# The hazards of high tech

Lenny Siegel and
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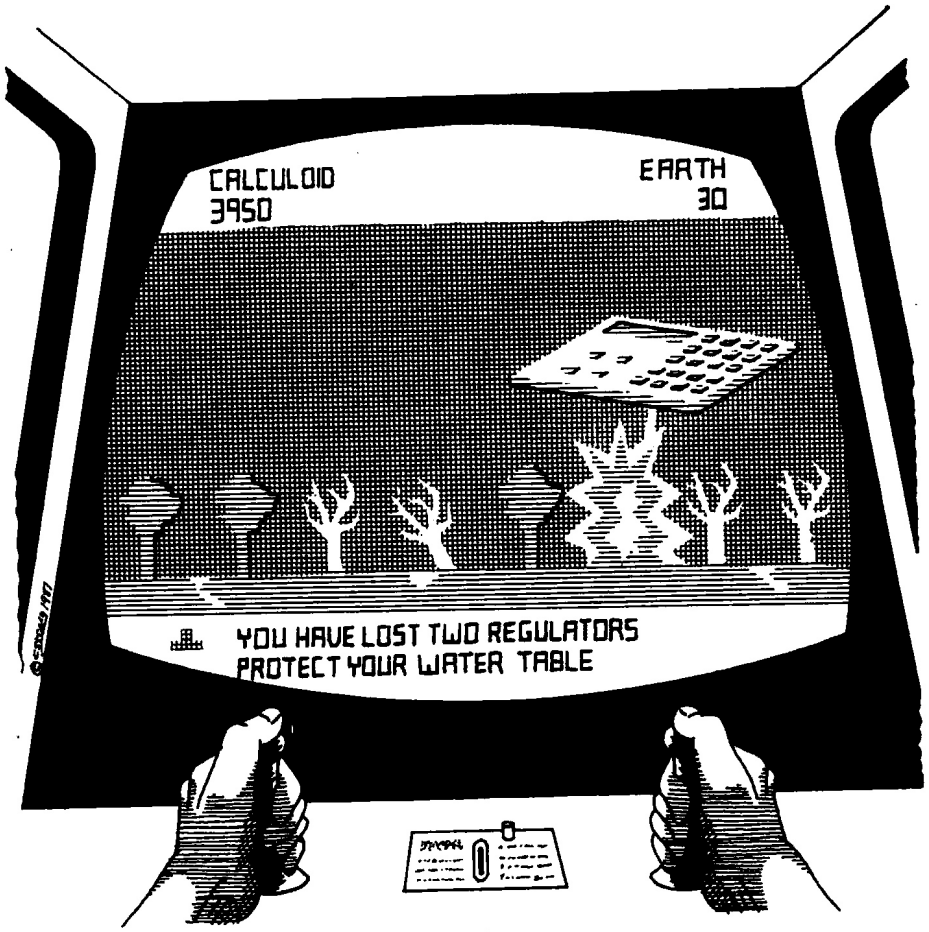


Pocket calculators. These days everybody seems to have at least one. In fact, some people are never seen without one of the small devices—about the size of a credit card. Even kids have them, sometimes in cute animal shapes.

As commonplace as the whole panoply of products of the microelectronics revolution are (they run the gamut from watches to weapons), it's hard to remember that not too long ago, they were science fiction, not fact. In the 1950s, there were only about 1,000 computers and no microprocessors, the tiny silicon chips that are the brains of new computers, in the United States. By 1976, 220,000 computers and three-quarters of a million microprocessors had been produced. By 1980, the United States was using more than 10 million microprocessors, those seemingly magical devices with amazing powers of memory and blinding computational speed.

Silicon chips and the products they're used in have appeared virtually overnight in a world which knows little about how they are made and what they can do—and a world that knows even less about what the environmental effects of manufacturing them are.

Meanwhile, local and state officials from all over visit California's Silicon Valley—the center of the industry and the Eldorado of reindustrialization—to try to lure the high tech companies to their cities and states. From the southwest corner of the San Francisco Bay area, they bring back tales of a clean, light industry that provides jobs, pays taxes and does wonders for a community's image.

But it may not be so clean. Electronics today is largely a chemical process in which highly toxic substances are used

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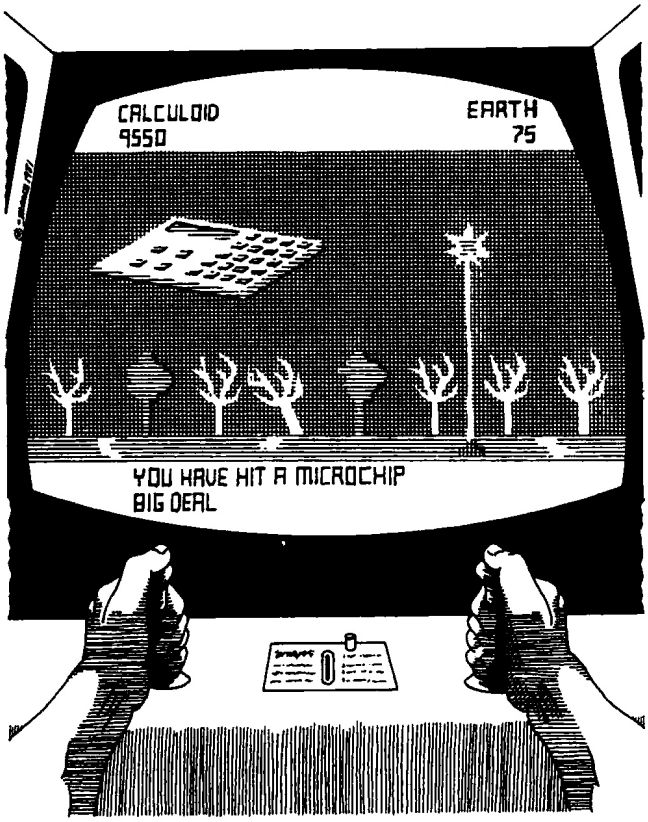


and toxic wastes are created. Any community that longs to become the next Silicon Mountain, Silicon Mesa or Silicon Strip should be aware of the problems those chemicals can create.

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The brain of that now ordinary pocket calculator begins its life as a tiny square etched into the surface of a thin disc of silicon four inches in diameter. Each square is a complex electronic circuit, but literally hundreds of them can fit onto each silicon disc, or "wafer." After the circuitry is photographically etched, the wafer is broken apart into individual "chips." These are then shipped to Asia, where low paid women attach microscopic strands of gold wire connecting the chips to individual holders. At this point, the product looks something like an inch-long caterpillar with 12 to 48 pairs of legs. Finally, the holders are plugged into printed circuit boards, along with resistors, capacitors, light emitting diodes and switches. The tiny device can now perform arithmetic marvels.

Generally, the process used in making the pocket calculator is repeated in hundreds of other electronics products, commonplace and unusual. Holders of chips are plugged into a board with many other chips. A full-sized computer may have 20 to 100 printed circuit boards, each holding literally thousands of integrated circuits, or chips.

Throughout this process, chemicals are used—chemicals which are beginning to turn up in alarming places in the Silicon Valley.

- Residents of a mobile home park in Sunnyvale, across the street from an electronics plant, have experienced increased incidences of liver and kidney problems, possibly due to emissions of toluene and a variety of ketones, which are used as cleaning solvents.
- Fairchild Semiconductor paid to clean up—but never admitted responsibility for—the spill of a highly alkaline substance into Stevens Creek, which extends through the Silicon Valley to San Francisco Bay.
- Santa Clara Metal Refining Co., which does recycling for several electronics firms, dumped sodium cyanide, a toxic salt, in its driveway, largely, it claims, because the substance was mislabeled.
- Small amounts of trichloroethylene (TCE), a solvent suspected of causing cancer, have been found in area wells, although local officials claim the level does not now pose a risk.
- Each week, a single electronics plant can produce a truckload of chemical wastes. Even when they're carted away to legal dumps, there is reason for concern. Bob Wenzlau, an environmental engineer and member of the Solid Waste Management Planning Committee of Santa Clara County (which just about *is* Silicon Valley), says, "Most of these substances don't break down. We're creating a waste management problem which may last for generations."
- And some toxics have been dumped illegally. A San Jose lawyer says he's spoken to half a dozen industry workers who admit having literally poured dangerous chemicals down the drain, and there have been spills into the area's storm drainage systems as well.

The chip was developed simultaneously at Fairchild Semiconductor in Mountain View, Calif. and Texas Instruments in Dallas about 20 years ago. Obviously sensing the new industry's potential, so many executives and engineers left Fairchild to form their own firms that by 1971, the surrounding area was dubbed Silicon Valley.

Today, five of the top eight U.S. based marketers of integrated circuits are based in Silicon Valley: Fairchild and its offshoots—National Semiconductor, Intel, Signetics and Advanced Micro Devices. And every kind of electronics device is manufactured in the valley—computer games, medical equipment, military systems. For example, some of the country's largest makers of small and personal computers—Apple, Atari and Hewlett-Packard—are based there.

But the high tech boom is going on in other places as well. Enclaves of chip users and producers are scattered all around the country, from Aloha, Ore. to Colorado Springs to the Boston area's Route 128 complex. Texas Instruments is actually still the largest chip seller. Also in the top eight are Phoenix based Motorola Semiconductor and Mostek, a spin-off of Texas Instruments, also based in Texas.

Most major semiconductor houses are now owned, wholly

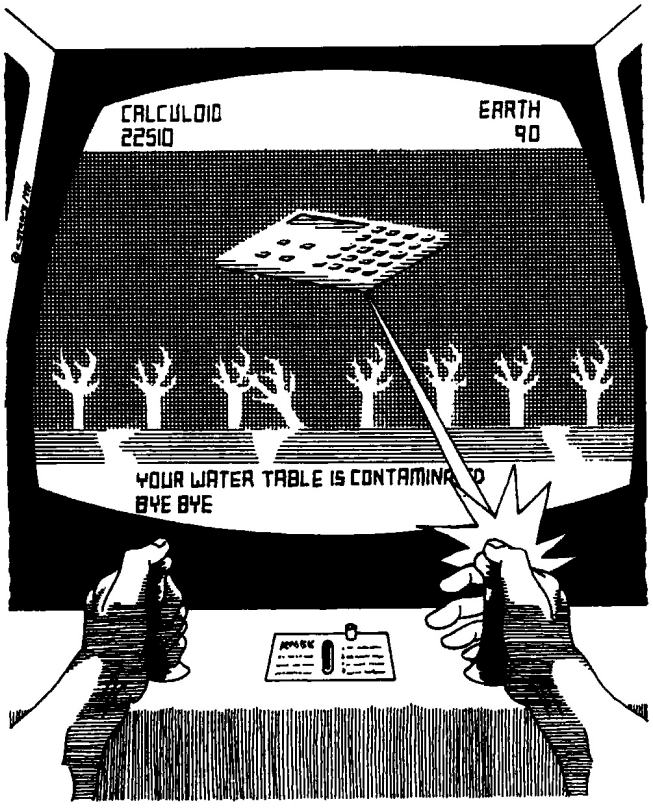
or in part, by large multinational corporations such as Schlumberger and United Technologies, while IBM, Western Electric, GM Delco and other electrical equipment manufacturers produce vast quantities of chips for their own use.

Still, whatever the effects of this electronics explosion, the first place they will be felt is in Silicon Valley.

The Silicon Valley's electronics industry is not unregulated, and, although it's new, in some respects it seems more receptive to environmental concerns than some older, so-called smokestack industries. In the valley, the regional Bay Area Air Quality Management District (AQMD) has required manufacturers to use scrubbers to prevent the release of airborne acids, toxic metal fumes and silicon particulates.

Although industry has not, for the most part, objected to installing the scrubbers, a biochemist with many years of industry experience says, "Eighty to 90 percent of the scrubbers don't work very well, at least on gaseous emissions." And while bigger firms often comply with the air standards, says AQMD's John Laird, smaller companies don't always do a thorough job.

Enforcement, too, can sometimes be lax—agencies, plagued with too many problems and too few people, often accept less than ideal solutions. For example, companies are often allowed to "reduce" air pollution by increasing the heights of air vents, says one industry source. Rather than getting rid of dangerous substances, all this does is dilute them.




And there are pollution sources which AQMD doesn't even have the authority to control. Take so-called indirect air pollution, such as hydrogen cyanide gas. This is created when the cyanide salts, which have occasionally been found in industry sewage outfalls, are exposed to slightly acidic sewage flow, creating the highly toxic hydrogen cyanide gas which, in turn, escapes into the atmosphere.

Then there is the problem of what to do with the chemicals used in the industry. For years, many firms simply dumped acids used in wafer etching and other processes directly into local sewage systems. Since the mid 70s, however, industry has been required to pretreat its sewage. Most first treat the wastes with lime to neutralize them and then remove metals like nickel and lead using a hydroxide precipitation process. Again, says Peter Burnes, industrial waste inspector for the Palo Alto Regional Water Quality Control Plant, most larger firms, like Hewlett-Packard, comply with the regulation; the problem is with the smaller companies.

The lime intended to treat the sewage has created its own problems as well. In 1980, National Semiconductor, the largest integrated circuits manufacturer in Silicon Valley, was cited three times for spilling large amounts of lime. While the spills, contrary to original reports, apparently did not contribute to the massive breakdown of the San Jose-Santa Clara sewage treatment plant, San Jose deputy city manager John Eastus says, "If we had a smaller plant—about five million gallons per day—it could have put us out of business." Ironically, 5 million gallons is roughly the size of the facility servicing Gilroy, just south of San Jose, where Advanced Micro Devices is planning a major integrated circuit production complex.

Even when it's done correctly, some experts say there are big problems with the treatment technology. Samplings taken near the Palo Alto plant outfall have shown growing concentrations of metals in San Francisco Bay sediments.

And Bob Wenzlau, for one, notes that low concentrations of toxic substances in industrial effluent increase during the sewage treatment process because the water in the effluent is removed. The resulting sludge has to go somewhere, and that poses yet another dilemma. One wastewater treatment expert says the whole treatment process used by the electronics industry is simply not environmentally sound because it creates sludge containing toxic metals such as cadmium.

Some experts believe the answer to at least some of these difficulties is recycling the chemical byproducts and creating fewer chemical wastes. For instance, Wenzlau says, "If production lines were slowed a little, workers would not contaminate one bath with another. A smaller volume would be needed, and recycling would be easier."

But as people look for solutions to the environmental risks posed by the electronics boom, one thing is clear. Whatever the magic of that pocket calculator, its production leaves us with some familiar, not too magical problems. Industrial processes, however delightful the final product, can produce some nasty side effects. ■

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