

Smithsonian

September 1994



Rare domestic breeds
stare extinction
in the face (p. 60)

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By Richard Wolkomir

We're going to have computers coming out of the woodwork

At the Xerox Palo Alto Research Center, or PARC, researchers are deconstructing the PC as we know it—and changing the way we will live

"We're talking about a technology so powerful it's invisible!" computer scientist Mark Weiser told me. That flew over my head.

Scientific journals had said that Weiser—one of Silicon Valley's leading wizards—was working on something he called Ubiquitous Computing: he meant to extract computing from computers and disperse it throughout society. But what did that mean? I had come to the Xerox Palo Alto Research Center, or PARC, to find out. And I suspected that when I finally understood it, I might not like it.

Weiser, a bald and black-bearded teddy bear of a fellow who is the director of PARC's computer science laboratory, put his fingers to his forehead, the place where all the thinking was going on. Then, having figured out how to give his not-from-Mensa visitor at least a glimpse of what he was up to, he led me briskly down the hall to see an office he had wired up for his lab's newest researcher, Helen Davis.

"See, these are my coworkers," Davis told me, pointing to a pad-size screen that sat upright on her desk. The screen was divided into multiple squares, or "windows." In each window appeared the image of another scientist, at work in another office somewhere in this sprawling think tank.

From her desk, Davis could watch her coworkers sitting at their desks. Some typed at computers. One woman held an impromptu meeting in her office. A man gazed out his office window toward blue San Francisco Bay in the distance, apparently in a trance induced

by deep thought. "They all see *us* right now, too," she said cheerfully.

Davis had worried she would feel uncomfortable, always visible. "But I found that it helps me to feel instantly part of the group," she said. She had not yet met all her video companions, "but even so, when they leave at night I feel isolated!" she added, glancing fondly at her flat-panel display screen.

Teams of on-screen colleagues, who might be spread out from New York to New Delhi, are only a small part of Mark Weiser's technological new world order. He means to kill off the personal computer as we know it. That is ironic, because PARC *invented* the personal computer in the early 1970s. But Weiser wants computers to vanish into the woodwork—literally. He intends to deconstruct the stand-alone computer, shell it like an oyster, and embed its microprocessors in the walls, desks, light sockets, doorknobs and practically every other square foot of your workplace and home. Those chips will communicate with one another and connect via the "information superhighway." Computing will be as available as electricity—wherever you are, a little gadget in your pocket can plug you into the global digital flow.

But what I really wanted to know was, what will Ubiquitous Computing do for us? And, maybe, *to us*?

At PARC they now talk about "social computing." They say: "This is not really about technology—it's anthropology." That is because the odds are that Mark Weiser might rearrange society as thoroughly as Thomas Edison did when he electrified the cities.

For one thing, since PARC opened in 1970 it has been computerdom's Oracle at Delphi, with a suitably magisterial motto: "The easiest way to predict the future is to invent it." And PARC's track record is legendary. After scientists here invented the personal computer itself, they went on to invent laser printers, "windows" (which allow a computer screen to show several operations at once) and the Ethernet system for networking an office's computers—in fact, much of what we regard as today's standard computer technology.

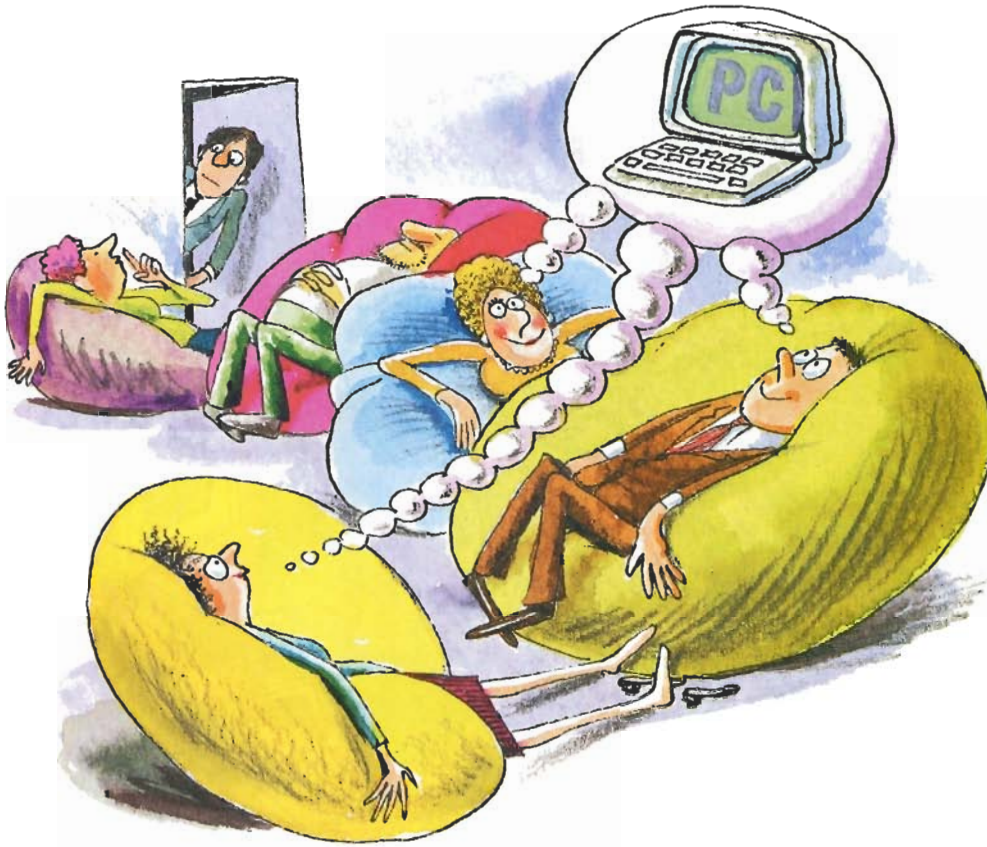
They are the researchers who brought us portable computing and modern chip-making technology. They also introduced an innovation so seminal that we never stop to think about it: icon-based computing. (In other words, the use of on-screen symbols—the kind you can click onto with your "mouse" or, in some instances, press with your fingertip to issue commands.)

Oddly, however, other companies—not Xerox—spun most of PARC's innovations into commercial gold. "There's no question we could have done a much better

Comes the technorevolution, "ubiquitous computing" is likely to have a remarkable effect on daily life.



Illustrations by John Huehnergarth



In a chummy chamber known as the “beanbag room,” pensive scientists lounging about in trendy chairs first dreamed up the personal computer.

job than we have done,” PARC’s director, John Seely Brown, told me. “But, having said that, virtually every piece of technology we’ve invented at PARC is now incorporated in our products.” By the early 1980s, he said, Japanese competitors were pounding Xerox. The company focused on its main product, building into its photocopiers such PARC innovations as icon-based computing. More or less by default—partly because the patent process for software was in its infancy, partly because some PARC researchers left to develop their ideas elsewhere—Xerox largely ceded development of its innovations’ personal computing aspects to other companies. (They did develop and market a proto-PC called the STAR, but it fell flat.) Now, said Brown, Xerox has reorganized so that it can better exploit radical inventions coming out of PARC.

But I had arrived in Palo Alto with the technological blues. I suspected “information superhighway” might be code for “Zap goes your job!” I write words that get printed on paper. Would I go the way of the writers of silent-film captions? I had just read about a new \$100 computer program that is replacing newspaper sports-writers. Who would be next? It made me cranky.

The Xerox PARC building is set into a hillside bounded by horse pastures. It is a low concrete-and-glass structure, with vines spilling over its eaves. Far off, San Francisco Bay sparkles, and the Hoover Tower pokes above

the eucalyptus trees on the Stanford University campus.

When I first visited PARC, I stopped at the famous “beanbag room” where, two decades ago, Xerox scientists lolling in funky chairs had thought up the personal computer. I sat in one of the beanbag chairs myself, but no brilliant insights came. So I headed upstairs to talk with Weiser, who thought up Ubiquitous Computing in 1988, perhaps in one of these very chairs. He had asked associates to predict new technologies that businesses might need. “A disaster!” he told me, grinning. “Trying to pick the future by committee is not going to work!”

So Weiser tried something radical for a technologist: “I had a lot of discussions with the anthropology group here,” he said. “I listened to their criticism of current computer technology and tried to think up a response—this intriguing idea of actually *listening* to the anthropologists!”

PARC employs anthropologists to study the workplace, making the think tank something of a high-tech oddball. So is Mark Weiser. Besides his day job as a Silicon Valley savant, he moonlights drumming for a rock band called Severe Tire Damage. Probably he is rock’s

Richard Wolkomir reports that he is waiting for PARC researchers to bypass a pesky glitch: he still can’t persuade his computer to oblige him by printing out an address on an envelope.

smartest drummer. He is ebullient about Severe Tire Damage. He is ebullient about computers. In fact, he is generally ebullient. And so when PARC anthropologists told him that a major flaw of current computers is that they are divorced from their surroundings, he caught the idea's rhythm. In the office—it was true—you were either at your computer or you were doing other things. You were never doing other things *and* at your computer: the computer does isolate you. "That is not the way technology works in a culture—it has to be integrated," said Weiser. "This could not last."

That was when he first imagined computer chips buzzing in all the walls, desks, file cabinets and light switches. A chip would be in your pen, too. And maybe in the bell at your front door. And you would carry chips around, the way you now stick a pencil in your pocket or wear a wristwatch. And all those chips would "talk" back and forth via radio or infrared signals.

Weiser decided that computers could then become functionally invisible, the way a telephone or a pencil seems invisible to us. You don't have to think about how to work a pencil. You don't need to know how they get the lead into it. You just pick it up and start writing. Why couldn't computers be that way—tools so easy to use that you hardly see them. You just use them.

And what if, eventually, it were not just your office buzzing with computers? What if it were the world?

"At first, I was so excited I couldn't sleep at night," said Weiser. "But that had happened before!"

Computers, computers, everywhere

This time, however, the idea stuck. Ubiquitous Computing is still at the Wright brothers stage. But university researchers already are taking up the idea. And PARC has developed pieces of the technology. "We should look at some more of this stuff," Weiser suggested.

On our way from his office to the adjacent lounge, we encountered a sofa. I walked around it. Weiser stepped over the sofa's backrest, walked over the cushions, then stepped to the floor—meanwhile continuing to talk, as if climbing over furniture wasn't the least bit unusual.

Would Ubiquitous Computing induce a new form of linear thinking? "Too early to tell," I wrote in my notes. Weiser pointed to a screen the size of a huge projection TV, with sofas and chairs facing it in a semicircle.

Corporate meetings used to be held around a blackboard, where chalk-wielding executives wrote up ideas and discussion points. Blackboards gave way to whiteboards and felt-tipped pens. Now Weiser's research team has developed the "LiveBoard." Xerox is selling LiveBoards—the first Ubiquitous Computing equipment to be marketed—as fast as it can make them. "The LiveBoard has a computer inside, and it communicates with other boards, which can be anywhere in the world,"

Weiser said. He scribbled on the LiveBoard's screen with an electronic stylus. With a flick of his stylus—circling a passage here, jotting a note beside a passage there—he sent some of his jottings into the computer's permanent files. Others he reorganized or moved or enlarged or rewrote. The LiveBoard can summon data from the information superhighway, too. And it can function as a centerpiece for teleconferences. If we had been in such a meeting then, what Weiser wrote on his board in Palo Alto would have instantly appeared, just as he wrote it, on other boards, which might have been in London, Sydney and Tokyo.

With currently available audio and video links, people can talk back and forth, face-to-face. Eventually, when video transmission costs drop (right now the video component is very expensive), the airlines will find that to be bearish news. Much business travel will seem



Your "tab" belted on, you would emit signals to receptors (in places like telephone poles) linked up to a network.



Researchers want to create a fail-safe technology for car navigation: computer error could flummox drivers.

pointless when you can stay in your office and still talk with colleagues or customers in other cities, share documents and drawings, and also *see* their telltale grimaces and grins as you negotiate.

Once, PARC director Brown took some visitors and their small daughter to this lounge to see the LiveBoard. Unable to resist, from the concealment of his office Weiser puckishly wrote messages to the visitors, which materialized on the LiveBoard in the lounge as if by magic. The guests looked dumbfounded, but the child blithely scribbled messages back. Apparently the next generation will take LiveBoard meetings in stride.

Weiser jotted the messages that appeared on the LiveBoard on another piece of equipment his team invented—the ParcPad, a miniature LiveBoard the size of a textbook. In a decade or so, he said, our desks will be littered with them, the way his own desk was now strewn with paper. Other “pads” will hang on walls like Post-it notes, except that their messages, such as cafeteria menus, will be constantly updated. He pointed to a stack of *Computer Architecture News* journals on his shelf. “That stack might be just one pad, and every so often I’d check it to see if the latest issue was out,” he said. Pads on your desk might each display a different project or different aspects of the same project. You would use them like

scrap paper, except they would have the capabilities of high-powered computers. So you could store what you wrote on them, or send it to other pads or LiveBoards, or have the pads perform calculations, or create graphs, or receive electronic mail, or cruise the information superhighway to fetch information. You could scribble on it with an electronic stylus or, to write at length, you might take a keyboard from your drawer.

Perfecting the pads will require better screens, and they are on the way. PARC engineers showed me a new screen they have developed on which images and print actually appear sharper than if printed in ink on paper. Right now the screen is costly. But Weiser believes that within a decade his “pads” really will be about as hefty as a pad of paper and just as cheap. And they will lie around everywhere. Just start scribbling.

Always “knowing” who you are

But for that to work, whatever pad you pick up must be “authorized” to connect to your personal digital files. And so the underlying Ubiquitous Computing system must always “know” who you are and where you are. Therefore, Weiser’s lab has invented one further piece of equipment—the ParcTab, about the size of a deck of cards. If the pad is a miniature LiveBoard, the “tab” is a miniature pad.

“Where’s my tab?” Weiser said, perplexed, as he swirled the mounds of papers on his table and groped in his briefcase. “This is the problem with having these tiny computers everywhere—you can never find them!”

Weiser finally did find his tab, which had a mini-screen and a few buttons. Designing it to fit any size hand was a major challenge, he said. Turn on your tab and you are plugged into the information superhighway. Weiser pressed a button: onto the screen popped an up-to-the-second Palo Alto weather report. One version of the tab, which PARC employees wear like a badge, identifies you to the computer system. Wherever you go, it radiates infrared or radio signals that tell the central system: “I am Mark Weiser and, at the moment, I am standing right *here*.” It can even be rigged so that any LiveBoard you pass flashes messages just for you.

“Let’s see, where’s Frederick?” Weiser asked, trying to locate a member of his team. He tapped some buttons and peered at his tab’s screen. “It says Frederick is in Room 2111, settled in.”

It works, said Weiser, much like a cellular telephone, which turns your voice into a radio signal. The signal goes to a receiving-transmitting station, where radio signals are converted into electrical signals that are in turn fed into the telephone lines. Each station serves a “cell,” a section of the city or countryside usually encompassing about one square mile. But such cells are too large for Ubiquitous Computing, which must track you from



Your own ever-vigilant household computer might signal for your water heater to be turned off—until it senses that you're about to wake up.

room to room. Weiser is now developing cells down to about room-size (ten feet square or so), so that wherever you are, the tab in your pocket emits extremely weak infrared or radio signals to tiny receptors mounted on walls or telephone poles and connected to the computer system. In that way, the system keeps tabs on you. Perhaps you are in Paris on business. Of course you've got your trusty tab in your pocket. Then you pick up a pad in your hotel room (the hotel of the near future will provide such amenities) and it instantly knows it is you. Via the information superhighway, you retrieve your e-mail or check your computer files back home or at your office. The pad lying in your hotel room has instantly become *your* computer.

What makes Ubiquitous Computing work—the system's ability to track you and whomever you meet—makes it scary. Big Brother, corporate or governmental, really could be watching.

"The person in my lab who's most against this has made his office a dead zone," Weiser told me cheerfully.

He understands the implications. But they don't scare him. "Right now, if you carry a cellular telephone, the cellular telephone company always knows where you are," he pointed out. "One reason I do interviews like this is because people should know what's coming."

Later I talked with PARC computer scientist Marvin Theimer, who is working on the privacy issue. "If we build it wrong, invasion of privacy *can* create problems," he told me. "Society will have to decide what's allowable—even today if Xerox requires my medical records as a condition of my working here, I've lost some privacy."

He held up the tab he carries in his pocket. "People

have given us a lot of flak about these kinds of devices," he said. "Well, Ubiquitous Computing is already being relentlessly deployed, whether or not you know it." Today, when computer chips can cost as little as one dollar, he pointed out, even your video rentals are recorded on a computer database at your neighborhood video store. "At the technological level, we can alleviate the problem, but we can't solve it."

One palliative is giving everybody as many different identification numbers as possible. Also, your tab would broadcast your secret numbers but not your name. Then the computer would know where "you" are, but nobody else would. Another safeguard would be to decentralize the system, so that your records are scattered, and nobody could learn all about you by going to one place. "But I can't design perfect security," Theimer said. "Ubiquitous Computing will be deployed, and it will present both benefits and dangers."

What, I asked, might be some benefits? Big things, small things, Theimer said. To shave your electric bills, the system might keep your water heater turned off until it sensed you were waking up. (It could start your coffee, too.) Your morning newspaper, either printed or on a paperlike screen, might focus on stories of special interest to you. The downside of such tailored reportage is that one of the glues holding our disparate society together—everybody getting roughly the same news every day—would break down.

Your car might be driven automatically by a central traffic controller, or the controller might suggest routes for avoiding slowdowns. You could easily work at home, setting a pad to show you video images of your cowork-



You needn't fret about leaving your oven on: you could tell a computer to turn it off from the air.

ers. Another pad might show your spouse or children as they went through the day. You also could live virtually anywhere. One PARC anthropologist told me she hoped the system would enable her to live in Costa Rica. And the world could, to some extent, customize itself just for you. "I walk up to a Xerox machine in Japan and it automatically shows me the instructions in English, or the street signs around me change to English as I walk by," Theimer said. If your flight to Europe were delayed three hours, he said, your airline's computer could call your house and reset your alarm clock. Not only that: the computer could transmit a notice to your screen at home explaining why you got to sleep late. "And you'd never have to worry about leaving your oven on—you could turn it off from your airliner," he added.

He said computing already is becoming ubiquitous. "Virtually every coffee machine now has a microprocessor inside, and so do cars. But it's all stand-alone, and the next big step will be to interconnect it all."

Corporations, according to Theimer, will reinvent themselves. Workers will no longer be tied to a central building. And at any time you could instantly canvas

your coworkers for somebody with expertise on a particular question facing you, no matter where in the world you were, just by jotting a note on your pad and sending it out through the system.

Right now, Theimer said, PARC is experimenting with the notion that a fair amount of corporate business is transacted around the coffeepot. Its researchers are working on a "social virtual reality project" in which workers can wander into a "virtual" coffee room that exists only inside the computer system. Currently, workers keyboarding their way into the digital coffee room receive only an on-screen written description of the imaginary room, giving such details as where the chairs are. "I could meet a colleague from the East Coast in the virtual coffee room, and anybody else who wandered in could join the discussion," said Theimer. Now the researchers are adding audio, so that people in the make-believe coffee room can talk instead of communicating via keyboard. When video transmission becomes cheaper, they will view the imaginary room on their screens and see the other people already gathered there.

When an electronic voice says, "Over to you!"

Ubiquitous Computing is sneaking up on us. The "personal digital assistants" now on the market, tiny computers with fax and cellular telephone attachments, are a step. And any self-respecting new oven or washing machine has microprocessors inside.

Better batteries will be needed. So will better software for handwriting and speech recognition. "We also need a better understanding of issues like fault tolerance," Theimer said. "We'd better not have the computer controlling your car go down when you're heading toward a wall—and an electronic voice suddenly says, 'Over to you!'" Probably the system will be decentralized, with no single computer in charge, so that if one computer shuts down others can step in.

Theimer said the hardest problem will be deploying Ubiquitous Computing in stages, so that each step generates profit. "You have to offer some value at the incremental steps or nobody will buy it. This is a very big issue, involving things like standardization." Within 15 years, the researchers estimate, Ubiquitous Computing will be mundane. Maybe sooner. "What you can do with Ubiquitous Computing sounds like science fiction," Theimer told me. "It will change the world."

That was exactly why I was cranky.

A Carnegie Mellon University researcher has developed a computer you wear like sunglasses. The news-magazines are agog over "intelligent agents," little digital butlers you send running around the information superhighway on data-collecting chores. Meanwhile, a company called Advanced Neurotechnologies Inc. has announced that it has taken the first steps toward devel-

oping a computer that you can control by thinking! All that and Ubiquitous Computing, too. It's left me with a deeply philosophical question: What about *me*?

I decided to ask PARC director Brown, the tall, bearded mathematician, physicist and computer scientist who is chief scientist at Xerox. He brought anthropologists to PARC and has a knack for seeing technology's social side. "The modern car often has more computing power than the modern office, but is anybody aware of it?" he asked. "Technology is finally getting powerful enough to get the hell out of the way!" That sounded faintly ominous. It was time, I decided, to hit Brown with my big question: "Is Mark Weiser going to deep-six my job?"

As Ubiquitous Computing sends everyone cruising along the information superhighway, I wanted to know, will every Tom, Jane and Junior who has the yen become an electronic writer and publisher, with a potential audience of everybody on the planet? Is the professional writer—I was now getting personal—a deceased duck? "No," Brown answered. Ubiquitous Computing, dark amber in my mind, suddenly was sunlit.

A magazine, Brown pointed out, "creates value" by choosing material for readers. Reading a magazine, you may find yourself fascinated by a subject you would never have thought to investigate on your own. (Who knows, maybe this one.) Also, a magazine or book is still a user-friendly technology: you can hold it in your

hands and just lie back in the hammock for a good read.

"What may go away is the reference book," he said. "If I could get the *Oxford English Dictionary* on my tab or pad, I would—I've never curled up in bed at night with the *Oxford English Dictionary*." Yes. Digitize the dictionaries and encyclopedias if you must. But ignore us ink-stained scribes. Let us keep plying our humble trade.

"Actually, the need for professional writers will continue to go up, to make sense out of the ever-increasing buzz of the world," Brown told me.

I left PARC feeling vitamin-enriched. However, by the time I drove my rental car into the lot at the San Jose airport, my mind had detoured off the information superhighway, and Mark Weiser's vision of computing's future—invisible but everywhere—seemed like the airy notions Lemuel Gulliver heard on Laputa, the flying island.

I parked the car and extracted my luggage from the trunk, ready to trek to the office and wait in line to get my bill adjusted. But an attendant showed up, carrying what looked like a small walkie-talkie.

He checked the car's fuel level and mileage, punched buttons, peered at the print that popped onto a screen. Then he punched another button. The instrument spewed out a sheet of paper, which he handed to me. It was my itemized receipt for the car, made out on the spot, in the parking lot, by a hand-held device in radio contact with the rental car company's central computer.

With access to tab technology, you can use your tiny computer device to send digital "butlers" scurrying down

the information superhighway at your behest, retrieving data, even turning up the heat before you arrive home.

