MICROCOMPUTERS: FROM MOVEMENT TO INDUSTRY

by LENNY SIEGEL

The microcomputer is the child of an odd marriage between the military industrial complex and counter-culture hackers from the fringes of the new left.* Ironically, this product of the anti-authoritarian visions of its inventors has become the darling of financiers and a symbol of the hope of the renewed dynamism of U.S. capitalism. The history of the microcomputer industry is thus a case study in both the constraints on innovation within large capitalist firms and the ability of those firms to coopt and control the products of renegade inventors. It is also the story of the creative energies unleashed by the liberatory impulses of the late 1960s, and the idealistic but fallacious belief that technical innovation per se can challenge the centralization of information and power, and the foundations of capitalist rule.

The Origins

Scientifically, the microcomputer represents a series of gradual developments rather than a sudden breakthrough. During the Second World War teams sponsored by the military and intelligence agencies in the United States, Germany, and Britain developed the first digital computers. After the war, orders from the Pentagon, the Census Bureau, the Atomic Energy Commission, and other government agencies propelled the private sector to develop increasingly complex computers. Initially the circuitry was based on vacuum tubes, which were bulky and unreliable. A 1950-vintage machine with as much computing power as the

Lenny Siegel is director of The Pacific Studies Center, 222B View Street, Mountain View, CA 94041, editor of the center's newsletter *Global Electronics*, and co-author of *The High Cost of High Tech: The Dark Side of the Chip* (New York: Harper and Row, 1985). The book and newsletter are both available from the center.

* A "hacker" is an (often amateur) computer enthusiast, with intimate nuts-and-bolts knowledge of the machinery and programming.

word processor on which I am typing was the size of a room, broke down several times a day, cost millions, and required many full-time attendants. Early on, IBM established a dominant position in the computer industry, accounting for three quarters of worldwide sales during the 1950s and 1960s.

In 1947, scientists at Bell Laboratories, the research arm of AT&T, invented the transistor, which eventually replaced the vacuum tube and opened the way to more reliable, smaller, and cheaper machines. This invention evolved directly from solid state physics research sponsored by the military. The Pentagon continued to play a critical role in the development and dissemination of semiconductors throughout the 1950s and 1960s by sponsoring research and providing the major market for the resulting products.* IBM quickly incorporated the new technology into its machines, and by 1960 had become the largest non-military customer of virtually every U.S. semiconductor manufacturer.

In contrast to the computer industry, which was dominated by IBM, the manufacture of the semiconductor components of computers (and other electronic equipment) was intensely competitive. Major electronics firms, such as GE, RCA, and Sylvania, chose not to invest heavily in semiconductors that competed with and undermined their existing product lines of vacuum tubes, leaving an opening for smaller newcomers such as Texas Instruments (TI) and Fairchild Camera. In the late 1950s engineers at TI and Fairchild invented the integrated circuit, which combined many transistors on a single chip of silicon, allowing dramatic decreases in the size and cost of electronic components. These tiny, cheap, powerful circuits made possible devices that had hitherto been unthinkable, and inspired the imagination of the firms' engineers. This blossoming of technical possibilities, combined with the relatively small amount of

* A transistor, like a vacuum tube, switches or amplifies an electronic signal. The term "semiconductor" originally referred to the materials (e.g., silicon) used to make transistors, diodes, and other miniature electronic components. It has come to be used as a generic term for the components themselves. An integrated circuit (IC or chip) is a single piece of semiconductor material which includes more than one (as many as millions) of transistors. ICs allow complex electronic circuits to be embedded in a single, small, reliable, and cheap piece of silicon.

capital then needed to manufacture integrated circuits, led to a proliferation of new electronics companies, many of them in California's "Silicon Valley." The low cost and small size of components made them practical not only for military and industrial hardware, but for consumer electronics gadgets as well. Japanese firms gained a large share of the consumer electronics market, starting in 1957 with the export of transistor radios, though U.S. firms continued to dominate the world semiconductor market until the late 1970s.

If any single invention marked the eclipse of the Pentagon's hegemony over high-tech electronics, it was the microprocessor. While the military purchased 70 percent of all integrated circuit production as late as 1965, it was an order from a Japanese calculator manufacturer that inspired engineers at Intel (a small Silicon Valley firm spunoff from Fairchild) to design the first microprocessor. This device combined the circuits of a programmable computer on a single silicon chip that could be mass produced for a few dollars. As Regis McKenna, the public relations whiz for Intel (and later Apple), pointed out, the "second generation" mircroprocessor (the 8080, which was the "brain" of many early microcomputers) was marketed by Intel in 1974, second-sourced by Japan in 1975, copied by the Soviets by 1977, and finally purchased by the Pentagon in 1979.

The Electronic Counterculture

The low cost of these increasingly powerful electronic components made them accessible to students and hobbyists as well as engineers. Radicals in revolt against authoritarian, centralized power structures symbolized by Ma Bell and the "Almighty IBM Machine" began to conceive of electronics as a weapon that could be turned against authority. Bill Gates, who later wrote programs for the first commercial microcomputer and conceived of the design for the IBM personal computer (PC), proved his smarts by simultaneously "crashing" all the computers in Control Data Corporation's national Cybernet network. "Phone freaks," among them future founder of Apple Computers Steve Wozniak, built and sold electronic devices (so-called blue boxes) to bypass the AT&T electronic billing system.

For a time, the high cost of computer components limited hobbyists to crashing corporate machines. The introduction of Intel's 8080 microprocessor on a chip in 1974 made it possible to build one's own. Basement hackers began to fantasize about small computers as common as telephones, which would decentralize control over information, and hence power. One of the editors of *The Whole Earth Catalog* later laid out the computopian view of city politics:

> Imagine how many people would speak out if they didn't have to occupy a precious evening by crowding into a public hearing room—if, instead, they could sign into a [computer] network several times a week, see the city's arguments, and raise their own without time pressure or the adrenaline flow that comes from speaking to a crowd. Imagine the heightened level of democracy in San Francisco if the channels of power were a two-way instead of a one-way street—or if each of us could galvanize the other people who felt the same way just by posting a notice on the right computer bulletin board.

But the Altair, the first commercially available microcomputer, was far more suited to the dedicated hobbyist than the ordinary citizen. Relying on toggle switches for input and blinking lights for output, it contained about enough memory for one paragraph of text. A great deal of skill was required to assemble and make any use of the machine. Still, when the Altair was featured in the January 1975 issue of *Popular Electronics,* its tiny manufacturer was deluged with orders. In northern California, hobbyists who built these and similar machines banded together in the Homebrew Computer Club, an anarchic group with no official membership, no dues, a free newsletter, and a view that the new technology should be shared by all. This subculture of hobbyists who designed, built, bought, programmed, and popularized personal computers was by no means a political movement. Still, most of these young men (and most were white, middle-class men) shared a suspicion of large institutions—IBM, the Pentagon, the University of California, etc. Some future microcomputer designers and entrepreneurs spent the 1960s and early 1970s organizing draft resistance (Fred Moore, founder of Homebrew); traveling in India seeking universal truth (Steve Jobs of Apple Computers); organizing free universities (Jim Warren of West Coast Computer Faire); pro-

testing the Vietnam war (Mitch Kapor of Lotus Development Corp.); and assembling homebrew bullhorns for Stop the Draft Week, the mass assault on the Oakland induction center (Lee Felsenstein of Osborne Computers).

Wozniak and Jobs, who frequented Homebrew meetings, proved that microcomputers (also called micros, personal computers, and PC's) were more than a fad for high-tech wizards. After selling a Volkswagon bus to finance the design of their first printed circuit board, they filled orders for the first fifty Apple I computers by buying parts on 30-days credit. Their Apple II, introduced in 1977, could be used by schoolchildren, not just engineers. They also broke with the tradition of other computer manufacturers in publishing the technical details of the machine and encouraging "third-party" suppliers to produce accessories and programs. Apple quickly attracted a PR whiz to capture the public's imagination, and a former Intel executive to provide business acumen and attract venture capital. Their success is legendary. By 1982 their machine epitomized for the public the mystique and promise of high-tech, while their company had made it into the Fortune 500.

Apple and other early microcomputer makers were able to prosper because established electronics and computer firms moved slowly into the realm of micros. Wozniak's employer, the electronics giant Hewlett-Packard (H-P), rebuffed Wozniak's attempt to design a personal computer for H-P. As a result, H-P first entered the micro market in 1980. Xerox designed personal-sized computers in 1974 but, fearful of undercutting their other product lines, marketed them at big computer prices until 1981. IBM, which never lost its dominance in the big computer market, moved hesitantly into microcomputers. But by 1980, IBM's top brass could no longer ignore this sensational new segment of the market. Realizing that micros were different from the rest of its business, they went to former counterculture hacker Bill Gates for the IBM PC's conceptual design. Gates convinced IBM to use widely available standard components and publish the machine's design, following Apple's lead and defying its own tradition of secrecy.

The IBM PC was neither technologically advanced nor a great bargain, yet virtually from the moment of its introduction it dominated the market. Within a year of its introduction the IBM PC was outselling the Apple, and most firms whose machines could not use the thousands of programs and accessories developed for the IBM were wiped out. IBM's entry legitimized personal computers in the eyes of corporate managers heretofore skeptical of the need to supplement their large central computers. Fortune 500 companies and government agencies bought micros, usually IBM's, as individual work stations for their white-collar employees. Corporations rapidly supplanted individuals as the main purchasers of micros, forcing manufacturers to tailor PCs to business applications. Programmers who got their start bypassing Ma Bell's billing system and crashing corporate data banks were now creating automated accounting packages and billing systems. Meanwhile, the domination of IBM and the slowdown in computer sales in the mid-1980s drove many of the smaller (and more innovative) microcomputer makers out of business.

Ironically, the corporate giants IBM and Apple vied to maintain the image of microcomputers as weapons for the little person. IBM ads evoked the image of Charlie Chaplin's little tramp, while Apple stunned Superbowl viewers in January 1984 with a commercial for its new Macintosh computer which showed a young woman evading riot police to smash a huge telescreen, and claimed that the Macintosh would keep the year 1984 from becoming Orwell's *1984*. This million-dollar-a-minute anti-authoritarian appeal was a fitting metaphor for the tension between Apple's renegade past and establishment present, a tension further emphasized in the subsequent departure from Apple of founder Jobs in favor of the former head of marketing for Pepsi.

Whose Tool?

While corporate dominance of the microcomputer industry has been thoroughly established, vestiges of its counterculture origins remain. Blue jeans, beards, and even women are acceptable in the labs and boardrooms of the younger companies. Apple—admittedly with much less to lose than the old-line computer giants—has halted all of its South African business in protest against apartheid. More important, in the thriving

world of microcomputer devotees and hobbyists there is a still powerful counterculture, directly descended from the 1960s counterculture, that seeks to use computer technology to decentralize the control of information, question authority, and work for social change. For instance, Lee Felsenstein, once a peace activist and the master of ceremonies at Homebrew meetings, and later the designer of the successful Osborne computer, remains active in Community Memory, a unique Berkeley experiment organized in the early 1970s to provide free public access to a computer information system and communications network.

The most hopeful progressive hackers continue to view microcomputers as liberating technology. They point to the potential for political participation and organization through networks of computers connected by phone lines; the ability of individuals and small groups to gain access to and manipulate data, do typesetting, and perform other tasks which previously required large and costly machines; and, perhaps most important, the demystification of computers themselves. The positive features have become a reality for many academics, professionals, and their children. However, the benefits of PCs are heavily concentrated among the privileged, and progressive hackers seem sometimes to confuse their own advantage with social progress for the masses.

Rather than serving as a leveling force, microcomputers seem likely to reinforce inequalities in our society. By 1985 only 7 million homes had computers, and fewer than half of these could communicate with other machines via phone lines. As phone rates skyrocket to pay for the replacement of voice service by the digital network needed for sophisticated computer uses, the share of households with telephones may fall precipitously from the current 92 percent. Lifeline phone service may help the elderly poor stay in touch with their grandchildren, but it will not allow connect time to plug into Compuserve or MCI Mail. Poor and minority children from homes and schools lacking computer resources (not just machines, but trained teachers and programs) will be ill prepared for the "silicon future." Similarly, while women clerical workers are perhaps the predominant (alienated) computer users, girls and women are conspicuously rare among the recreational and professional users

whose lives are enriched by computers. As the affluent begin to mail, bank, and use libraries "on line," traditional information services are likely to decline. The great mass of computer have-nots will be like the car-less urban poor who were trapped in decaying cities by the rise of the automobile and the abandonment of mass transit.

But this portrait is perhaps too bleak. Microcomputers continue to pose new challenges to the smooth functioning of capitalism. Proprietary computer programs and data, unlike other commodities, can be easily copied and distributed. One need merely insert a floppy disk into a PC disk drive and instruct the machine to copy, a process which takes seconds and costs virtually nothing. Though illegal, such copying is almost impossible to detect and has become socially acceptable. While some program vendors use complex codes to make copying difficult, such schemes are rapidly circumvented by the thousands of computer hobbyists who consider each new copy-protection code an entertaining puzzle to be solved. Many of these code-breaking programs are widely available, and vast numbers of hackers maintain the cooperative and outlaw spirit of microcomputing's early days, freely exchanging licit and illicit copies of programs, breaking into Pentagon and corporate computers, and generally raising electronic hell.

Two decades ago campus radicals viewed computers as monsters: distant, impersonal, and threatening. They pleaded "I am a human being! Do not fold, spindle, or mutilate me!" The coming of the micro was accompanied by the computopian vision of social relations as a mere reflection of technology. But in political terms computers are like many other tools. The ruling classes have always had more, larger, and more sophisticated printing presses and weapons, but books and bullets were also the media of Marx and Mao. Today, left-wing computer literati put out newsletters, generate mailing lists, target precincts, edit this issue of MR, and in other ways put microcomputers to progressive use. Others lend their skills to third world countries such as Nicaragua, which need data processing to strengthen their economies. And should the powers-that-be ever assemble a "Big Brother" computer system, we can hope that there will be plenty of hackers out there prepared to bring the system crashing down.