Reinventing the PC

BY FRED GUTERL

Twenty years after its birth, the PC is set to disappear into the fabric of everyday life. Here are five ways it might resurface.

EVERYBODY KNOWS THAT Alexander Graham Bell invented the telephone, Thomas Edison made the first incandescent lightbulb, and Henry Ford first thought of a way to mass-produce the car. But when it comes to the premier invention of our day, the personal computer, the inventor's name is not generally known.

In the early 1960s, when computers were hulking mainframes that took up entire rooms, engineers were already toying with the then-extravagant notion of building a computer intended for the sole use of one person. By the early 1970s, researchers at Xerox's Palo Alto Research Center had realized that the pace of improvement in the technology of semiconductors—the chips of silicon that are the building blocks of present-day electronics—meant that sooner or later the PC would be extravagant no longer. They foresaw that computing power would someday be so cheap that engineers would be able to afford to devote a great deal of it simply to making nontechnical people more comfortable with these new information-handling tools. In their labs, they developed or refined much of what constitutes PCs today, from "mouse" pointing devices to software "windows."

Although the work at Xerox PARC was crucial, it was not the spark that took PCs out of the hands of experts and into the popular imagination. That happened inauspiciously in January 1975, when the magazine *Popular Electronics* put a new kit for hobbyists, called the Altair, on its cover. For the first time, anybody with $400 and a soldering iron could buy and assemble his own computer. The Altair inspired Steve Wozniak and Steve Jobs to build the first Apple computer, and a young college dropout named Bill Gates to write software for it. Meanwhile, the person who deserves the credit for inventing the Altair, an engineer named Ed Roberts, left the industry he had spawned to go to medical school. Now he is a doctor in a small town in central Georgia.

To this day, researchers at Xerox and elsewhere pooh-pooh the Altair as too primitive to have made use of the technology they felt was needed to bring PCs to the masses. In a sense, they are right. The Altair incorporated one of the first single-chip microprocessors—a semiconductor chip that contained all the basic circuits needed to do calculations—called the Intel 8080. Although the 8080 was advanced for its time, it was far too slow to support the mouse, windows, and elaborate software Xerox had developed. Indeed, it wasn't until 1984, when Apple Computer's Macintosh burst onto the scene, that PCs were powerful enough to fulfill the original vision of Xerox researchers. "The kind of computing that people are trying to do today is just what we made at PARC in the early 1970s," says Alan Kay, a former Xerox researcher who jumped to Apple in the early 1980s.

Researchers today are proceeding in the same spirit that motivated Kay and his Xerox PARC colleagues in the 1970s: to make information more accessible to ordinary people. But a look into today's research labs reveals very little that resembles what we think of now as a PC. For one thing, researchers seem eager to abandon the keyboard and monitor that are the PC's trademarks. Instead they are trying to devise PCs with interpretive powers that are more humanlike—PCs that can hear you and see you, can tell when you're in a bad mood and know to ask questions when they don't understand something. Some researchers go so far as to want the PC to disappear into the woodwork. "If you could talk to your PC, you'd have less need for a keyboard," says Nathan Myhrvold, head of research at Microsoft. "Nothing says that future PCs are going to have the same form they do now."

It is impossible to predict the inventions that, like the Altair, crystallize new approaches in a way that captures people's imagination. What follows, though, are five new ideas on personal computing, some of which may provide the stuff of future Altairs.

PHOTOGRAPHS BY STAN GAZ

WEARWARE

Michael Hawley hates arriving at his favorite hotel, where he's stayed a thousand times, and having to give his name and telephone and credit card numbers to a receptionist, who each time enters the information into a computer. He is looking forward to the day when the receptionist smiles and greets him by name, the elevator knows which floor to take him to, and the door to his room swings open as if by magic when he approaches. The key to such convenience, he thinks, is to have computers in your clothing.

Hawley, a computer scientist at MIT's Media Lab, is working on a project, called Things That Think, to make tiny computers and embed them in sneakers, belt buckles, tie clasps, and wristwatches. The devices will communicate with one another through a "body net," a weak electric current sent through the wearer's body, and, via radio, with other computers placed in the "environment"—which means virtually anywhere.

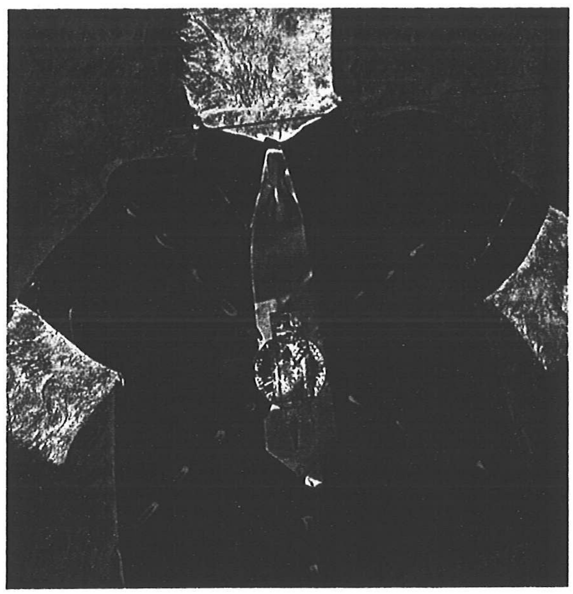
With tiny wearable computers, people might don a microphone that lets them communicate verbally with all the devices they encounter throughout the day. "Someday you may put on your telephone as you put on a tie," says Hawley, "but rather than merely sending your voice over a distance, it becomes the primary speech interface with everything around you. That's a big change. It means you might pick up a camera and say 'Flash' instead of fumbling with some bizarre, twisted little interface."

So far, he and his colleagues have taken only the first step. One of his coworkers, Neil Gershenfeld, has made a wearable device that allows two people to exchange business-card information automatically when they shake hands. Another researcher, Thad Starner, walks around the MIT campus wearing glasses that double as a computer screen. Hawley is working on a project at the Aspen Ski Company in Colorado whereby skiers will get electronic IDs instead of lift tickets. He is placing sensors around the resort that will keep track of where visitors are at any given moment and, eventually, automatically route telephone calls to the nearest phone, or messages to the nearest printer. Along with researchers at Intel, Hawley has also introduced a scheme for sending computer data over power lines into the home. That would enable your washing machine to call the repairman when it breaks down or your alarm clock and videocassette recorder always to know the correct time.

Hawley believes that one day so many tasks will be performed by such computers that the world will seem as magical as it did in medieval times, when people could not explain the world around them except by superstition. "When there's so much computation, and it's so invisible, the magic will come back," he says. "Then we really won't understand what's happening around us."

THE FORCE FIELD

Neil Gershenfeld's research at MIT's Media Lab had little to do with personal computers until a year ago, when cellist Yo-Yo Ma came to MIT to help build electronic string instruments. Gershenfeld needed to come up with a way of keeping track of the position of a violin bow as it moved over the strings. He attached a tiny low-frequency radio transmitter to the bridge of the violin, and a strip of electricity-conducting plastic to the bow. The idea was that the transmitter would create an electric field that would induce an electric current in the strip of plastic as the bow moved over the strings. This current would, in turn, drain energy away from the electric field. By precisely measuring the intensity of the field, Gershenfeld thought he would be able to determine the bow's position relative to the strings.



It was a great idea, but it didn't work. The violinist's hands interfered too much with the electric field, much as a person walking past a television aerial causes interference with the reception. This unexpected result sent Gershenfeld back to the drawing board, but it also piqued his interest in the way human bodies interact with the faint electric fields that surround them. If these fields are so sensitive to the movement of a hand or even a single finger, perhaps they could provide a simple, inexpensive way of imbuing PCs with knowledge of a person's whereabouts.

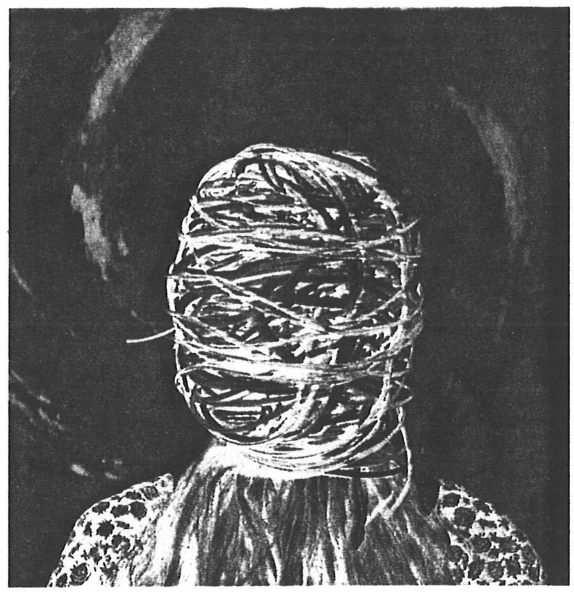
Gershenfeld now has high hopes for these nanoamp force fields. He has already whipped up a "smart" table in his lab. Electrodes and transmitters hidden underneath it generate a force field that tells his PC what his hands are doing. To demonstrate, he calls up on his computer screen what look like two pages in a book. When he moves his hands over the table as though he were turning a page, the pages on his PC turn. His next project is to develop a pointing device that has no mouse, only an invisible force field that tracks your pointer finger. "You can begin to think about having spaces that know what you're doing, unobtrusively," he says. "Down the road, you can assume that the PC has complete knowledge of the physical state of a person. Then you can ask how you want gesture to control things. Maybe you want to wave at your monitor to tell it to display your E-mail."

To show what a PC force field can do, Gershenfeld and his Media Lab colleagues developed a PC that lets you navigate simply by moving your hands. The PC displays what researcher David Allport calls information space—a three-dimensional volume filled with images or text or both. To demonstrate the device, Allport sits in front of a normal-looking PC whose screen shows an animated factory suspended in midair. When he leans forward as though he were plunging into the image, the perspective zooms up close to the factory, stopping only when he withdraws. He then proceeds to "fly" around the factory by moving his hands this way and that. Allport has also created a way of storing text in three dimensions so that it reads like a series of billboards hanging in space.

INFORMATION OVERLOAD

A string hangs from the ceiling to the floor in Mark Weiser's office and wiggles like a twisted, vibrating piece of spaghetti. He calls it the dangling string interface, his favorite "information appliance." Connected electrically to the cable that carries data that shoot around from computer to computer at Xerox PARC, it wiggles violently when lots of data go by, gently when traffic slows down.

Ask the computer scientist what the string is good for and he recommends you get a mind-set adjustment. The dangling string is not designed to accomplish real work. It's there to let the folks in his office feel the pulse of the information age. "There's no computation, no interpretation," he says. "You don't have to look at the string; you can hear it whooshing in the background. It's like looking out your window at the weather. It's a kind of data weather, and people talk about it that way. They'll look over at the string and say, 'Looks like a busy day on the network.' "



In Weiser's vision of the office of the future, the network is likely to be very busy. In his office today he has a couple of television screens, each displaying several colleagues—one is sitting at his desk, another types into a computer, still another chats on the telephone. Weiser leans back in his chair and flips channels with a remote control, bringing his 50 or so colleagues into his office, 7 at a time. The video console is Weiser's answer to people who complain about information overload. What they don't appreciate, he says, is that information is like a river. Rather than piping it through a fire hose and drinking, he suggests swimming in it instead. Having colleagues watch one another on video breaks down the isolation of a closed-door office, Weiser thinks, and promotes a feeling of community. Perhaps this is the true meaning of the global village. The information highway, when it finally gets built, will mean that everybody will have his or her own channel. "People ask how many channels there will be—500, 5,000?" he says. "I think there'll be 5 billion." Of course, nobody yet knows how to build a network that can handle 5 billion video channels.

Weiser's vision of increased data traffic is certainly not confined to the office. He is working on building a computerized apartment in which lights, heating, and appliances are all under the control of a computer that keeps track of your movements. Such a system would require planting hundreds of tiny computers throughout the apartment, each running on battery power. The problem, he says, is that researchers, in their single-minded pursuit of ever faster and smaller electronics, have neglected to invent low-power circuits that preserve a long battery life.

Weiser insists, however, that the human problems are far trickier than the technological ones. "You have to know a lot about human beings to make technology disappear to them," he says.

LIP-READING COMPUTERS

Computers have gotten pretty good at converting the spoken word into words on a page, but they are still light-years away from understanding what those words mean. Artificial-intelligence researcher Alex Waibel at Carnegie Mellon has reluctantly come to accept this limitation, but he is as determined as ever to find a way to get his point across to these stupid machines. The big problem is how to avoid misinterpretation. "We're trying to take away the keyboard and make communicating with your PC more natural," he says. "But we can't do that with 100 percent accuracy. So finding a way of dealing with errors is critical."

One way of avoiding the problem is to restrict computers to a small vocabulary, which greatly reduces the possibility of misinterpretation. Bill Warner, an engineer entrepreneur who founded the company Wildfire Communications, developed a system that responds to only about 30 spoken commands but can still perform a wide variety of useful tasks. Despite the rigid vocabulary, the system seems to be able to carry on a conversation. "The trick is to design the system so that it gives you the impression of intelligence," says Warner, "while at the same time leading you to respond in a relatively predictable way."

The longer-range goal, however, is to get computers to understand their human masters no matter how they express themselves. The key, says Waibel, is to give computers the ability to recognize when they are in error and to take steps to "repair" themselves. One method is to get PCs to keep track of the context of a passage of speech, which would allow them to recognize when their interpretation goes awry. Waibel programs computers in his lab to count the occurrence of words and then use statistics to calculate the odds that a certain word is out of context. If he's talking with his colleagues about business, and his PC thinks it hears him suggest that everybody *eat* on Thursday, it might suspect that he intended to say *meet*.

To get his PCs to correct their errors, Waibel programs them to supplement the spoken word with the gestures and lip movements that go along with it, giving them additional clues to the meaning of speech even if it can't make head nor tail out of a word or phrase. If Waibel tells his PC to schedule a meeting but it doesn't catch the date, it might note the day he circled on his computerized calendar. Likewise, a technician working in a noisy aircraft hangar might want a PC that can read his lips.

Waibel hasn't given up entirely on the problem of meaning. He is developing a method of breaking up the parts of speech and assigning a specific meaning to each part. He calls it a semantic grammar, and he has already used it in a program that translates spoken English into German, Spanish, and Korean, and vice versa. It converts the spoken language to text, sorts the sentence fragments according to grammar, matches each fragment to its counterpart in the target language by way of an intermediate "computer Esperanto," and reassembles the translated passage. A speech synthesizer then speaks the translation aloud. His long-range goal is to extend this capability so that a computer could deduce what new phrases mean by their context, continually adding new phrases to its repertoire. If he can do that, he will have gone a long way toward cracking AI's toughest problem.

SOFTWARE SERVANTS

A few years ago Tom Mitchell built a personal secretary entirely out of computer software. All he asked it to do was schedule appointments. Mitchell would give it all the information it needed, such as who was requesting what meeting where, and his "secretary" would check his calendar to make sure there was no conflict, propose alternate dates or locations if necessary, and either make the appointment or refuse it. After Mitchell put in countless hours refining the software, at best it got things right nine times out of ten. "You'd fire a secretary who made that many mistakes," he says.

Chastened by this ordeal, Mitchell is now more careful about how he applies the artificial-intelligence tools he has developed as a computer scientist at Carnegie Mellon. He's not alone. AI researchers in general are picking their problems more carefully, and they are more realistic about the limitations of their craft. Mitchell has abandoned his secretary for now and is instead working on a program that sifts through the thousands of messages posted in Internet newsgroups that he doesn't have the time or inclination to read. Called the news weeder, the program counts how many times each word occurs in each message and comes up with a list of numbers. Using statistical techniques, it then compares the list with those of other messages that it knows Mitchell has liked in the past. If the new message is close enough, it gets saved; otherwise Mitchell never sees it.

The program makes plenty of mistakes—only half the messages in his inbox are worthwhile, Mitchell reckons. But that's a big improvement on the roughly 99 percent chaff he had to sort through before. "The problem with statistical methods is that the relationship between the lists of numbers and the meaning of the text is loose," he says. "But they work fine for an application where the consequence of making a mistake is not great, and any improvement is better than none." D