THE NEW YORKER

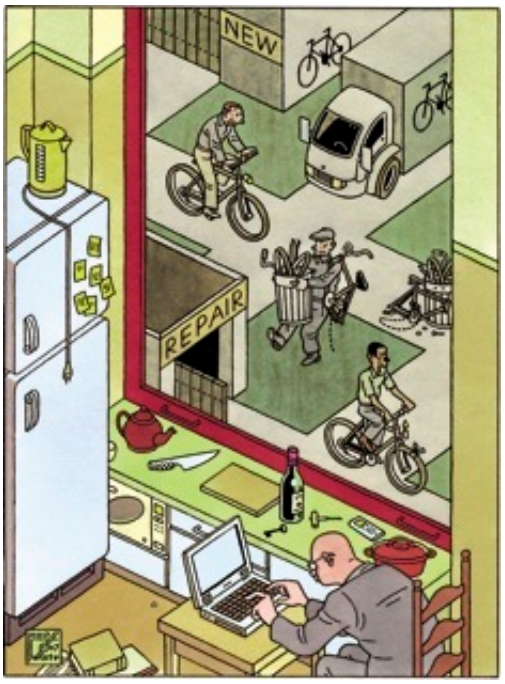
BOOKS

WHAT ELSE IS NEW?

How uses, not innovations, drive human technology.

by Steven Shapin

MAY 14, 2007



We tend to think of technology in futuristic terms, barely noticing many older technologies so ubiquitous as to be almost invisible.

- 1

I'm writing in the kitchen, surrounded by technology. There is a cordless phone, a microwave oven, and a high-end refrigerator, and I'm working on a laptop. Nearby is a gas range, a French cast-iron enamelled casserole, and a ceramic teapot. Drawers to my left hold cutlery—some modern Chinese-made stainless steel, some Georgian sterling silver. In front of me is a wooden bookstand, made for me by a talented friend and festooned with Post-it reminders of things to do (a method I prefer to my digital calendar). I'm sitting on a semi-antique wooden chair, though when my back is hurting I tend to switch to a new, expensive ergonomic contraption.

Perhaps you think I should have said that I'm surrounded by *things*, only some of which really count as technology. It's common to think of technology as encompassing only very new, science-intensive things—ones with electronic or digital bits, for instance. But it's also possible to view it just as things (or, indeed, processes) that enable us to perform tasks more effectively than we could without them. The technologies that we have available substantially define who we are. The nineteenth-century Scottish essayist Thomas Carlyle didn't much like the new industrial order, but he did understand the substantive relationship between human beings and their technologies: "Man is a Tool-using Animal. . . . Nowhere do you find him without Tools; without Tools he is nothing, with Tools he is all." Seen in this light, my kitchen is a technological palimpsest. Even the older items were once innovations—like my Brown Betty teapot, whose design goes back to the seventeenth century but which is still produced in England, not having been significantly improved on since. And even the newest items contain design or functional elements from the past, such as the QWERTY keyboard of my laptop, patented in 1878.

The way we think about technology tends to elide the older things, even though the texture of our lives would be unrecognizable without them. And when we do consider technology in historical terms we customarily see it as a driving force of progress: every so often, it seems, an innovation—the steam engine, electricity, computers—brings a new age into being. In "The Shock of the Old: Technology and Global History Since 1900" (Oxford; $26), David Edgerton, a well-known British historian of modern military and industrial technology, offers a vigorous assault on this narrative. He thinks that traditional ways of understanding technology, technological change, and the role of technology in our lives, have been severely distorted by what he calls "the innovation-centric account" of technology. The book is a provocative, concise, and elegant exercise in intellectual Protestantism, enthusiastically nailing its iconoclastic theses on the door of the Church of Technological Hype: no one is very good at predicting technological futures; new and old technologies

coexist; and technological significance and technological novelty are rarely the same—indeed, a given technology's grip on our awareness is often in inverse relationship to its significance in our lives. Above all, Edgerton says that we are wrong to associate technology solely with invention, and that we should think of it, rather, as evolving through use. A "history of technology-in-use," he writes, yields "a radically different picture of technology, and indeed of invention and innovation."

"Is that legal? Can the old man force me to take a performance-enhancing drug."

Consider the Second World War. When we think about the technologies that figured large in it, what comes to mind? Perhaps Germany's V-2 terror weapons, with their emblematic role in Thomas Pynchon's "A screaming comes across the sky." Or the triumph of theoretical physics and metallurgical engineering at Hiroshima and Nagasaki. These are the things that capture the imagination, and yet Edgerton offers an arrestingly different perspective, calling German investment in the V-2 project "economically and militarily irrational." One historian wrote that "more people died producing it than died from being hit by it." Edgerton estimates that although the Germans spent five hundred million dollars on the project, "the destructive power of *all* the V-2s produced amounted to less than could be achieved by a single raid on a city by the RAF." Similarly, considering the cost of the atomic bomb against the conventional weaponry that could have been bought for the same money, "it is not difficult to imagine what thousands more B-29s, one-third more tanks or five times more artillery, or some other military output, would have done to Allied fighting power."

So what forms of technology really pulled their weight in the war? Horse-powered transport, for one. Long past the age of steam—and well into the age of automobiles and aviation—the power of horseflesh remained critical. In the Italian campaign alone, the United States Army's 10th Mountain Division used more than ten thousand horses and mules, and the great tank general George S. Patton wished he'd had many more:

> In almost any conceivable theater of operations, situations arise where the presence of horse cavalry, in a ratio of a division to an army, will be of vital moment. . . . Had we possessed an American cavalry division with pack artillery in Tunisia and in Sicily, not a German would have

escaped, because horse cavalry possesses the additional gear ratio which permits it to attain sufficient speed through mountainous country to get behind and hold the enemy until the more powerful infantry and tanks can come up and destroy him.

The Germans were better supplied: at the beginning of 1945, the Wehrmacht had 1.2 million horses in its ranks, and, altogether, the Germans lost some 1.5 million horses during the war.

Even today, horses aren't quite history. In Afghanistan, the American Special Forces have had to rediscover how to use them. "Horses are actually an ideal way to get around there," one correspondent embedded with the Green Berets has said. "No manual has ever been written on how to coordinate horse attacks with B-52s, so the Green Berets had to do OJT"—on-the-job training. "Early on, there was a cavalry charge with about three hundred horses where they had cut it so fine that as soon as the bombs hit the ridge the horses were riding through the gray smoke; it was quite an impressive sight."

Technological palimpsests are everywhere; it's the normal state of things. Darfurians are being slaughtered by Janjaweed militia mounted on horses and camels, while their Sudanese-government sponsors chip in with helicopters and Antonov cargo planes retrofitted as bombers. September 11th was a technological pastiche of new and old technologies (Boeings and box cutters), as was the 2003 Iraq invasion (stealth fighters, cruise missiles, and laser-guided smart bombs for the "shock and awe," and jury-rigged sandbags and scrap-metal armor for Army Humvees when the Pentagon failed to provide high-tech alternatives). The Iraqi insurgents have revived the use of chlorine gas as a terror agent, a technology pioneered by patriotic German chemists in the First World War, and Saddam Hussein, whose aircraft dropped modern nerve-gas bombs on the Kurdish town of Halabja, was executed by hanging, a technology of judicial killing that goes back to the ancient Persian Empire.

Edgerton calls the tendency to overrate the impact of dramatic new technologies "futurism." Few things, it turns out, are as passé as past futures. In the mid-twentieth century, a world was promised in which nuclear power would provide electricity "too cheap to meter," eliminating pollution, forestalling energy crises, and alleviating world poverty; hypersonic civil air travel would whip masses of us around the globe in an hour or two; permanent settlements would be established not just on the moon but on the planets; nuclear weapons would put an end to war.

And so it goes. The "paperless office" was celebrated as long ago as 1975, in *Business Week*, but since then we've had avalanches of the stuff: global consumption of paper has tripled in the past three decades, and the average American worker now goes through twelve thousand sheets of paper every year. In 1987, Ronald Reagan announced that high-temperature superconductor technology would "bring us to the threshold of a new age," but commercializing that technology has proved much more difficult than the original hype suggested. In 2000, Bill Clinton speculated that, as a direct result of the Human Genome Project, "our children's children will know the term 'cancer' only as a constellation of stars." (That would be nice, if only because it would indicate an improved knowledge of astronomy.) Predictions like these don't inspire great confidence in the utopian futures now being spun around stem-cell research or nanotechnology.

But neither should we have great confidence in the more dire prophesies. In the middle of the nineteenth century, it was thought that railways would whirl people about the world with such

vertiginous speed that their nervous systems could collapse under the strain. Decades later, it seemed that the telephone would be a socially disruptive force, causing aural communication to take place without any of the rich cues of face-to-face interaction, breaking down the barriers between public and private space, and making it intolerably hard not to be "at home" when one *was* at home.

Learning how to make new technologies is one thing; learning how, as a society, to use them is another. Carolyn Marvin's illuminating book "When Old Technologies Were New: Thinking About Electric Communication in the Late Nineteenth Century" (1988) notes that, during the early years of the telephone, there was confusion about what codes should regulate faceless and socially clueless speech. The telephone operator, typically female, often had the responsibility of waking up the master of the house, and so joined the wife as a woman who could talk to the man in bed; Marvin writes that "sweet-voiced" telephone girls at the turn of the century "were often objects of fantasy." It was also thought that, if just anyone could use the new device, its utility would be completely undermined. Marvin notes the firm opinion of the British postmaster general in 1895 that "the telephone could not, and never would be an advantage which could be enjoyed by the large mass of the people." He was wrong, but understandably so. The story of how we came to terms with the new technology—how we adjusted to it, adapted to it, domesticated it, altered it to suit our purposes—didn't come with the technical spec sheet. It never does. No instruction manual can explain how a technology will evolve, in use, together with the rhythm of our lives.

Old technologies persist; they even flourish. In that sense, they're as much a part of the present as recently invented technologies. It is said that we live in a "new economy," yet, of the world's top thirty companies (by revenue), only three are mainly in the business of high tech—General Electric (No. 11), Siemens (No. 22), and I.B.M. (No. 29)—and all three go back more than a century. The heights of the early-twenty-first-century corporate world are still occupied—as they have long been—by petroleum companies (Exxon Mobil, Royal Dutch Shell, and B.P., Nos. 1, 3, and 4), retailing (Wal-Mart, No. 2), automobiles (General Motors, No. 5), and finance (I.N.G. and Citigroup, Nos. 13 and 14). No Hewlett-Packard (No. 33); no Microsoft (No. 140); no Merck (No. 289).

The tendency to exaggerate the impact of technological innovation follows from an artifact of historical consciousness. When we cannot conceive what life would be like without e-mail, say, we correctly note the pervasiveness of the new technology, but we may incorrectly assume that the things we now do through e-mail could not have been done in other ways. Of course, we must know that many things now done through e-mail were once done, and to some extent are still done, by telephone, fax, snail mail, or actually stopping by to see someone. But we can never know how the technologies that existed before electronic communication would have developed had e-mail not become dominant, or what other technologies might have come along whose development was forestalled by e-mail.

In 1897, to move mail around the city, Manhattan started to equip itself with an island-wide system of underground pneumatic tubes, which soon extended from 125th Street as far as the Brooklyn General Post Office. Through the nineteenth century, the pneumatic tube had developed

roughly in step with the telegraph and then the telephone. For a long time, indeed, pneumatic tubes seemed promising—perhaps they could shunt people around as well as mail—although, ultimately, it was the telegraph and the telephone that flourished, becoming the ancestors of the electronic communication systems we use today. Yet, had there been a century of continuous improvement, who knows what benefits a dense and speedy system of message tubes might have brought? A man working on Eighty-sixth Street could send a scribbled note, chocolates, and a pair of earrings to his girlfriend on Wall Street. To have left your wallet at home could be a mistake remedied in seconds. It's a safe guess, anyway, that, while aware of a distant past containing such figures as postmen and delivery boys, we would be unable to imagine life without the pneumatic tube.

This kind of counterfactual history has a credibility handicap—we know how things did turn out but can only imagine how they might have turned out. Still, there's no reason to assume that the technology we have is the only technology we could have had. The birth-control pill, we say, caused a sexual revolution, and perhaps that's true. But it joined (and only partly replaced) many other methods of contraception, some of which—like the condom—have continued to improve in all sorts of ways since the advent of the pill. And it has been argued that the pill had a dampening effect on the development of other technologies, such as male hormonal contraceptives. Is the pill the best possible outcome? The answer depends on who you are, what you want to do, and the resources you command. As it turned out, the replacement of the condom as a sexual technology, so frequently announced in past decades, was premature. The emergence of AIDS caused condom sales to more than double between the early nineteen-eighties and the mid-nineties. And, for the first time, the old technology of the condom enjoyed an advantage previously monopolized by the new technology of the pill: it could be freely talked about in polite society.

Our obsession with innovation also blinds us to how much of technology is focussed on keeping things the same. The dikes of Holland maintain the integrity of the nation, and great ingenuity goes into preserving and improving them. We're going to need a lot more, and more powerful, technologies of conservation: not just the technologies of levees and barriers against the ocean but technologies to maintain the supply of potable water, breathable air, and arable soil; technologies to maintain as much biodiversity as we can or want to maintain; technologies to preserve and renew our crumbling Victorian legacies of infrastructure (sewers, rail beds, roads, and bridges); technologies to stabilize and prevent the dispersal of radioactive waste. There may be hype attending new technological artifacts, but there's money to be made, and spent, in maintaining them in usable shape. According to Edgerton, the take-home price of a P.C. is typically only about ten per cent of its lifetime cost, and sixty per cent of the lifetime cost of some military equipment is maintenance. The federal government spends twice as much on preserving highways as it does on building new ones. More than half of automobile-dealer profits come from servicing cars, less than a third from selling new cars, and much the same is true of the civil jet-engine business.

The importance of maintenance becomes even clearer if we take a global view. Edgerton notes that as things get older they tend to move from rich countries to poor ones, from low-maintenance to high-

maintenance environments. In many African, South Asian, and Latin-American countries, used vehicles imported from North America, Western Europe, and Japan live on almost eternally, in constant contact with numerous repair shops. Maintenance doesn't simply mean keeping those vehicles as they were; it may mean changing them in all sorts of ways—new gaskets made from old rubber, new fuses made from scrap copper wire. "In the innovation-centric account, most places have no history of technology," Edgerton writes. "In use-centered accounts, nearly everywhere does." John Powell's marvellous study of vast vehicle-repair shops in Ghana, "The Survival of the Fitter: Lives of Some African Engineers" (1995), describes a modern world in which vehicles imported from the developed world initially decay, and then something changes: "As time goes by and the vehicle is reworked in the local system, it reaches a state of apparent equilibrium in which it seems to be maintained indefinitely. . . . It is a condition of maintenance by constant repair." Much of the world's mechanical ingenuity is devoted to creating robust, reliable, and highly adapted "creole" technologies, an ingenuity that is largely invisible to us only because we happen to live in a low-maintenance, high-throwaway regime.

Maintenance has implications for the identity of technological artifacts. There's a traditional conundrum about "my grandfather's axe": over its lifetime, it has had three new heads and four new handles, but—its owner insists—it remains his grandfather's axe. Philosophers have their proprietary version of the axe problem: "Locke's socks" developed a hole, which he had darned, and then darned again. The socks kept the philosopher's feet warm, but they troubled his head. Many people make their living repairing things; a very few make their living pondering whether repaired things are the same. But the identity of repaired and maintained things is not just a philosophical problem. The Bush Administration recently decided to build something called the Reliable Replacement Warhead, or R.R.W., a revised design for such weapons as the W76 thermonuclear warhead on submarine-based Trident missiles. The Administration argues that the technology is based on previously tested components and is just an updated version of the same thing. Critics disagree, seeing this as a new weapon that might be used to justify renewed testing. So judgments of whether the R.R.W. is or is not "the same" technology may well become central to whether or not there will be yet another post-Cold War round of the expensive and dangerous nuclear-arms race.

The astronomer Carl Sagan once said, "We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology." If he meant that we are unfamiliar with the principles on which the technology around us works, he was right—there's an enormous gap between the knowledge of makers and the knowledge of users—but this is exactly as it should be. As users, we typically want our technology to be a black box; we don't want to be bothered with adjusting it, monitoring it, repairing it, or knowing about its inner workings. A sure sign of the success of a technology is that we scarcely think of it as technology at all. The Brown Betty teapot is very old and seemingly simple. Its design is superbly adapted to its function, but I cannot give an account of how its composition and its shape help it to brew a really good cup of tea. Does this mean that I know nothing about the teapot—or, for that matter, the phone or the fridge?

Knowing about technology is not the same thing as understanding the scientific theories involved. Just as innovators commonly understand the fundamentals of a technology better than subsequent users, so users can acquire knowledge that would never have occurred to the innovators. In 1817, Thomas Broadwood, a vastly successful English piano manufacturer, visited Beethoven in Vienna and, shortly after, sent the composer a top-of-the-line instrument. Which of these two men understood the piano better—the craftsman-entrepreneur whose product adorned drawing rooms throughout Europe or the deaf genius whose works are a glory of piano repertoire? Or, for that matter, Liszt, who later owned the piano, and could do things at the keyboard that no performer previously could, or the curator in the museum where it resides today? The piano is one thing to a pianist, another to a piano tuner, another to an interior designer with no interest in music, and yet another to a child who wants to avoid practicing. Ultimately, the narrative of what kind of thing a piano is must be a story of all these users. It's a narrative in which we turn out to know a surprising amount about the technologies that have infiltrated our lives, and in which knowing only as much as we want and need to know about them is, in a sense, to know a lot. "The Shock of the Old" is a necessary reminder of just how important things are in our lives, and how important we are in the life of things. ♦

ILLUSTRATION: JOOST SWARTE