly useless texts per day it does not follow that replacing the typewriter with a word processor capable of generating 3,000 mostly useless lines" will make a firm more productive.

With texts as with data, revenge effects don't stop at the first draft. The ease of correction can relax the incentive to get things right the first time; writing may take as much time as it did conventionally. It's all too easy to fiddle with perfectly good work, making neutral or even harmful re-

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visions. And data of all kinds do seem to expand to fill ever cheaper storage technology. According to the market analysis firm Dataquest Inc., American users bought nearly four times the IBM disk storage in 1987 alone that they had in the seven years between 1975 and 1982.

A decade ago, the experts imagined that this abundant storage and electronic networking would reduce the need for hard copy. Instead, the most surprising and striking revenge effect of all has been a paradoxical proliferation of paper. The paperless office has already gone the way of the fiberglass bungalow and the robot butler. From 1975 to 1987, total sales of printing and writing paper (excluding newsprint) increased from 10.9 to 23.4 million short tons. The techno-pundits ignored how much easier and cheaper it was becoming to print out a new document. They imagined that the computer was central and the printer "peripheral." They didn't see how soon the speed, quality, and economy of printers would improve. They didn't understand that most people hate long hours at a terminal and fear losing data. And they didn't realize the electronic-driven potential of paper, from high-volume, self-diagnosing copier-duplicators to faxes to satellite-transmitted national newspapers. No wonder experts once predicted that 5,000 plain-paper copiers would satisfy the entire demand of the United States. (There are approximately 5,224,000 in circulation today.)

Image processing is beginning to reduce the need for long-term paper storage. Its revenge will probably be even more frequent paper retrieval. No more rummaging through filing cabinets, walking down the hall, and waiting in line; instant photocopies will follow a few keystrokes. Cheaper and faster laser printers will encourage making more copies of longer documents. Inexpensive plain-paper faxes will transmit these from office to office, while postal volume will continue to grow as people continue to mail confirmation copies.

Because there will be more documents

but no more hours in a day, the proliferation of paper will make it even harder to attract attention and to pay attention. Top managers will cope with information overload only at a price: Assistants will screen and organize data. Professor William Melody of the British Program on Information and Communications Technology (PICT) even foresees "corporate electronic monks" giving context and meaning to data and raw information. On the front lines, some blue- and white-collar workers will have more and more information pre-organized electronically. Already, American Express credit card authorizers use an expert system summarizing account information that once took as many as 16 screens from six data bases. Middle managers will have less help.

Will the next decade and beyond be as tantalizing as the 1980s? Not necessarily. We are starting to learn from experience about technology in organizations, and there are encouraging lessons. Automation doesn't solve the problems of organizations. The hierarchies borrowed from the military and old-style manufacturing are poorly matched with the ability of new technology to share information and to upgrade work. Some companies already give more authority to smaller numbers of better-educated and highly-trained production employees—"gold-collar" workers, as Robert Kelly at Carnegie-Mellon University has called them. The same is possible in the service sector. New corporate structures can give initiative to larger numbers of employees. The real challenges are no longer electronic but human.

Once we realize how commonplace revenge effects are, we can do something about them. (Sometimes there's nothing wrong with them: Isn't it better to recycle paper than to force people to stare all day at terminals?) We can plan for them, take advantage of them, or train ourselves to avoid them. Blind optimism makes it more likely that they will dominate us. The age of Tantalus need not extend indefinitely. But we must resolve to end it.