SCIENCE FOR THE PEOPLE

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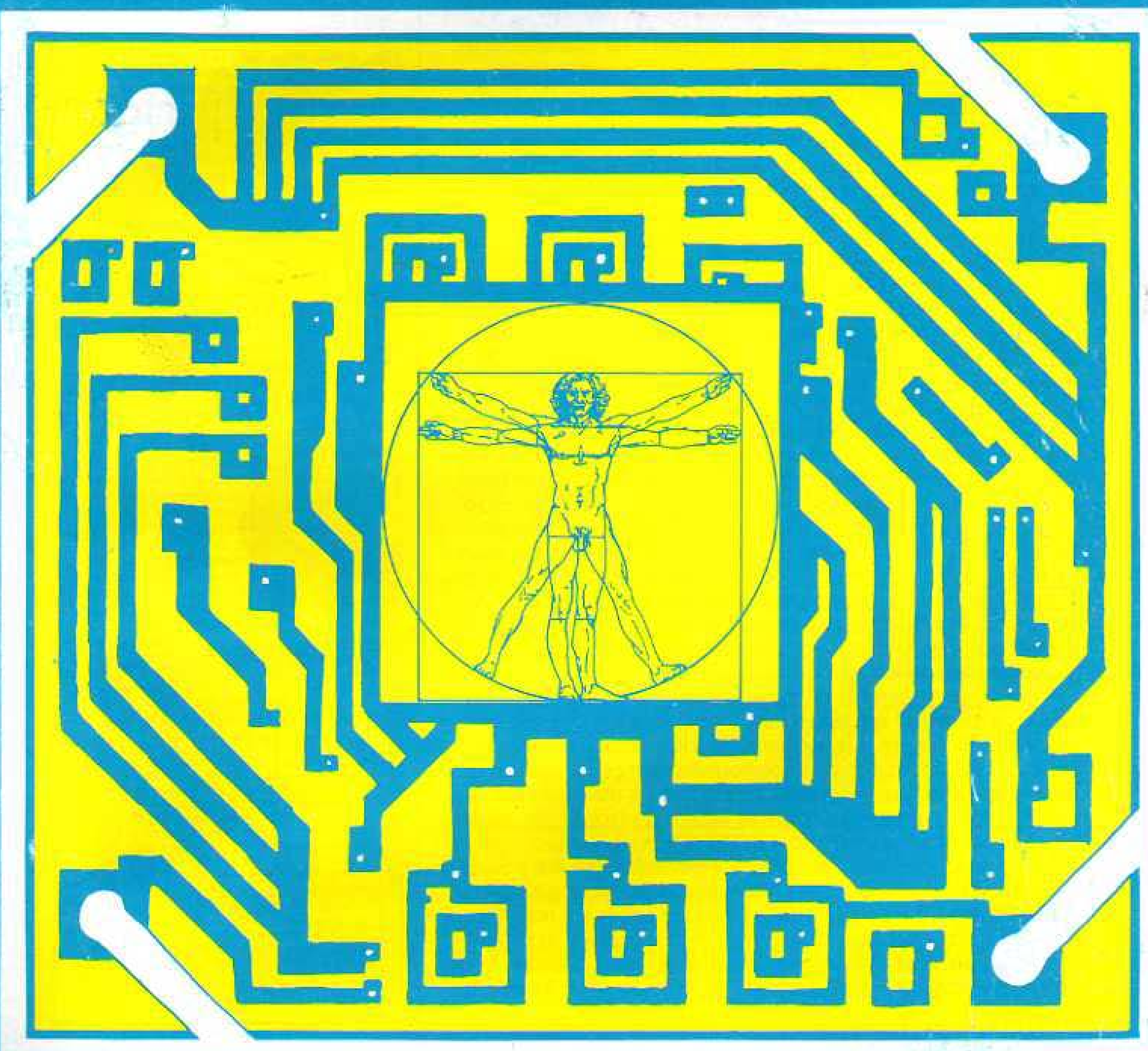
Computing the Future



Preview

In case you hadn't noticed, computers are everywhere. If you don't use one at work or own one at home, chances are good that you deal directly with one when you go to the bank, shop at the supermarket, or even, in many places, dial directory assistance. The arrival of the "computer revolution" has been trumpeted with much fanfare in the media, most often for the "convenience and efficiency" it is supposed to bring with it. But this is only part of the story. As this collection of articles shows, a deeper look also uncovers the computer's many other subtle and sometimes insidious impacts on our lives.

The clean image of the high-tech industry, for example, hides the harsh truth about its effects on our environment and our workers. The mad rush by many states in this country to attract high-tech firms obscures the true effects of this new industry on our jobs. Ken Geiser exposes the health dangers behind the high-tech industry's clean image and several authors in our special section on computers and education investigate what kind of jobs computers and the high-tech industry will really bring.

Meanwhile, as the computer revolution marches on, schools are buying computer hardware almost as fast as they can, while other areas of the education budget face severe cuts. What are teachers doing with these machines? Are students learning new creative skills, or are they being drilled and dehumanized? Who gets access to computers, and when they do, what are they being taught? It is questions such as these that we set out to answer in the education section.

While we were looking, we came across an "educational" usage of computers so onerous that it demanded attention. As Thomas Bartholomay details, Control Data Corporation has been working with the apartheid government of South Africa to establish a massive computerized education system that will help to further repress blacks and maintain white rule. It is a painful example of the frightening potential of computers to repress and control, to track and monitor. South Africa is not alone in this respect. As we have covered previously, similarly repressive uses of computer systems are already in place in West Germany, and pose a growing threat here in the U.S. as well.

But of all the impacts of computers, perhaps the most devastating is also one of the least known, and the least reported: their deadly role in current military plans. As three separate articles in this issue reveal, the increasing computerization of our weapons systems portends many ominous possibilities for the future, all of which threaten to bring us closer to violent conflict. These articles provide cause for concern and a call to action.

Unquestionably, the computer is a powerful tool. But powerful tools are often dangerous tools, especially in the wrong hands, or used carelessly. The concerns raised in these pages are mainly concerns about control, both control over the technology itself, and its uses. They are, from this vantage point, questions of crucial importance as we collectively try our hand at computing the future.

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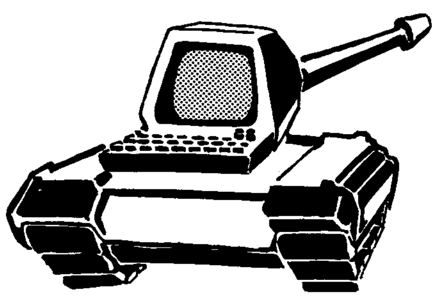

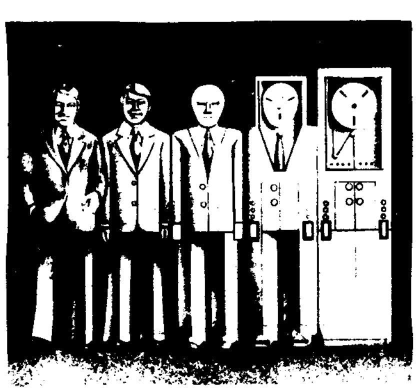

Computing the Future

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Letters

Euromissiles and U.S. Scientists

Dear SftP:
This letter has been slow in coming to express enormous appreciation for the article "Euromissiles and U.S. Scientists" by John Harris (SftP Vol. 16, No. 5). I've reproduced it in many copies and have been sending them to appropriate groups in order to call attention to its crucial information.

Herbert York addressed a huge gathering in Los Angeles organized by Physicians for Social Responsibility which I attended. He presented truths, half truths, and a general pattern of disinformation. His *Scientific American* magazine article, Oct. 10, 1983, while better on some data, essentially went along with the administration's propaganda by dragging in the subject of the invasion of Afghanistan. This type of rhetoric undermines the important need to work for US-USSR nuclear weapons disarmament agreements. Should the USSR inject the US invasion of Vietnam or Grenada to obstruct a US-USSR nuclear weapons freeze?

Unfortunately, too many in the bilateral nuclear weapons freeze movement and nuclear disarmament effort have fallen prey to these tactics and haven't yet figured out how to disentangle themselves. John Harris' article should help people see this most basic aspect of the process more clearly. Herbert York must have learned soon after 1978 that Carter, Callaghan, Giscard D'Estaing, and Helmut Schmidt signed a secret agreement that year without consultation of their parliaments, congresses, bundestags, deputies, to deploy Cruise and Pershing II missiles in Europe.

Molly Siegel
Manhattan Beach, CA

Important Dialogue

Dear SftP:
I was very glad to see "The Limits of Science" by Steven Rose and "Technology and Human Freedom" by Philip Bereano in the Nov./Dec. issue. As a scientist and activist, I find it important to have this kind of dialogue on broader theoretical issues to work out perspectives for our activities. What's very germane to this discussion but often forgotten, is Karl Marx's profound critique of science and technology. On technology not being neutral, for instance, take Marx's painstakingly detailed proof in vol. 1 of Capital that machinery not only causes unemployment but "is the most powerful weapon for suppressing strikes, those periodic revolts of the workers against the autocracy of capital."

As Bereano and Marx both show, technology is not "'neutral" but an integral part of society. Marx goes on to show how in capitalism this produces not just a "sense of alienation" but alienated labor, wherein the worker is reduced to "an appendage to the machine."

Where Bereano points to "a very long and intricate kind of process to raise the consciousness of people," the Marxian dialectic shows that process as the very law of motion of capitalist society: as the machine comes more and more to dominate and fragment the worker, so grows the worker's "quest for universality." In fact, history shows (and any factory worker knows) that it is precisely when new forms of technology are introduced that new forms of revolt arise.

To see this in our age, SftP readers would be interested in *A 1980s View: The Coal Miners' General Strike of 1949-50 and the Birth of Marxist-Humanism in the U.S.*, published in 1984 by News & Letters, 59 E. Van Buren, Suite 707, Chicago, IL 60605. The authors describe both the first U.S. strike against Automation and the new philosophy expressed in the striking miners' question: "What kind of labor should human beings do?"

Franklin Dmitryev
Chicago, Illinois

Impermeable U.S. Media

Dear SftP:
I appreciated your issue on "Science, media and Policymaking" (Volume 16, No. 4). It reminded me of my efforts to find a North American journal to publish a short article critical of present science. My experiences illustrate, I believe, the impermeability of U.S. journals to the radical science perspective.

My saga began in January 1981 when Bernard Feld, editor-in-chief of *Bulletin of the Atomic Scientists*, invited me to write an article for them based on my book *The Bias of Science* (reviewed in SftP, volume 12, number 6). I submitted a short simple article, discussing state and corporate influences on research topics, on the organization of the scientific community, and on scientific knowledge. I also discussed the possibilities of a more community-based science. But this was rejected by *Bulletin of the Atomic Scientists*, allegedly due to lack of space.

The ideas I was presenting are old hat to most SftP readers. They are also well understood—if not fully subscribed to—in some academic circles, such as the sophisticated though academic analyses of science in the British journal *Social Studies of Science*. So I decided to try to find an outlet in North America among more orthodox journals where these views are seldom presented.

Rejections came quickly from the *Progressive* (too academic for them) and *Commentary*. *Technology Review* took more interest. After a 7-month delay, I received suggestions for rewriting. The article was to be somewhat shorter, much more convincing and answer a number of other points. My revision was rejected. It seemed to me from the comments I received that I was required to do the impossible: provide a critique of science and an alternative perspective, fully convincing to tough conventional scientists, all in 2,000 words!

Not too much weight can be placed on these particular experiences. After all, my article wasn't the world's best. But other information also confirms my impression that the radical science perspective is thoroughly marginalized in the US more so than in the UK for example. There seem to be fewer outlets for even mild criticisms of science. There are good reasons why this should be the case in the US: the stronger power of capital, lack of a major social democratic party, weakness of the labor movement. All of these help inhibit critical thought and action among scientists and those who study science.

All of this just underlines the important job you at SftP are doing: keep up the good work!

Brian Martin
Canberra, Australia

Computer Manufacturers Say VDT Hazards a Comfort Issue

As any telephone operator or data entry clerk can testify, the stresses associated with VDT work are varied: eyestrain, backaches, nausea, even heart disease and clusters of miscarriages among VDT workers have been reported. For some time NIOSH and the Center for Disease Control would not investigate such reports. But after a group of long distance operators in Michigan counted 17 miscarriages among 32 pregnancies, NIOSH changed its mind; an epidemiological study of VDT work became a high priority. Other studies have previously noted that working at an automated clerk can be more stressful than even an air traffic controller's job.

One fascinating response to such job hazards is that of the Computer and Business Equipment Manufacturers Association (CBEMA). CBEMA president, Vico Henriques, testified in Washington before the House Subcommittees on Health and Safety that "advice to managers and users is the best way to make people more comfortable in the office, reduce stress, and let people know that visual displays are completely safe."

In order to spread such advice and good feeling throughout the computer and high tech industries, CBEMA plans a largescale promotional campaign through 1985. Radio and TV announcements, "educational" advertisements in print media, and brochures are in the works, aimed at countering what Henriques terms the "public's delight in the sensational" stories about miscarriages and the widespread "misconception" that computer work isn't mentally stimulating.

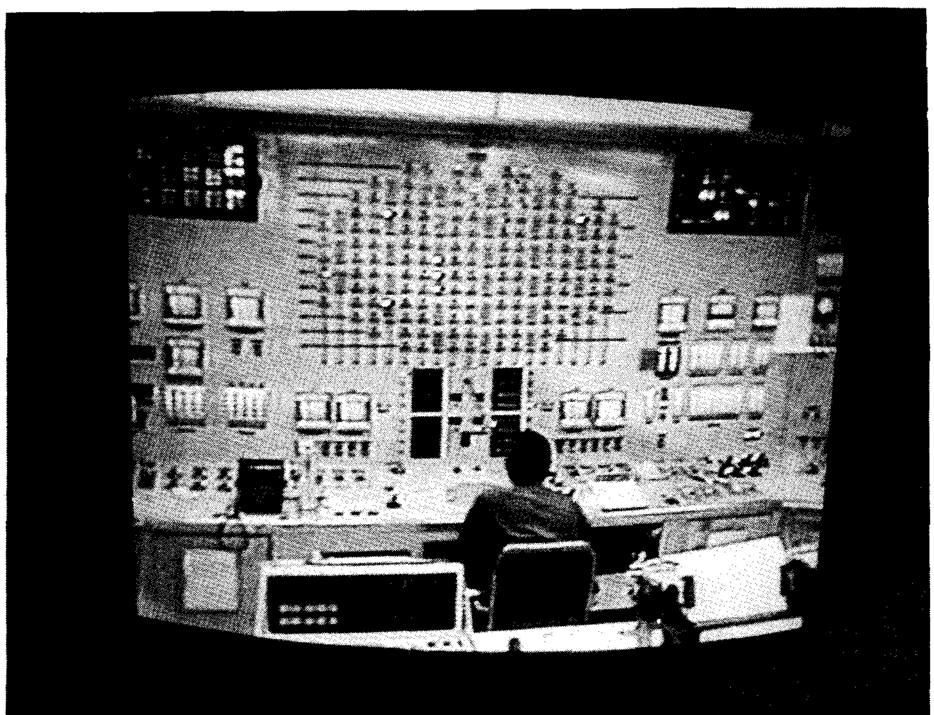
Conspicuously absent from Henriques recommendations are any examination of computer technology itself or the structure of workplace authority. Other testimony, such as that from the American College of Obstetricians and Gynecologists discounted radiation as the cause of miscarriages clustering in VDT workers, but their spokesperson was careful not to extend such claims to include other work-related factors.

But at CBEMA, public relations remains the key. If it worked for nuclear power (remember "too cheap to meter"?), then why not the VDT? Brochures would pose much less of an inconvenience to both industry, which could continue to computerize in good conscience, and workers who would consequently be spared the invasive questions of epidemiologists and disruptions of their keystroke quotas by health and safety inspectors.

Henriques' testimony was offered in response to legislative action in several states to regulate VDT operators' working conditions. In the lexicon of Reagankultur, "regulate" seems to carry the moral tenor of "fornicate" or "amputate": an unseemly act of the last resort. While the CBEMA president acknowledges that there are "comfort problems" with VDT workstations, he maintains that "legislative mandates would force citizens to conform to a legislator's supposition about what will make them feel better." Apparently, forcing citizens to conform is the private sector's duty.

—*Gary Keenan*

Scheduling That Meltdown



Ellen Shub

In yet another misguided nuclear power plant evacuation scheme, the Long Island Lighting Company (LILCO) announced plans to use Long Island's Nassau Coliseum as a staging and relocation area in the event of an accident at its Shoreham Nuclear Facility.

According to the evacuation plan filed with the Nuclear Regulatory Agency, LILCO, working without the participation of state or county authorities, established the agreement with Nassau Coliseum management. The Coliseum would also be used for decontamination and the Red Cross would have a hand in relocating the poeple who were evacuated from the first perimeter near the plan.

There's only one hitch: the Coliseum management apparently told LILCO that access to the area would have to be restricted to those times when the Circus, the Ice Show, or the Islanders were not performing. Let's just hope LILCO has enough sense to schedule any Shoreham accidents accordingly.

—information from the *Oceanside Trader*
Jan. 5, 1985.

Newsnotes

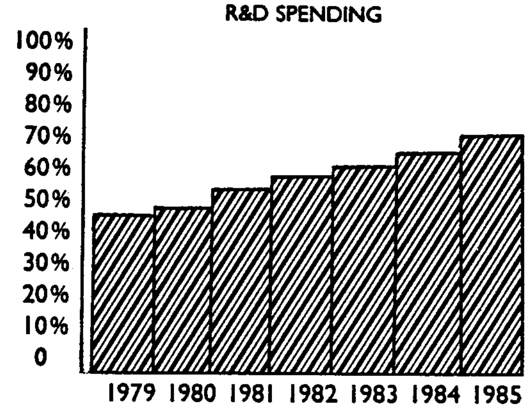
The Growing Appetite of Military R&D

Science for the People has consistently reported on the stranglehold military funding for research and development has over the broader scientific community. An important guage of this effect can always be found in the yearly appropriations. As the table and graph below illustrate, funding for military R&D has doubled in dollar amounts since the beginning of the Reagan Administration, more than tripled in the past decade. But even more importantly, the past five years have seen military R&D steadily and markedly increase as a portion of the total government expenditure on R&D.

While military R&D has long consumed roughly 50% of the total U.S. budget (gigantic as compared to many other Western, capitalist countries, such as Japan, and W. Germany where military R&D makes up 10% or less) the figures for 1985 show spending to be over 70% of the total, or almost $37 billion. Close to three quarters of all government funding for R&D is funding for military research.

And if that weren't enough, it is important to point out that these figures don't even tell the whole story of government R&D funding. The remaining 30% of the total includes expenditures for space research and technology, and energy, both areas that sponsor research with many military applications. One thing is clear: if we are to ever be able to make science and technology more closely serve human needs, these ominous trends must quickly be reversed.

MILITARY R&D FUNDS AS % OF TOTAL R&D SPENDING



FEDERAL FUNDS FOR R&D BY BUDGET FUNCTION

$ Millions	1979	1980	1981	1982	1983	1984	1985
National Defense	$13,791	$14,946	$18,413	$22,070	$24,936	$29,275	$36,975
Health	3,401	3,694	3,871	3,869	4,298	4,801	4,913
Space research & technology	3,009	2,981	2,696	2,584	2,134	2,286	2,683
Energy	3,461	3,603	3,501	3,012	2,578	2,565	2,422
General Science	1,119	1,223	1,340	1,359	1,502	1,717	1,942
Transportation	798	888	870	791	876	1,091	1,148
Natural resources & environment	1,010	999	1,061	965	952	985	900
Agriculture	552	583	659	693	745	760	795
TOTAL	$28,080	$30,017	$33,319	$35,988	$38,768	$44,367	$52,660

Melt That Ice

We see a lot of strange science stories at the *SftP* office, but this one caught us up: according to a column in *NewScientist*, laboratory-created urine is to be used this winter in some areas of the Midlands in Britain to de-ice roads.

It remains unclear exactly what the advantages of the plan are. Proponents say fermenting urine converts it into a liquid, alkaline salt solution with effective de-icing properties. We are willing to take their word for it, but for the sake of whoever is behind this move, the de-icing capabilities of this new concoction had better be excellent: not only does the scheme have an inherent public relations problem, it is projected to cost ten times as much as salt.

C-NET: A Computer Database for Peace Goes on Line

Why should the military and government be the only ones benefiting from new developments in computer technology? The Center for Innovative Diplomacy (CID), in Palo Alto, California, is trying to decentralize technical information about the arms race. Last August, in a joint project launched with members of Computer Professionals for Social Responsibility (CPSR), CID began to lay the groundwork for an experimental computer network dedicated exclusively to nuclear weapons issues and designed to help those concerned with the very real threat of nuclear war. C-NET, once fully established, will allow anyone with a computer terminal and a telephone modem to gather and disseminate information about nuclear weapons, arms control, and alternative security strategies.

"In political organizing or research, everything boils down to information," said CID Project Director Hal Harvey in an interview in the August/September 1984 issue of *The CID Report*. "You write things, you talk to people, you meet with people, and so on, but what you're really doing is developing and moving information. We now have technologies which can drastically increase the efficiency of doing this. With C-NET, we intend to harness these technologies for the peace movement. Using the database, a concerned citizen could tap into a rich library of information to rebut, say, an editorial contending that the U.S. is 'behind' the Russians in nuclear weapons."

C-NET's host computer is being shared with Community Data Processing of Palo Alto, an organization that helps nonprofit groups take advantage of computers for data processing and office automation. At present, most of the direct users of C-NET are from the San Francisco Bay area, and contact C-NET by local telephone calls. Direct use is faster and more convenient, giving access to C-NET's database in a "real-time" interactive manner that allows the user to engage another person in a live computer conversation or get instant responses to database requests. Indirect users have access to most of C-NET's resources and communicate with the system via electronic mail, but responses to requests for information may take several hours.

Although C-NET doesn't have access to restricted databases, it is currently connected, or gatewayed, into three large computer networks: ARPANET, CSNET, and USENET. ARPANET was created by the U.S. Department of Defense's Defense Advanced Research and Projects Agency and its database is limited to official government business and research. CSNET is a network formed by the National Science Foundation Computer Science Research. USENET, an operating system developed by AT&T, is decentralized, with no restrictions or policing, and is free. These connections have already allowed mail to be exchanged between C-NET and users in Europe within several hours.

C-NET's developers are negotiating to gain access to the legislative database of the Arms Control and Computer Network (ACCN), a Washington, D.C. coalition of eight major arms control and peace groups (Friends of the Earth, SANE, Physicians for Social Responsibility, Greenpeace, Lawyers Alliance for Nuclear Arms Control, the Freeze Campaign, and the Coalition for a New Foreign and Military Policy), to begin using their legislative database. This database, which is updated regularly, includes Congressional voting records on bills related to the military or international affairs and a list of key congressional staff members working on these bills.

Preliminary discussions have also been held with the Stanford Center for International Security on the possibility of jointly building a new database containing recent books, articles, and monographs concerning arms control and international diplomacy. Because only a select group of people at the Pentagon, the Senate Intelligence Agency, and various think tanks now have access to these kinds of databases, the opening of these resources to the public would be a significant step in democratizing nuclear policymaking.

Jess Gugino

Building Permit Blocks Trident II

On November 28, 1984, the Santa Cruz County California Planning Commission, in a 3-2 vote, denied a building permit to Lockheed Missile and Space Company thereby blocking production of parts for the Trident II missile. Members of Citizens for Industrial Accounting (CFIA) in Santa Cruz, a group which helped organize the opposition to Trident II, claim that this vote marks the first time anywhere in this country that elected officials have used the power of building permits to block nuclear weapons expansion.

Lockheed officials, calling the board's decision an "inconvenience" that would force the company to find another production site, appealed the issue to the county Board of Supervisors this month. In a landmark decision, coming after a five hour meeting attended by some 300 citizens, the supervisors voted, also by a 3-2 margin, to uphold the Planning Commission's decision. Voting finally at midnight after hearing the testimony of over thirty speakers the Board found that there were "significant and reasonable land-use reasons to deny the permit."

As Doug Rand, one of the CFIA organizers, stated, "we're encouraging others elsewhere to challenge these weapons every step of the way. We must take responsibility for what goes on in our own backyard before expecting people to make changes elsewhere."

The Dollars and Sense of Health Care Policy

"Alternative policies would have different health and cost consequences that should be analyzed, made explicit and publicly debated. Perhaps the American people and their physicians would choose to condemn 30 people to early deaths for lack of free care so that three well-insured patients could take cholestyramine and live, or a hospital might [buy a computer to] maxime its DRG (Diagnosis Related Group Reimbursement) income."

So wrote Drs. David Himmelstein and Steffie Woolhandler, authors of a recent report in the *New England Journal of Medicine* which points out the biases inherent in decisions about where our health dollars are spent. Himmelstein and Woolhandler compared two well-publicized studies to demonstrate that when there are powerful constituencies behind a health policy, the cost of it is often not even considered.

The cost-effectiveness of a "breakthrough" cholesterol-reducing drug was compared to the cost effectiveness of free health care (with its accompanying mortality reductions) which some called "not sufficient to justify free care." The difference between the mortality rates of the at risk control group and the at risk cholestyramine therapy patients was so small that the authors of the study found that it took over $9 million of this "breakthrough" therapy to prevent each death, whereas, in fact, $156,000 paid for free medical care for the same age population prevented each additional death above its control group.

While the cholestyramine therapy was reported as a great success on the front page of *The New York Times* and other newspapers, only six weeks earlier the free health care study was reported as proving "health does not seem improved when care is free."

Through such a comparison, Himmelstein and Woolhandler did a service by illustrating that it is only when widely differing policies are put to the same comparison of deaths prevented and cost of therapy that the public can become truly informed of health care choices. Without such perspective we can too easily remain unaware of the bias and hidden value judgements that determine where our medical dollars are spent.

Nancy Shulman

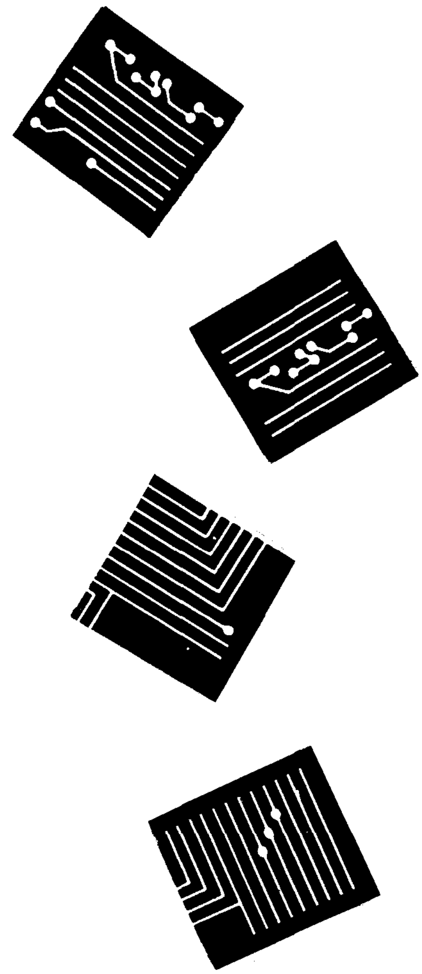
Upcoming Issues of Science for the People

The next two issues of *Science for the People* promise to be some of the best ever. Slated for May/June 1985 is a special issue assessing the current state of genetic technologies. The East Coast editorial committee is currently soliciting articles for the issue following that: July/August 1985, which marks SftP's 100th Issue published. Specifically sought is information about current grassroots struggles around the world to strive for a science and technology which more closely meet human needs. Please send articles, outlines, graphics and other materials to: Science for the People, 897 Main St., Cambridge, MA 02139.

THE CHIPS ARE FALLING

Health Hazards in the Microelectronics Industry

by Ken Geiser

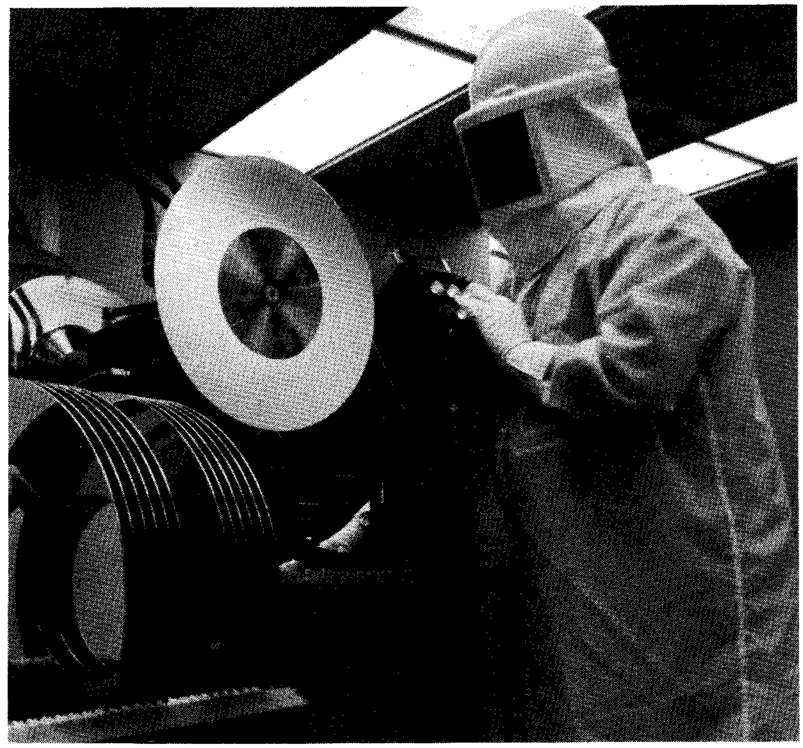


In May of 1984, Jay Zemotel died of an overexposure to arsine gas at one of Massachusetts' leading semiconductor plants. His death sparked a local controversy that has added fuel to an emerging national debate about the health and environmental hazards posed by America's high-tech industry.[1]

Joseph Bothwell, a vice president at M/A-Com's Burlington, Massachusetts plant where Jay Zemotel worked, called Zemotel's death an apparent suicide. Alleging that Zemotel deliberately exposed himself, Bothwell points to a state investigation that concludes that the plant was operating within governmental guidelines. But others dispute these findings. The Massachusetts Coalition for Occupational Safety and Health challenges the state study, and Rand Wilson, an organizer for the Communication Workers of America, claims that the company was negligent in its employee training and in its management of toxic chemical procedures in the plant. Wilson is not hesitant: "This is not a suicide as the company alleged to the press. It's a case of industrial homicide."[2]

The high-tech industry is often praised for having clean facilities with bright, attractive labs and safe and comfortable work settings. It is contrasted with older industries like steel and chemical where work is risky and smokestacks belch out odors and soot. The popular image of high-tech work envisions technicians in white lab coats working on intricate tasks at comfortable lab benches. It is this image that attracts prospective job applicants and it is this image that encourages local community planners across the country to try to lure high-tech firms to their new industrial parks. But as gradually as pollutants percolate into groundwater, an alternative image of the high-tech industry as a toxic and hazardous workplace is seeping into national consciousness.

Ken Geiser teaches in the Urban and Environmental Policy Program at Tufts University. He is actively involved in hazardous waste issues, and has participated in efforts to pass state Right to Know legislation.



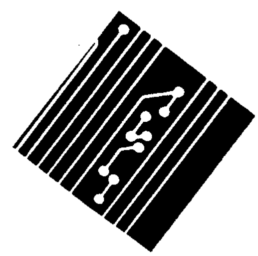
The evidence of toxic and hazardous chemicals in high-tech firms did not originate in Burlington, but, rather, on the West Coast in America's other major center of high-tech industry, Santa Clara County's fabled "Silicon Valley." In this rapidly industrialized valley south of San Francisco, among orchards and quiet subdivisions, the first alarm about high-tech chemicals arose not about deaths, but about reproductive failure. June Ross and her neighbors in South San Jose first began by joking about their propensity for miscarriages. The jokes soon grew humorless when the news media revealed that the groundwater from which they received their drinking water had been contaminated with trichloroethane, a toxin to internal organs and a suspected carcinogen. The trichloroethane was found to be leaking from underground storage tanks at a nearby Fairchild microelectronics production plant.[3]

While events have moved dramatically in California and Massachusetts, consciousness and science have lagged. Health professionals, public officials and corporate management have been hesitant to acknowledge that high-tech production may be hazardous to workers and local neighbors. The myth that high-tech is clean is not easily retired. Yet, there is increasing evidence that the high-tech industry manifests significant health and environmental hazards. It is not that the high-tech industry is dramatically more dangerous than other industries. It is the *perception* that it is cleaner and safer that is dangerous.

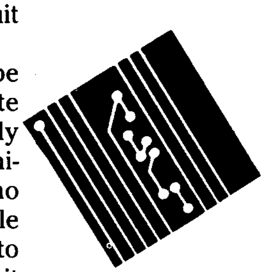
What is the Microelectronics Industry?

While the term "high-tech" is used loosely by a wide range of manufacturers, microelectronics is central to the industry.[4] The microelectronics industry has largely developed in the past 30 years, with roots in the early post-World War II development of the transistor at Bell Laboratories. This little amplifier, first made of a germanium chip and later produced more cheaply with silicon, revolutionized everything from radios and hearing aids to military armaments. In the 1950s, many now well-recognized corporations were small highly innovative garage-scale laboratories. Texas Instruments produced the first silicon transistor in 1954, and Fairchild Semiconductor produced the first silicon transistor by the planar method in 1957.

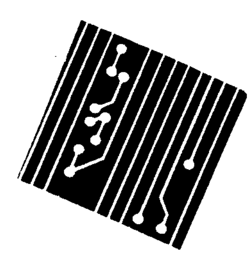
The so-called "planar technique" became the standard production process for the industry. This process involves three operations: oxidation, photo-etching, and diffusion. A small sheet or wafer of silicon is oxidized and then coated with a polymer sensitive to ultraviolet photographic light. A desired pattern of circuitry is then photographed onto the surface making the pattern vulnerable to certain etching chemicals. Next the etching chemicals are applied to cut into the silicon oxide underneath. Thus, after a solvent bath, the pattern is etched into the wafer. Highly conductive chemicals are then washed over, or diffused, into the rawly exposed pattern and the wafer now has a conductive circuit etched upon it.



This etching and diffusion process can be repeated several times to build up intricate layers of currents before the wafer is finely cut into tiny little circuit disks called "semiconductor chips." Such chips are typically no larger than a stamp. Hundreds of these little chips may then be inserted, or "stuffed," into laminated insulators called printed circuit boards or "PC boards."[5]



While the first semiconductors were used in telephone equipment and hearing aids, the real revolution in the industry occurred in computers. The development of the stored program digital computer and the semiconductor chip was synergistic. The chip made it possible to reduce the size and cost of the computer from the room-sized equipment of the 1950s to the desktop models of today. Computer production created the voracious market for millions of chips.



From its beginning the microelectronics industry has been highly innovative and profitable. By 1968, Intel had become the leader in chip production and IBM was the giant of the computer business. Fairchild and National Semiconductor in California and Digital and Wang in Massachusetts became the seed bed for the spinning off of hundreds of small firms. Many of these failed within several years, but others prospered and grew. Two industrial centers soon emerged in the country: the Santa Clara, Silicon Valley area and the Route 128 region around Boston. Both these areas provided the right combinaion of venture capital, creative entrepreneurs, skilled labor and access to major technical universities needed by the growing industry. The significant role played by Stanford University in California and MIT in Massachusetts combined with the easy access to federal Department of Defense contracts in determining the rapid growth of the two centers. Defense contracts for missile systems, fire control mechanisms, radar systems, computers, and other technology-intensive hardware provided an early market for many products first produced with semiconductors and printed circuit boards.[6]

Today, high-tech industrial centers are emerging throughout the country and the world. New centers are being developed in Texas, Illinois, North Carolina and Arizona. In Oregon, there has been a 60% increase in the number of high-tech firms in the past decade.[7] These new centers are developing as congestion and limited industrial space are limiting new growth in Massachusetts and California.

Increasingly, the high-tech industry has become global. Semiconductors are still produced domestically (25% in Silicon Valley), but much of the "stuffing" of chips into printed circuit boards is being done by workers in Ireland, the Philippines, Korea, Singapore, Puerto Rico and Mexico.[8] Today some 70% percent of printed circuit board assembly is "offshore."[9] Firms seek foreign shores for production and assembly due to low wages and the absence of various regulations including health and environmental standards.

Is the Microelectronics Industry Clean and Safe?

Among the worst consequences of the clean image of the high-tech industry is how it deflects research interest in occupational and public health issues. While there are increasing stories of reproductive hazards, organ damage, skin, throat and eye harm, cancer, and death, there is very little scientific study; a search of the literature reveals little research of consequence.

The best work to date comes from Sweden which maintains the best occupational statistics covering toxic chemical exposure. A longitudinal study of Swedish workers in the electronics industry revealed a slightly elevated incidence of all cancers among workers, particularly cancers of the larynx and respiratory system.[10] During the mid-1970s, the U.S. National Institute of Occupational Safety and Health (NIOSH) completed specific health hazard evaluations of firms in the electronics industry. At the conclusion of the study, NIOSH reported: "It is NIOSH's opinion that a significant occupationally-related health problem exists."[11]

Two U.S. studies sponsored by NIOSH since then have explored health problems in the semiconductor industry. One study

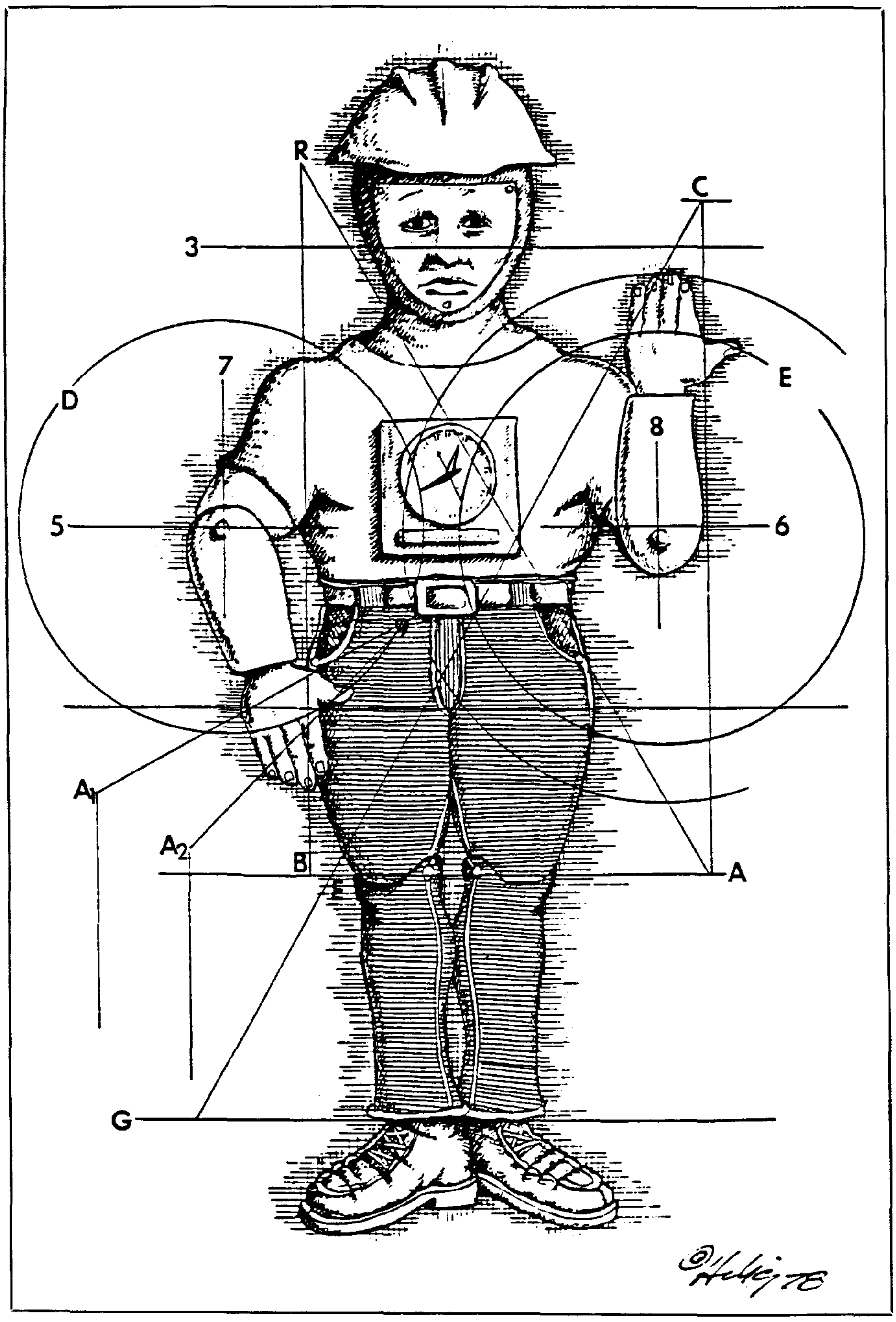
Health Hazards in High-Tech Production

Type of work	*Chemicals commonly used*	*Health effects*
degreasing and cleaning	methylene chloride	dermatitis (skin disease), nausea, eye damage
	methylethyl ketone	narcosis (stupor, unconsciousness), anesthesia
	carbon tetrachloride	depression, suspected carcinogen (cancer-causing agent)
	trichloroethylene	headaches, narcosis, nerve damage, suspected carcinogen
wafer fabrication	germanium dioxide	
	silicon dioxide	silicosis (dust-caused lung disease)
wafer doping	arsenic	jaundice, liver and heart damage, carcinogen
	antimony	tiredness
	phosphorus	bone destruction
wafer diffusion	phosphine	vomiting, diarrhea
	arsenic	jaundice, liver and heart damage, carcinogen
photoetching	hydrofluoric acid	skin and eye problems, chemical burns
	phosphoric acid	chemical burns
	hydrochloric acid	chemical burns
	nitric acid	chemical burns
encapsulation	liquid epoxy resins	skin irritants, sensitizer
	polyurethane plastics	eye and respiratory tract irritant, sensitizer
	chloronaphthalenes	suspected carcinogen
	PCBs	chloracne (skin disease), liver and kidney damage
electroplating	nickel oxide	dermatitis ("nickel itch"), risk of lung and sinus cancer from inhalation of dust
	cyanide salts	dermatitis, eye and respiratory irritant, nausea and vomiting, tiredness
	chromic acid	suspected carcinogen
	cadmium	water retention in lungs
drilling and shearing	fibrous glass	dermatitis, respiratory damage
bonding and soldering	cadmium oxide	respiratory damage, liver and kidney damage
	lead oxide	reproductive hazards, anemia, long-term exposure: brain damage
	zinc oxide	respiratory damage
	zinc chloride	respiratory damage
assembly work		stress, eye strain, fatigue, back strain

Source: compiled from Cindy Talbot and Andrea Hricko, "Hazards of the Electronics Industry."

by the Battelle Institute found that etching equipment can produce above-standard exposure to radiation. Further, production and maintenance workers can be exposed to large doses of arsenic and toxic gases such as arsine and phosphine under normal working conditions.[12] A second study by the Research Triangle Institute suggested that synergistic effects of exposure to the wide array of toxic chemicals used in semiconductor production may put workers at greater risk than computable when chemicals are considered individually.[13]

In 1981, the California Division of Occupational Safety and Health completed a study based on 42 California semiconductor firms. Not only did the data indicate three times as many cases of occupational illness in semiconductor production as in general manufacturing (1.3 illnesses per 100 workers for semiconductors compared with 0.4 cases per 100 workers for all manufacturing), but also during the same period compensation statistics show that 46.9% of all occupational illnesses among semiconductor workers resulted from systemic poisoning (mostly toxic chemical exposure).[14]



Why is the Microelectronics Industry Particularly Risky?

Myths persist where facts are absent. The microelectronics industry is perceived as clean due to the absence of contrary facts, and because there is so much to be gained by neglecting the bad news about high-tech. The high-tech industry is touted by both liberal and conservative politicians as the industrial salvation of the U.S. economy — the jobs and investment replacement for the faltering American steel and auto industries.[15] Local politicians promise jobless workers new employment opportunities as high-tech firms are lured to new industrial parks and recycled mill buildings. And, beyond hope and rhetoric, high-tech firms are highly profitable. A recent report in Massachusetts found that the top nine Massachusetts firms earned $939 million in profits in 1981 or a return on investment of 13.3 %.[16]

With so much to be gained by maintaining a positive popular image of high-tech, it is not surprising that so little citicism exists. But, while political and corporate leaders may consciously neglect the potential costs of high-tech production, it is not personal malevolence that leads high-tech production to be particularly risky. Instead, these risks are a consequence of the industry's current state of development. Capitalist enterprises develop around particular technological innovations and this development occurs within the context of certain social relations between corporate owners, workers, financers and consumers. The particular combination of these factors that has made the high-tech industry boom, is also responsible for the significant health and environmental hazards that have resulted.

First, the microelectronics industry is developing in a new age of synthetic chemicals. Since World War II, major technical innovations in the petrochemical industry have produced a wide range of synthetic chemicals for industrial production. Early work by the National Bureau of Standards and the American Petroleum Institute during the 1930s shifted the focus of hydrocarbon production from coal to petroleum. Combined with the heavy defense investments in chemical research during the war, this led to an explosion of new chemicals on the market following 1945. The total U.S. production of synthetic chemicals

continued on page 45

E.T. GO HOME

The Revolution in Not-So-Conventional Weapons

by Derek Rasmussen

"It isn't God, but it's pretty close to it." — Major Duffy McCallum on the new $20 million high-tech test range at Cold Lake, Alberta.[1]

Hyped as "Star Wars" gadgetry and as the answer to the West's nuclear "dependence," new high-tech "conventional" weapons are beginning to roll off assembly lines and into U.S. and NATO arsenals.[2]

More weapons *systems* than weapons, these new "smart" devices are armed with dozens and often hundreds of high explosive mini-warheads connected to complex arrays of sensors, communication links, targeting and delivery systems, and computerized "brains." With the destructive potential of three to four kiloton nuclear bombs, these new "conventional" weapons, according to awestruck NATO generals, make their present arsenals look like "sixteenth century bombs"[3] in comparison. Demonstrating his gift for insight and understatement, U.S. Army General James H. Merryman had this to say about the accuracy of modern weapons: "War is getting very lethal."

While these new "smart" weapons are based on Western advances in microelectronics and computers, the United States is banking on future advances in biotechnology, artificial intelligence, large space structures and other areas to give it the lead in "ET" systems. "ET" is the acronym coined by cynical minds in the Pentagon for military "emerging technologies," people-killing devices which will not be available until the 1990s.[4]

From "McNamara's Wall to RPVs

"Smart" weapons first drew attention in the 1973 Arab-Israeli war when Egyptian soldiers carrying portable wire-guided missiles destroyed many Israeli tanks. Smart weapons had been used previously in the Vietnam war with little notice, with the exception of the infamous "McNamara Wall," a fence of bombs, computers and sensors between North and South Vietnam which killed as many or more refugees and civilians than it did guerrillas.

Nonetheless, smart weapons and their closest offspring, Precision Guided Munitions (PGMs), became popular in the and led to the motto "if you can see the target, you can kill it." Wire-guided bombs led to T.V.-and laser guided bombs, but all were susceptible to bad weather. What the new high-tech weapons will offer is a third generation of PGMs whose sensors use microwaves, millimeter waves and other forms of radiation to make them all-weather capable. With these new "fire and forget" weapons, the motto being offered is: "Even if you can't see the target, you can kill it."[5]

The real turning point for smart weapons was the Falklands war and the Israeli invasion of Lebanon—mostly the latter. Stocks in electronic warfare companies shot up and their executives were ecstatic. "Star Wars of the future is what it's all

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about," said Bernard Schwartz, chairman and CEO of Loral (one of the U.S. high-tech firms which supplied Israel), "The lessons of Lebanon will dominate military thinking for the next ten years."[6]

The lessons included the Israeli use of small pilotless aircraft called RVPs (Remotely Piloted Vehicles). Equipped with T.V. cameras and sensors, the RPVs were used to get instant pictures of battlefields, or even of particular intersections in the city of Beirut, and to then guide PGMs straight to their targets.[7]

The New High-Tech Weapons

The soon-to-be-available high-tech "conventional" weapons will be even more "impressive." In the new U.S. "Apache" AH64 attack helicopter, movements in the pilot's cornea while he watches a target are measured by a laser and used to guide missiles to the target. The Apache will carry 16 laser-guided Hellfire missiles, 76 rockets, or 1,200 rounds for its 30 mm cannon, and it will be the first helicopter with night vision and all-weather capability. The cost? $7.4 billion for 572 helicopters.[8] The long list of high-tech "conventional" weapons systems is mind-boggling, with names like WAAM, BOSS, and "Incredible Hulk"; but here are a few highlights:[9]

Assault Breaker: The star of this new generation of weapons; the Assault Breaker's almost unknown to the public. One of the Reagan administration's three top-priority armaments, along with the MX missile and the B-1 Bomber, Assault Breaker belongs to the "standoff" group of weapons (weapons with longer ranges and greater destructiveness than PGMs). It will be loaded with "smart" submunitions (small, highly explosive charges) and advanced guidance systems and sensors, and will seek targets deep in enemy territory after being fired from a safe distance (100-200 km).[10]

Fuel-Air Explosives (FAEs): These are among the most potent of the revolutionary new explosives and warhead technologies. FAEs dispense a cloud of highly volatile fuel which, when ignited, can produce atmospheric overpressures similar to those developed by nuclear weapons. A near-miss can sink an aircraft carrier or level entire city blocks. An advanced version, FAE2, is now being developed by the Pentagon.[11]

Multiple Launch Rocket System (MLRS): This system can fire its 12 rockets in less than one minute, scattering 8,000 submunitions (each with the power of a hand grenade) over an area as big as six football fields. MLRS rockets loaded with "Skeet" submunitions have been favorably compared with low-yield nuclear weapons.

The Pentagon Appeals for Canadian Help

This last example, the MLRS, is very popular with the Reagan administration because it is one of the first of these "revolutionary" new weapons to be deployed. This is how the MLRS was described by the Pentagon's head of NATO affairs, Frank Cevasco:

> [Each MLRS rocket could have] six terminally guided missiles, four inches in diameter, two feet long. The things fly out over a pattern—they hunt, they scan, they do basic signal processing decision-making: "is this a real target?" They run a series of computational checks. If a determination is made that it's a target or probable target, then they go down and kill it. From the top, where it's softer. We don't steer it. We don't look through an eyepiece. We put it out there and it finds the target itself if we're smart enough to know to point it, then it takes over, you lose control. That's the kind of thing microelectronics can do for us that was not possible in the past. A two foot long, four inch wide missile [that] I can hold in my hand flies a whole buildingful of computational equipment and all the apparatus that go with it. *That's* what's revolutionary![12]

Cevasco made these remarks at a high-tech conference and trade show in Ottawa, Canada, this May. The conference, the second in two years, was organized by the Canadian Advanced Technology Association, representing over 150 Canadian firms, and the National Security Industrial Association, whose membership list—Boeing, Control Data, IBM, Lockheed, Litton, United Technologies, etc.—reads like a "Who's Who" of top U.S. war contractors. The U.S. government has shown a lot of interest in these conferences—much more than its Canadian counterpart—sending up planeloads of top Pentagon officials and scientists.

This apparently unprecedented attention to a specific area of Canadian industry can be explained by a glance at the Pentagon's budget: 50 cents of every dollar goes for electronics in weapons and communications.[13] The U.S. wants NATO—and Canada in particular—to share the cost of researching, developing and producing the "guts" of the new ET and high-tech weapons.

The parade of top brass has included the two most prominent proponents of the new weaponry: Dr. Richard DeLaurer, head of Research and Engineering for the Defense Department, and James P. Wade, Jr., his principal deputy. Canada, they say, is a "stable," secure neighbor which can be trusted with secret military R&D, the only country whose war industry is considered to be part of the U.S. military-industrial base. "Our nations have," as James Wade noted, "for all practical purposes, joined together in a North American defense industry base."[14]

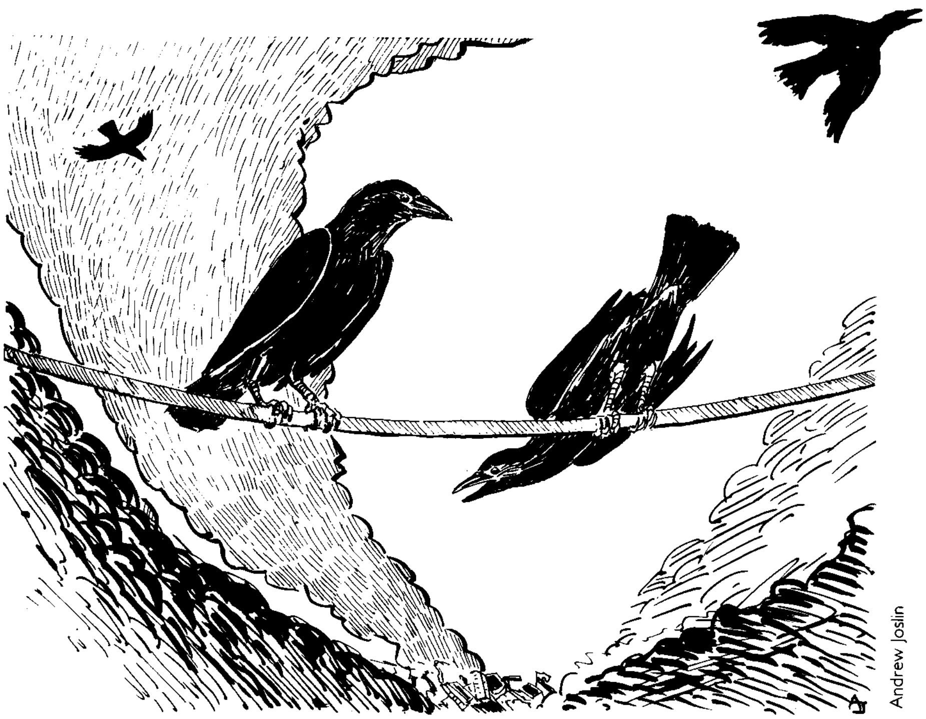
With these new "fire and forget" weapons, the motto being offered is: "even if you can't see the target, you can kill it."

"See-Cubed-Eye"

As Canadian companies repeatedly point out, however, none of this equipment actually kills people. It's just communications equipment, sensors, satellites or computers—all lumped together in military terms as C^3I, or Command, Control, Communications and Intelligence. Canadian C^3I has a good reputation worldwide and it is C^3I, coincidentally, which the Reagan administration has recently promoted to equal priority with armaments.[15] The Pentagon's former chief scientist for C^3I, Dr. Neil Birch, spoke at the first CATA/NSIA conference in Ottawa last year and gave the following frank appraisal of the Canadian military technology scene:

> All right, let me get to the bottom line. I think that the potential here is great. The atmosphere is good . . . it's very high-tech, the political risks are minimal [and] the quality of your products is excellent.[16]

At the moment the most important American C^3I system is the NAVSTAR eighteen satellite Global Positioning System (GPS) to be completed in 1987. NAVSTAR's three-dimensional locating accuracy (within 10 metres) will give nuclear missiles first-strike precision, give police and intelligence agencies worldwide vehicle surveillance capability (Canadian Department of Correctional Services is participating in these preparations as well),[17] and have a variety of tactical uses. Helicopters could land on a dime in the dark, planes would have increased bombing accuracy, and Special Forces "advisors," in Central America for example, could direct military strikes without needing large forward patrols.[18] Why send the Marines if you don't have to?



Additional Information

U.S. corporations involved in Emerging Technology (E.T.) and high-tech weapons:

- **Advanced Cluster Munitions** "Skeet" made by Avco. **Other Companies:** Honeywell, General Dynamics.
- **Assault Breaker:** candidates are versions of Vought's T-22 missile, and Martin Marietta's T-16.
- **AH-64 Advanced Attack Helicopter:** Hughes Helicopters.
- **MLRS:5 Vought.**
- **Electronic Warfare (biggies):** IBM, RCA, Eaton, TRW, GTE, Sylvania, Raytheon, Grumman, Hughes Aircraft, Litton, I.T.T., Westinghouse, Ford Aerospace, Northrup, Lockheed, Boeing, Hewlett-Packard, Motorola, and National Semiconductor.

The Need for ET and High-Tech Weapons

The reasons for this increased emphasis on ET, high-tech weapons and C³I are simple. First, the U.S. military wants to overcome the "Vietnam Syndrome." A quick victory in Grenada notwithstanding, polls show that the American public is still "suffering" from an unwillingness to support long, drawn-out, high-casualty U.S. wars in Third World countries, thus, the shift from labor-intensive battles to capital-intensive high-tech weapons for fighting quick, brutal wars.

Second is the dilemma of "horizontal arms proliferation." With industrialized nations peddling all sorts of sophisticated weapons to various shaky regimes, what's the U.S. to do when these governments fall and the arms end up in the hands of unsavory types which the United States would like to do away with? This was the case in Iran, for example, where the U.S. could have found itself up against some of the best weapons in the world—it's own. Lt. Col. William T. McLarty, head of the Combat Vehicle Technology for the U.S. Army, puts the problem this way: "Third World countries are increasingly acquiring substantial combat power . . . Within arms reach, however," he adds, "are solutions [which] involve the application of technological innovations that were, until recently, more the purview of science fiction writers than miliary planners."[19] These solutions are the new smart weapons systems.

Third, and finally, is the problem that has turned out to be more help than hindrance: the nuclear disarmament movement and the Euromissile controversy. The problem was the possibility of restrictions on the use of nuclear weapons—the weapons which have been so important in keeping the U.S.S.R. at bay and as a back-up to American intervention forces (for more on the frequent use of the "nuclear threat" during American interventions in the Third World, see for example, Daniel Ellsberg's writings).[20] But with the peace movement focusing on Europe the solution was obvious. ET and high-tech weapons, say the enthusiasts, will raise the nuclear threshold in Europe and lessen the chances of all-out nuclear war. This claim is wrong on a number of counts, but has nonetheless earned the support of many influential voices in the "peace" and nuclear freeze movements. Robert McNamara, late of "McNamara's Wall' fame (but now a dove), praises the new weaponry because it will do "with conventional weapons what previously had required nuclear munitions." The U.S.

Even debated on their own terms, these new weapons will increase the chances of nuclear war, not lessen it.

Democratic Party and the Union of Concerned Scientists have also come out strongly in favor of the new high-tech "conventional" arms.[21]

The Nuclear Risk

Even debated on their own terms, however, these new weapons will *increase* the chances of nuclear war, not lessen it:[22]

- Many of the new weapons will use delivery vehicles common to nuclear weapons (e.g. Cruise, Trident, Lance, and Pershing 2 missiles). Soviet forces are unlikely to hang onto their nukes while waiting to see if the missiles fired at them have conventional or nuclear warheads.
- The deadliness of the new high-tech weapons verges on 3-4 kiloton nuclear effects, thus *lowering* inhibitions on the use of nukes, and blurring any so-called "firebreak."[23]
- The temptation to add nuclear warheads to the high-tech weapons has already proven too great to resist. Proponents of the new systems were shocked to learn last November that Lawrence Livermore Labs had already tested a nuclear warhead for the Assault Breaker.
- The three new fighting doctrines meant to accompany these weapons all insist that the use of nuclear weapons is vital to the successful use of the new conventional arms—a point downplayed by their proponents. The already-implemented AirLand Battle doctrine, described as "the first fundamental change in Army doctrine since World War II,"[24] calls for the full integration and first use of "conventional, nuclear, chemical and electronic means." General Bernard Rogers, the proponent of his own "Rogers Plan" and the "Strike Deep" doctrines, has admitted that these doctrines rely on nuclear weapons for success. Furthermore, while pushing these new doctrines through congressional committees, military officials have repeatedly requested "nuclear predelegation authority" to allow field commanders to order the use of nukes without Presidential approval—but they have so far been denied.

The European Theater: Red Herring?

The new high-tech conventional weapons, in any case, aren't really intended for use in the European theater at all. Certainly it's hoped that with a few of them in Europe some steam might be knocked out of the peace movement, but their real usefulness is elsewhere. As Eisenhower's chief of staff, Nathan B. Twining, said in reference to battlefield nukes (another weapon which was claimed as necessary for the European theater but used elsewhere), "If employed once or twice in the right targets ... [tactical nuclear weapons] would stop *current* aggression and stop *future* subversion ... Congos, Cubas, Vietnams and the like."[25]

Pentagon planners have the same purpose in mind for the new high-tech conventional weapons and their chemical and nuclear "reinforcements." The official adoption of the AirLand Battle doctrine was preceded in 1981 by the AirLand Battle and Corps 86 Study conceived for Europe, the Middle East and Korea, but the wider geographical focus was hushed up before the doctrine reached its final form.

The AirLand Battle 2000, an official Army concept but not yet doctrine, assumes a high-tech, virtually automated battlefield by the year 2000. It calls for NATO to look "southeastwards," where dependence on Middle East oil is called a threat to Central Europe of *"equal importance"* to the threat of Warsaw Pact attack.[26]

> **"We don't steer it. We don't look through an eyepiece. We put it out there and it finds the target itself . . . That's what's revolutionary!"**

Finally, a Pentagon study called Air Force 2000, leaked to Reuters, warns that "the U.S. is much more apt to be drawn into wars involving Third World nations than into a war in Europe, where combat with Soviet forces is not likely in this century." The most likely battleground, the report says, is "the area plus or minus 30 degrees from the equator. For example . . . war in the Middle East is virtually inevitable."[27]

Obviously, as these reports and doctrines indicate, the U.S. sees new high-tech conventional weapons as a means of policing its empire without giving rise to domestic resistance.[28] Justifying these weapons as a non-nuclear defense against the Warsaw Pact is (excuse the pun) a red herring. Technological fixes *propel*, not prevent, arms races. And given the terrible destructiveness of the new weapons and the nuclear tripwire they represent, any claims that they are the "lesser evil" or are more humane should be exposed for the lies they are.

Non-nuclear war is changing beyond all recognition. It is hardly "conventional" anymore.

Nuclear Refinements: Shrinking Firebreak

At the same time as conventional weapons are being upgraded, nuclear weapons are also being transformed. Scientists at Lawrence Livermore Laboratory in California are developing a "third generation" of nuclear bombs accentuating either the blast, heat, radiation, or EMP (electromagnetic pulse) effects. The neutron bomb is a crude prototype of these "refined" weapons. "The aim of all this, of course" writes defense analyst Michael Klare*, "is to make nuclear weapons appear more controlled in their effects and thus more 'usable' as everyday weapons." The converging forces of conventional upgrading and nuclear downgrading may wipe out the so-called *firebreak* between the two weapon types completely—lessening the inhibitions to "use the nukes."

*M. Klare, "The Era of Super-Violence", *MERIP Reports*, January 1983, p. 17. See also: M. Klare, "Conventional Arms, Military Doctrine, and Nuclear War: The Vanishing Firebreak", *THOUGHT* (Fordham University Quarterly), March 1984.

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THE DEFINITIVE GUIDE TO HIGH TECH

by Ray Valdes

In recent years many of us have been overwhelmed by a flood of new products whose major virtue appears to be the label "High-Tech." From computers to Cuisinarts, manufacturers proudly tout their latest widget as being indubitably superior to the competition because their particular widget has the key quality of being High-Tech.

But some of us may wonder why one brand of squash racquet or tampon deserves to be called High-Tech while another does not. A distinction that is presented as being intuitively obvious does not seem to stand up to continued scrutiny.

Take, for example, your average homely phone from Bell Telephone. Even though it has worked faithfully and reliably through years of being dropped on the floor, getting singed on the kitchen stove, and falling with the diapers into the washing machine, it can by no stretch of the imagination be called High-Tech.

On the other hand, that swept-back phone design with the cherry-red racing stripes that set you back $199 at the Electronics Boutique in your local shopping mall definitely *is* High-Tech, regardless of the fact that it stopped working after the first week.

What is the distinguishing factor? After many weeks of research, we at Science for the People have come up with the answer to this vexing question. We proudly set forth below some principles and guidelines that will enable you, too, to move confidently through the mid-1980s, secure in your ability to recognize whether a particular item is or is not High-Tech. In fact, if you study these principles carefully, you may even be able to design your own successful High-Tech products.

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Nick Thorkelson

Materials

One of the first steps in designing a High-Tech product is choosing what it's made out of. Unusual or exotic materials are of great help in elevating a product from "low-tech" to High-Tech.

Take, for example, running shoes. Running shoes are basically sneakers made out of nylon instead of cloth. This fact alone was able to provide High-Tech status to these shoes when they were first introduced to the consumer market in the early 1970s.

After a while, however, nylon as a material for running shoes was no longer so unusual. Sears and Bradlees began making and selling the shoes, and now the shoes are threatening to become a low-tech commodity item like galoshes or baking soda. However, one forward-looking product designer had been able to secure his brand's High-Tech status by adding graphite as a reinforcing material to the soles—and by jacking up the price.

Currently, graphite is a genuine High-Tech material in almost any product, from squash racquets to windsurfboards. The single exception, of course, is pencils, which can only be High-Tech if they *don't* have graphite.

Stainless steel is another material that can be High-Tech if it is in products that don't normally use it. For example, a stainless steel table lamp is definitely High-Tech. So is a stainless steel sports car. Of course, a stainless steel fork or tablespoon definitely could *not* be considered High-Tech.

Chrome is no longer a High-Tech material although it could be seen as a precursor from the 1950s. Boron is High-Tech in everything but gasoline. Plexiglas is High-Tech in cookbook holders but not in windows. "Hot new" materials like Kevlar and Mylar are High-Tech in almost everything.

Computers

Computers are the ultimate material to incorporate into a product. If anything is intrinsically High-Tech it is these overgrown calculators. By themselves they are good. They can elevate the most proletarian product to the realm of High-Techdom.

You can take your old Maytag washing machine from its current location in the backyard near the outhouse, and move it respectably and confidently into your kitchen (or even your living room) if you put a computer in it.

You've seen computers added to copiers, typewriters, cars, and stereos. Look for them in unusual places like abacuses, wastebaskets, and sewing kits. The ultimate is to put a computer inside another computer, in order to make that computer easier to use. Then, as with a Chinese box, put another computer inside that whole kaboodle. The only limits to taking this process further is the size of the customer's wallet.

Location

Putting things in unusual places illustrates another method of making something High-Tech: the importance of location cannot be stressed enough.

Almost anything you move from your house to your car will become High-Tech. A TV set or telephone is not High-Tech in your house. But put it in your car and it magically becomes High-Tech. Product designers are now scouring the home for other things to move into cars. Look for the new generation of cars to have disposals and food processors.

Another good location is your ceiling. Take an ordinary high-intensity desk lamp. Hang it from the ceiling, call it track lighting and you have entered the world of High-Tech. The same is true if you dust off your old Magnavox stereo speakers and hang them above the doorway (remember to dress them up with Mylar or Kevlar). Or take your entire body and hang it from the ceiling, upside down, of course, using High-Tech Gravity Boots.

One thing that doesn't belong on the ceiling, however, is the ceiling fan. That should be mounted sideways on the wall. There are an infinite amount of permutations. Product designers have been playing musical chairs for years now. First, you take the TV and put it on the wristwatch. Then you take the wristwatch and put it on the lamp. Take the lamp and put it on the ceiling. Take the ceiling fan and put it on your TV . . . Well, you get the picture.

The Person

The best, most High-Tech location of all is "the Person." Take almost any product and put it on "the Person" and you can confidently call it High-Tech.

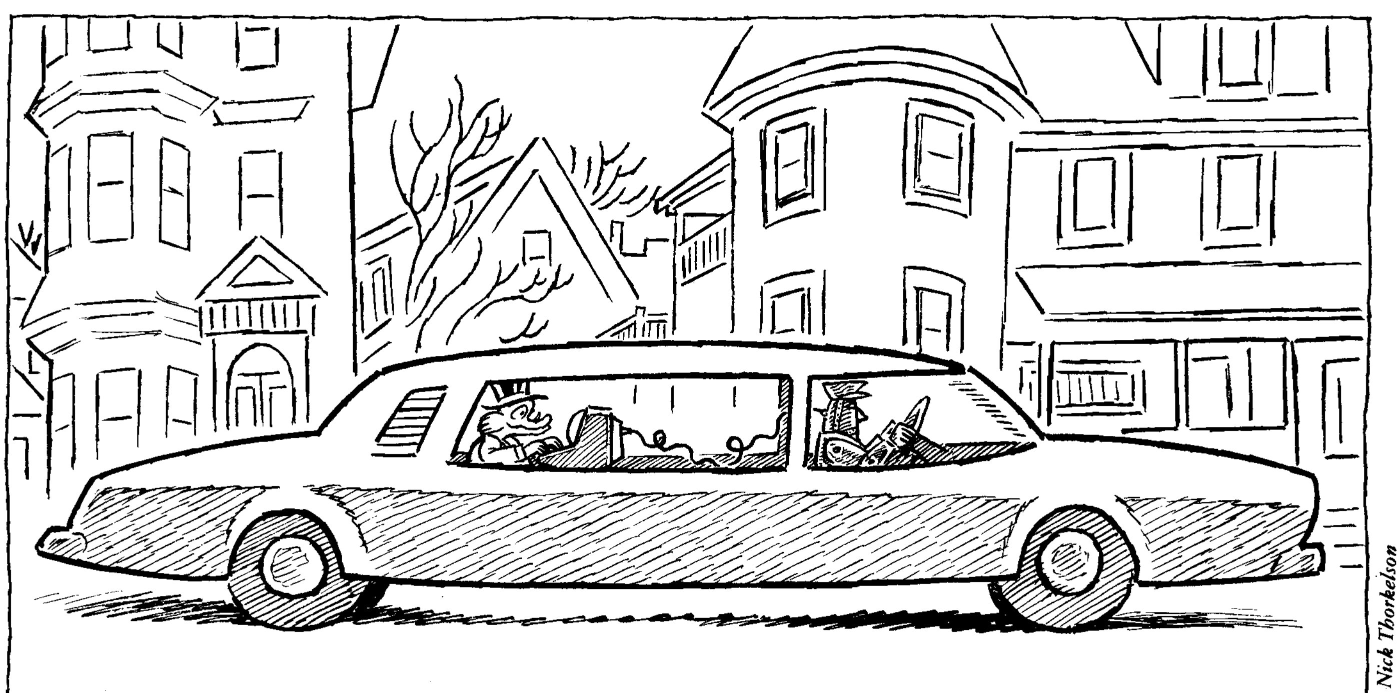
First Sony came out with the Walkman Personal Stereo. Then came IBM with the Personal Computer, and Canon with the Personal Copier. The reason this concept is so popular with industry is, of course, that you can sell many more widgets if everybody thinks they have to have their own individual unit.

There are now personal exercise treadmills for the home, and personal telephones you can carry with you wherever you go. Look for personal portable airconditioners coming soon to a store near you.

Combinations

If you try the above methods of location and materials and still can't come up with a High-Tech product, then try combining or joining together existing prosaic products.

In sports, once bicycling, running and swimming became activities for the masses (i.e., commodity sports), the combination of the three was created and given the name Triathlon. The Triathlon opens up a whole new market for expensive exotic gear (special shoes that can be worn in the water, on a bike and on the road, special shirts made out of exotic



Nick Thorkelson

materials, etc.). The Triathlon is rapidly becoming the hottest sport for the mid-1980s, two magazines now available on supermarket newsstands.

This method of combining things has been used a lot with wristwatches. There are now watches that are also calculators and appointment books. There are radio-watches, TV-watches, biofeedback-watches and watches that let you play Pac-Man. Actually, there is not too much more that you can add to a watch that hasn't been added. It is best to look at other products that have not yet been combined.

Swiss army knives, one of the original product combinations, are not High-Tech because they were introduced so long ago. If they were introduced now, they would definitely be High-Tech, especially if they were made of graphite.

Packaging

Now that you've designed your high-tech product, don't think you can get away with putting it into any plain old box or package. Any high-tech product worth its salt has to have genuine High-Tech packaging.

The first rule of high-tech packaging is: If it doesn't have a grid on it, it isn't High-Tech. Whether it's a new food processor, squash racquet, or personal computer software, the package has to have a grid on it as a background for the label and other product information.

Also, no matter what product you're selling, it helps to have pictures of other high-tech products on it. This is why Apple has a picture of a running shoe on its Macintosh computer or why a running shoe manfacturer has a computer sitting underneath its product.

As for package colors, if it were the 1960s, you'd have Tie-Dye Purple on Denim Blue. In the 1970s it was respectable to use Butcher-Block Beige or Fern-Bar Green. For the 1980s, however, the required colors are Space Shuttle White, Royal Ronald Reagan Blue, or Pin-Stripe Grey. These colors are for background mostly, and are accented by any of the bright Chroma-Carcinogen colors.

The product name has to be a *Synthetic-Word*. That is, it has to be a combination of two separate words joined together in upper-and-lower case: LaserDisc, Walk-Man, VisiCalc, or ColecoVision. Anything else is just not acceptable.

Make sure that your company name is as up-to-date as the rest of your packaging. You can no longer get away with General Electric or Amalgamated Can. Even starting your company name with the letter Z, as in Zenith, no longer helps. Nowadays, your company name has to be a set of initials like TRW or IBM, unless it is a *SyntheticWord*, like MicroSoft.

The best company name of all starts and ends with the letter X, has at most one vowel in it, and is a *SyntheticWord*. If you send in a small fee, we will let you use what we at Science for the People have determined to be the most High-Tech name of all: Xytex.

Manufacturing

Many people think there is an antiseptic, Space Shuttle White factory where High-Tech products are made. In this factory, rôbot-controlled energy-efficient machinery extrudes each product in one piece and in one step, with no muss or fuss. This, however, is a gross misconception. High-Tech products do not have to be produced in a High-Tech fashion.

The name of the game is lowest cost for highest profit. The space suits for the Shuttle astronauts are stitched on an old Singer sewing maching by a group of little old ladies in New Jersey. (This is true! It was shown on TV.) More commonly, high-tech products are produced in sweatshops in the Philippines, Taiwan, Korea, Puerto Rico and (until recently) El Salvador. Many of these shops were previously producing low-tech commodities like earmuffs or galoshes.

It is also a misconception that any of these factories have to be environmentally clean. They say that Silicon Valley is just Gary, Indiana, with the smokestacks going underground. These new "smokestacks" are the sewer conduits that pour High-Tech chemicals into the sewer system and water table. Look for interesting results when these fluids combine with wastes from the biotechnology firms now moving into full-scale production. We may end up with High-Tech products that design themselves, so we won't have to.

Productivity and Profits

Another common misconception is that High-Tech has something to do with increasing productivity and efficiency. The fact is that there is little or no relationship. High-Tech doesn't have to work efficiently or reliably for the buyer. It just has to generate profits for the seller.

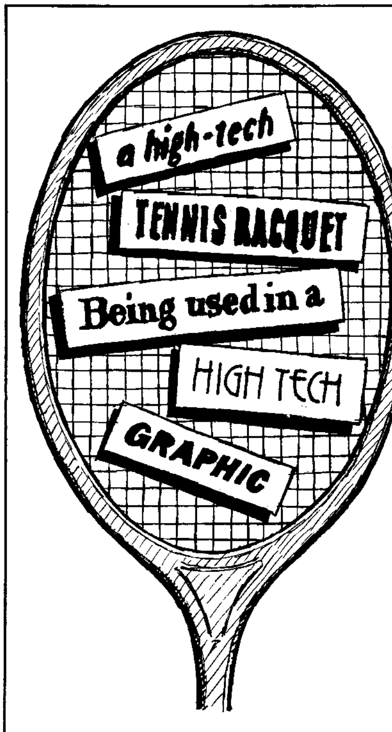
Biotechnology was High-Tech a couple of years ago, when it was making money for investors who were selling shares of it to other investors. This all happened without a single firm producing a real product, much less one that actually worked. Artificial intelligence is now heavily High-Tech for the business community and will be as long as shares can be sold by AI companies even though they have yet to produce usable products.

But what about the buyer? The buyer is often buying image and elitism rather than productivity. Recently, a large printing company bought a $60,000 graphics workstation. They found it took an operator on that machine longer to do their typical job than an operator using $100 worth of drafting equipment. They kept the machine, however, because it lent an unmistakably High-Tech aura to the reception area. Diehard High-Techies will do their taxes at home on their personal computers even though it takes twice as long and you still have to check everything by hand.

Conclusion

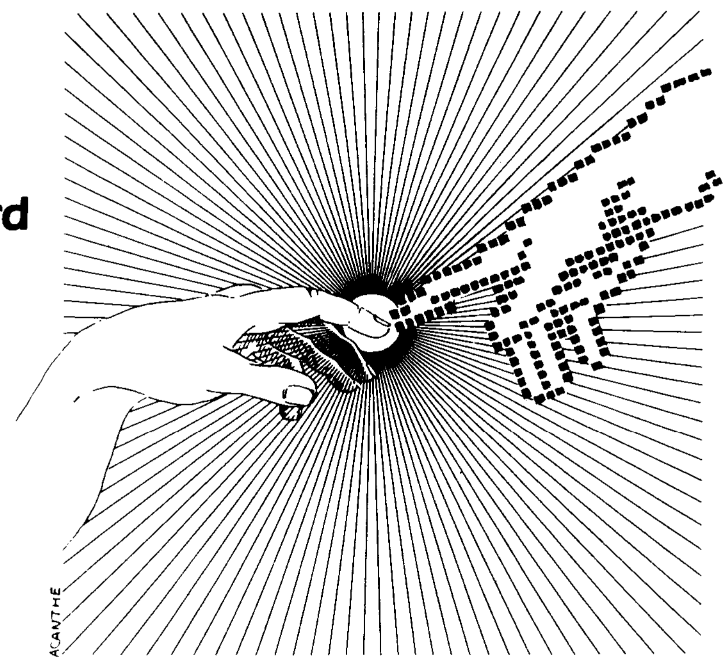
This brings us back to our original question of why our home phone from Bell Telephone is *not* High-Tech, and a postmodern design from the new AT&T *is* High-Tech. The determining factor, we have concluded, is the size of the profits. Old-fashioned, reliable profits may have been good enough for Ma Bell and the 1950s. For the mid-1980s, however, unless it makes MegaProfits, it's not High-Tech.

The whole concept of High-Tech is a tribute to American industry and many status-conscious American consumers. Where else can you get a buyer to jump through hoops, run on treadmills, hang from the ceiling, say it's wonderful and—most important—pay through the nose for it?



Nick Thorkelson

THE STRATEGIC COMPUTER INITIATIVE



A Double-Edged Sword

Jonathan B. Tucker

In the 1980s, computers have assumed a central role in the conduct of warfare. Electronic brains are now deeply involved in such diverse military activities as early warning and intelligence, communications, weapons guidance, simulated war games, and the command and control of forces in the field. These developments have greatly increased the complexity and lethality of the high-technology battlefield.

Now the Department of Defense (DOD) is seeking to apply artificial intelligence technology to warfare. On October 28, 1983, the DOD announced the Strategic Computing Initiative (SCI), a ten-year, coordinated effort by industry, academia and government laboratories to develop a new generation of superintelligent computers with the ability to see, reason, plan, and supervise the actions of military systems in the field. Although many computer scientists remain unconvinced of the program's feasibility and military justification, the SCI is proceeding at a rapid pace. Already, SCI contracts have been let to Texas Instruments, Martin Marietta Aerospace, Rockwell International, and other firms.

The program is being managed by the Defense Advanced Research Projects Agency (DARPA), which funds research and development on "high-risk, high-payoff" technologies with potential military applications. Congress authorized $95 million for the SCI in fiscal year 1985 (which began last October 1), and DARPA plans to spend approximately $1 billion on the program by the end of the decade.

Over the past two decades, DARPA's Information Processing Techniques Office (IPTO) has been the primary sponsor of computer-science research at universities and industrial labs, investing some $500 million to develop a large base of widely applicable hardware and software. In the field of artificial intelligence (AI), DARPA has funded research on knowledge representation, natural-language understanding, learning, vision, and other general problem areas with both civilian and military applications. But now the agency has decided to apply the results of this basic research to develop systems of more direct military utility.

Quantum Leap Sought

The SCI seeks a quantum leap in computer technology with potential strategic implications as great as the development of nuclear weapons in the 1940s. According to the initial SCI proposal published by DARPA, if the technology evolves as planned, "instead of fielding simple guided missiles or remotely piloted vehicles, we might launch completely autonomous land, sea, and air vehicles capable of complex, far-ranging reconnaissance and attack missions. The possibilities are quite startling, and suggest that new generation computing could fundamentally alter the nature of future conflicts."

DOD's rationale for the SCI is twofold. First, new military scenarios such as the U.S. Army's "Air Land Battle 2000" contend that in future conventional wars, opposing forces will rarely be engaged along orderly, distinct lines. Instead, battalion and regimental formations will be highly dispersed throughout the area of conflict, making it impossible to differentiate between rear and forward battle areas. Moreover, the use of highly sophisticated and lethal weapons that can be fired from beyond the horizon will mean that an attack could come from any direction with virtually no warning. In such a scenario, events on the battlefield would be so rapid and unpredictable that human soldiers and their rigidly programmed weapons systems could well be unable to react in time.

To address this potential vulnerability, DOD seeks "intelligent machines" capable of processing huge amounts of tactical information in real time and of adapting to complex, rapidly changing battlefield situations. Rather than simply automating routine tasks, these computers would assist and even replace decision-making by experienced soldiers and commanders.

A second factor driving military interest in AI and robotics is the perceived need to "conserve manpower," both in combat roles and in noncombat operations such as logistics and maintenance. The declining proportion of 19-20 year olds in the population implies a shrinking demographic base of candidates for the armed services. Military personnel is also very expensive; salaries and benefits consumed nearly a third of the entire Army budget in fiscal-

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year 1983. In light of these demographic and financial constraints, a National Research Council study performed for the Army in 1983 recommended replacing human soldiers with intelligent computers and robots in order to conserve manpower and reduce battlefield casualties.

Program Goals

Developing the truly intelligent computers and robots proposed by DARPA will require major advances in computer hardware and software. DARPA's research plan is three-pronged, including intensive efforts in microelectronics, computer architectures, and AI software, all of which will be closely tied to specific military applications.

The microelectronics research program will focus on designing integrated circuits containing a high density of functional elements, an approach known as Very Large Scale Integration (VLSI). The SCI also envisions gradually replacing silicon integrated circuits with chips made of a different semiconductor material known as gallium arsenide, which offers faster computing speeds, lower power consumption, and greater resistance to nuclear radiation, making it more "survivable" in a nuclear war. Meanwhile, the computer architecture program will focus on building "massively parallel" computers in which large numbers of microprocessors work simultaneously on different facets of a problem. The goal of this effort will be to obtain at least a thousand-fold increase in net computing power.

The software development program will focus on AI capabilities. Computer vision systems will be developed for interpreting intelligence-satellite photographs, terminal guidance of missiles and bombs, and autonomous navigation and piloting systems. A program in human-machine communication will seek to enable people to communicate with computers by typing commands in English and other natural tongues instead of arcane computer languages. And a program in speech understanding will aim at enabling computers to respond to spoken language. AI systems that can interpret individual sentences within a limited subject area are already becoming available, but DARPA wants software that can understand fluent speech without pauses between words and with a vocabulary of 5000-10,000 words. Special emphasis will be given to speech recognition over ordinary telephone lines and in the high-noise environment of fighter-aircraft.

The SCI research program will also place strong emphasis on AI programs known as "expert systems," which attempt to simulate the thought processes of a human expert. These programs encode deep knowledge of a highly specialized subject area, employing rules of thumb, factual data, and reasoning mechanisms to help solve problems in this narrow domain. Expert systems have been developed in such areas as medical diagnosis, molecular genetics, and mineral exploration, as well as a number of military applications. Examples of the latter include AIRPLAN, for planning flight operations around aircraft-carrier battle groups; HASP/SIAP, for tracking and identifying submarines with sonar signals; TATR, for tactical air targeting; and prototype systems for analyzing tactical battlefield communications and strategic indicators and warnings. DARPA contends that expert systems could aid military decision-makers in such areas as nuclear planning, logistics, flight operations, equipment maintenance, and management of complex battle situations.

Initial Projects

DARPA seeks to initiate the use of advanced AI and robotics technology for military applications with three demonstration projects, one for each branch of the armed services. For the Army, DARPA proposes an autonomous land vehicle that could serve as a self-driving tank, a robot soldier, or a remotely piloted drone for reconnaissance on land, in the air, at sea, and in space.

The project specifications include visual sensors working in conjunction with a large databank of codified human knowledge and experience that would enable the robot vehicle to sense its environment, detect obstacles, locate and identify landmarks, and respond effectively to unforeseen circumstances. The proposed computer for the autonomous vehicle would take up less than 15 cubic feet, weigh only a few hundred pounds, and consume no more than a kilowatt of power. Traveling cross-country at speeds of up to 60 kilometers an hour, the robot vehicle would navigate to a designated point some 50 kilometers distant. According to the DARPA proposal, such capabilities would require a vision system capable of executing 10-100 billion instructions per second compared with 30-40 million instructions per second on today's most powerful supercomputers.

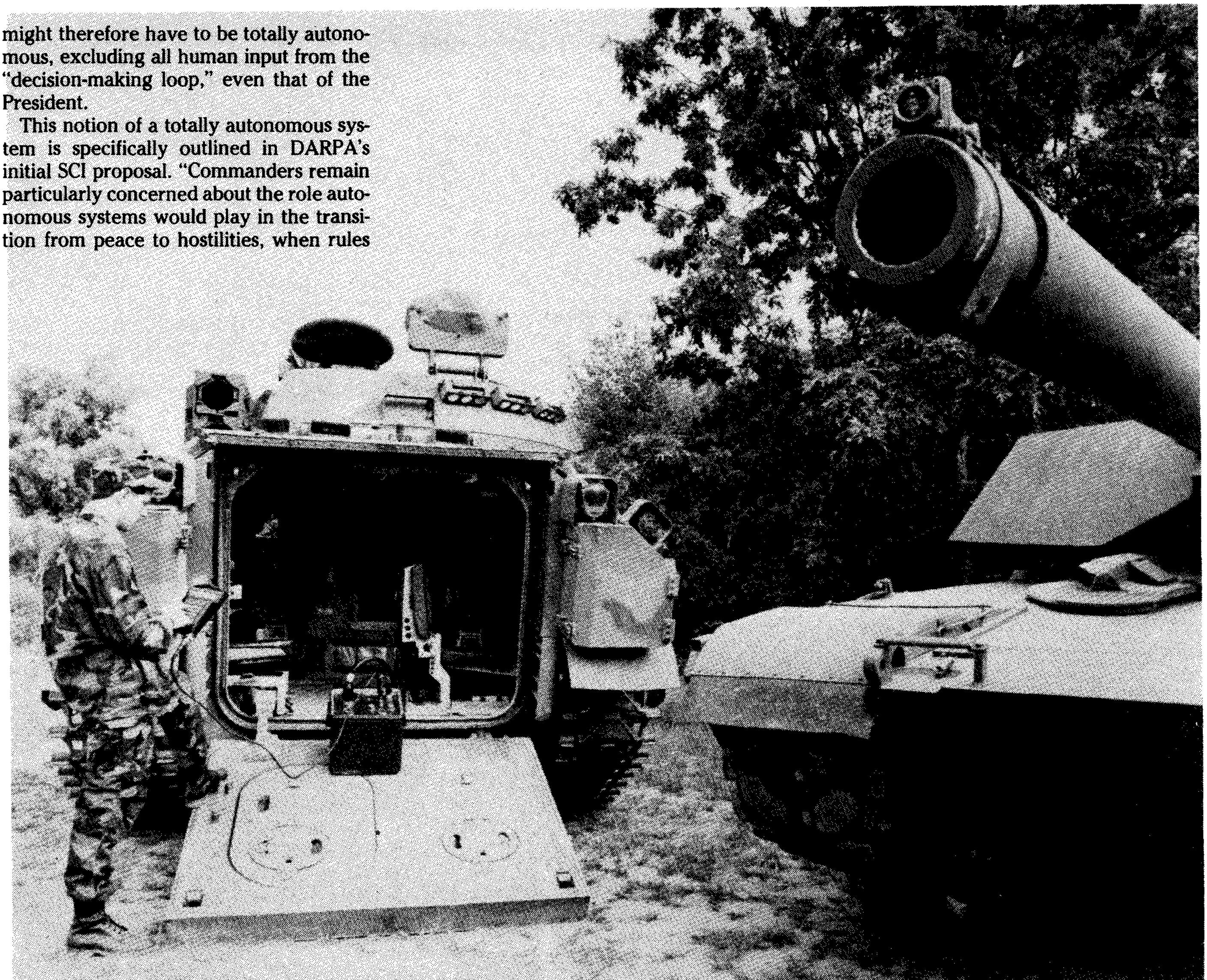
For the Air Force, the SCI proposes a pilot's associate system to assist fighter pilots in managing avionics and weapons systems during aerial combat. The plan calls for the use of expert systems and speech recognition technology, to give the computer copilot the ability to respond to commands in spoken English. The computer would automatically activate sensors, interpret intelligence data, and prepare the appropriate weapons systems to counter hostile aircraft or missiles. According to the DARPA proposal, the human pilot, freed from having to deal with many of the technical minutiae of flying, would be able to concentrate on strategy and tactics.

For the Navy, the SCI proposes an expert system to help commanders of carrier battle groups plan and conduct major battles at sea. Interacting with human commanders through graphics displays and synthesized speech, this system would analyze enemy force movements by interpreting data from intelligence sensors. It would then simulate the effects of various courses of military action and recommend responses such as dispatching fighters or firing missiles. The program would be designed to adapt to changing battle conditions and to resolve conflicts between competing goals. DARPA believes such a system would require 20,000 rules; current expert systems rarely contain more than 1,000 rules.

The SCI proposal does not specify the extent to which the battle management system would be autonomous. But although military commanders may be loathe to delegate decisionmaking to computers, missile attacks can take place so rapidly that automated or semi-automated responses may be necessary. "In general, it's not easy to draw a clear line between advice-giving and decision-making, especially when things are happening very fast," says Joseph Weizenbaum, professor of computer science at the Massachusetts Institute of Technology (MIT). "Take the air-defense situation. I doubt that a commander will think twice when the computer says, 'An enemy missile will be arriving in two minutes. I suggest you push button 3.'"

The SCI proposal also envisions fully autonomous command-and-control systems, which would compare real-time sensor data with stored information and initiate automatically a sequence of responses. For example, the so-called "Star Wars" system for nationwide defense against nuclear ballistic missiles, proposed by President Reagan in March 1983, is intended to destroy enemy missiles or warheads in flight. Such a system would have at most a few minutes—and perhaps as little as seconds—to detect missile launches, assess the nature of an attack, and track and destroy thousands of targets. Command and control of the system might therefore have to be totally autonomous, excluding all human input from the "decision-making loop," even that of the President.

This notion of a totally autonomous system is specifically outlined in DARPA's initial SCI proposal. "Commanders remain particularly concerned about the role autonomous systems would play in the transition from peace to hostilities, when rules of engagement may be altered quickly," the report says. "An extremely stressing example of such a case is the projected defense against strategic nuclear missiles, where systems must react so rapidly that it is likely that almost complete reliance would have to be placed on automated systems. At the same time, the complexity and unpredictability of factors affecting the decisions will be very great."



Because photos of the actual weapons systems described are not yet available (the weapons do not yet exist), the photos included are of current conventional weapons and satellites.

Criticism Mounts

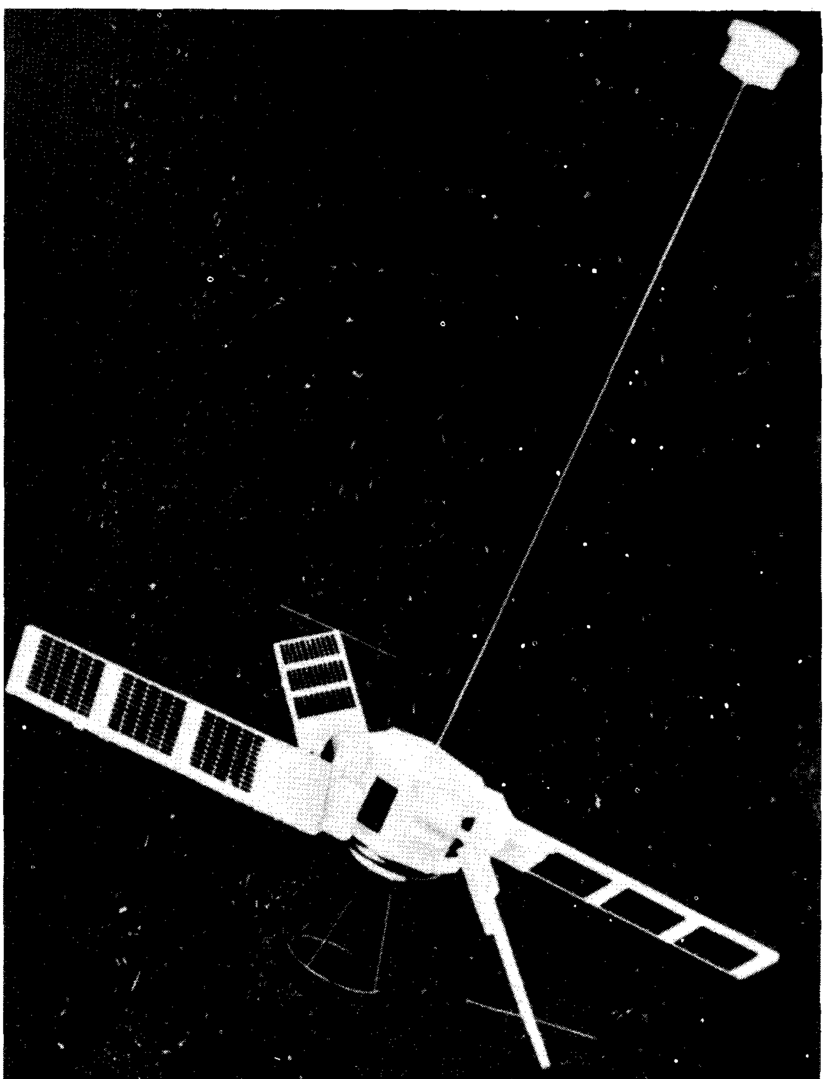
Criticism of the SCI has come from computer scientists as well as members of the wider community. Objections range from doubts about technical aspects of the program to broader concerns about its goals. Many computer scientists believe that the hardware objectives of the SCI can probably be met, but that the notion of superintelligent software is unrealistic. David Waltz, professor of computer science at Brandeis University, is skeptical about the ability of expert systems to progress from highly restricted fields of knowledge to more general forms of intelligence. "I think these programs work by radically different means than the way human experts actually think," he says. "The rule-based method assumes that a small number of variables will be sufficient to select from a large number of actions or analyses, but that's only likely to be true in very narrow domains. Probably 30 years from now, expert systems based on rule-based chaining will be viewed as a dead-end."

In order to achieve the SCI's extremely ambitious objectives, AI researchers will have to develop computer systems that are capable of assimilating new information from the environment, dealing with inconsistent or incomplete data, and planning a response. Yet today's AI systems cannot even take simple dictation, let alone converse with a pilot or adapt to changing situations. "Some AI systems can react and respond in simple-minded ways to unpredictable contexts," says Steve Berlin of MIT's Laboratory for Computer Science, "but no AI system today demonstrates what we would call basic common sense." A major obstacle to developing truly intelligent computers is the fact that the complex processes by which human beings learn, reason, and innovate are poorly understood.

The military utility of AI/robotic systems is also in doubt. First, there would be substantial concern about sending robots into battle. "How do you know that a robot is really debugged enough before you trust the system to choose and fire at its own targets?" Waltz asks. "And what happens if the enemy devises countermeasures to confuse the system?" Other unknown variables include the impact on computer systems of indirect nuclear-weapons effects such as electromagnetic pulse— the massive electrical discharge induced by a nuclear explosion—and intense ionizing radiation.

Recently, Computer Professionals for Social Responsibility (CPSR), a Palo Alto-based lobbying group, has strongly criticized the SCI by pointing out the dangers of automating complex processes of assessment and judgement in an area so fraught with momentous consequences. In an article in the *Bulletin of Atomic Scientists*, CPSR chairman Severo M. Ornstein and colleagues Brian C. Smith and Lucy A. Suchman dispute the SCI's implication that computers can eventually be made so intelligent and reliable that they could be entrusted with the power to intiate acts of war without human intervention. In fact, they write, all computers have inherent limitations and fallibilities; despite the increased flexibility provided by AI systems, "intelligent" computers may still respond inappropriately in unanticipated situations. "Because this limit on their reliability is fundamental," the CPSR members write, "we argue against using them for decision-making in situations of potentially devastating consequences."

The source of the unreliability of computers is that their behavior depends entirely on rules that a human programmer has coded in advance by sorting possible events into pre-specified categories. Yet except for trivial cases, it is impossible for the programmer cannot foresee every situation that might occur. This limitation is particularly true in an environment as complex and unpredictable as high-technology warfare. Thus the computer may attempt to carry out the programmer's instructions under inappropriate circumstances, resulting in faulty responses.



Trends in military technology, such as the increasing accuracy and speed of nuclear-weapons delivery systems, are placing growing pressures on the leaders of both the United States and the Soviet Union to rely more heavily on computerized command-and-control systems. Flight times of intermediate-range missiles deployed in Europe (such as the Soviet SS-20 and the U.S. Pershing II) are as short as five minutes, as are those of Soviet submarine-launched missiles patrolling off the coasts of the United States. The shrinking time interval available for decision-making is pushing both the United States and the Soviet Union toward a "launch-on-warning" strategy, in which preprogrammed computer responses would take the place of human decision-making.

Even in peacetime, however, the massive computers that control the U.S. strategic arsenal are beset by human and mechanical errors. In November 1979 and June 1980, false alarms occurred at the North American Aerospace Defense Command (NORAD), causing U.S. strategic forces to be placed on alert. The 1979 incident reportedly involved a test tape containing simulated attack data that was fed accidentally into a computer at Strategic Air Command (SAC) Headquarters; the 1980 false alert was triggered by a faulty integrated circuit. In both cases timely human intervention was required to prevent escalation to nuclear war. Fortunately, the false alerts took place during a period of low tensions; had they occurred in the midst of a superpower confrontation, accidental nuclear war might well have resulted.

The growing reliance by military commanders and political leaders on complex and inherently fallible strategic command-and-control systems is an ominous trend. Fully automating these military systems would clearly open a Pandora's Box of new dangers, including the possibility of accidental war triggered by hardware or software malfunction. For example, one can imagine scenarios in which a computer might misinterpret the coincidental juxtaposition of several unrelated military deployments or exercises as a coordinated attack.

Moreover, there is no foolproof way to test and debug large, complex computer systems in advance. Even in highly

US Army

reliable computer systems, subtle flaws may emerge only after the system has been operating for a long period of time and under a wide variety of conditions. For example, the Space Shuttle's computer system is both highly redundant and more thoroughly tested and simulated than perhaps any other computer system in the world. Yet in 1984 the orbiter's computer failed during two successive launch attempts in the final seconds of the countdown. If a computer system can fail under those ideal conditions, it would be a miracle if a vastly larger computer network operated reliably in the midst of a nuclear war. "All experience with complex systems indicates that it is the circumstances that we totally fail to anticipate that cause the serious problems," Ornstein, Smith and Suchman write. "Yet it is an inescapable fact that military systems—especially nuclear systems—cannot be fully tested in advance, nor can crisis conditions ever be fully simulated."

Abdicating Responsibility

The SCI is yet another example of the military's penchant for finding technological solutions to political problems. Computers are clearly not the answer to making nuclear weapons "fail-safe." As long as these awesomely destructive weapons exist, neither human nor computer control can guarantee our safety. Even if the SCI yields results, it will spark yet another expensive, inconclusive, and destabilizing round of the arms race. Only a concerted effort to resolve the deep political conflicts underlying the strategic competition and to achieve sharp reductions in nuclear arms can bring about a safer world.

The SCI is objectionable on moral grounds as well. Although it is true that replacing soldiers with robotic devices would reduce American casualties, it would also make military intervention in the Third World more acceptable to U.S. public opinion. Indeed, robotic soldiers could engage in atrocities that no human eyes would witness, enabling the government to wage brutal and secret wars without the knowledge or consent of the American people. More generally, enabling military commanders and political leaders to pass the burden of decision-making to "intelligent" computers may make it easier for them to initiate conventional or nuclear war, while abdicating moral responsibility for the consequences.

How should computer scientists respond to the tempting funding opportunities provided by the SCI? First, they clearly have a responsibility to expose the deep technical flaws in the proposal, such as the problem of computer unreliability, to government policymakers and the public at large. As far as working on DARPA-funded projects is concerned, researchers should resist the temptation to avoid the moral issues with excuses such as "compartmentalization" or "drawing the line somewhere." Instead, they should make an informed decision about accepting such funding on the basis of a clear understanding of the program's objectives and of what they believe is right. "Computer scientists should ask themselves if what they're doing is in the service of life or of death," Weizenbaum concludes. "In many instances, the answer will be very clear."

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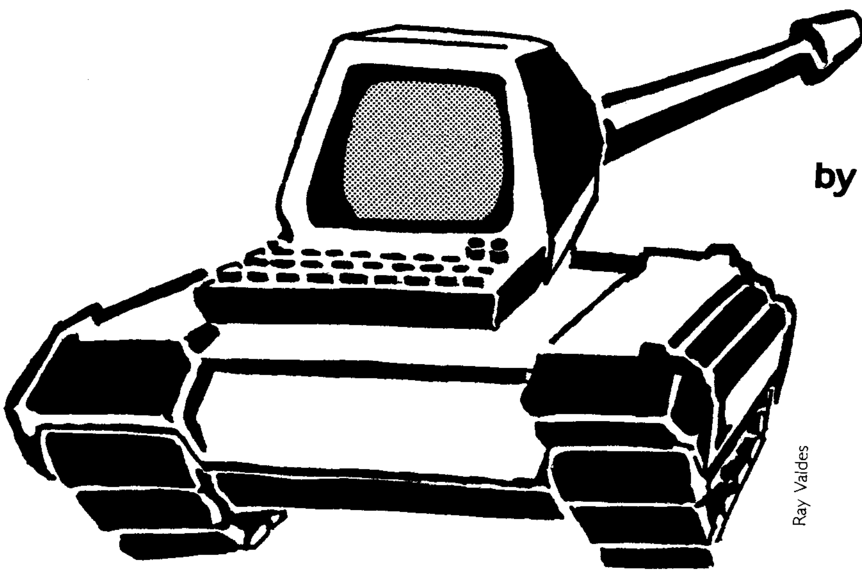
COMPUTERS IN UNIFORM: A GOOD FIT?



by Joseph Weizenbaum

When we consider the connection between the computer and the military, the first thing to observe is that the computer was born—in a number of places but more or less simultaneously—as an instrument to help in warfare. For example, in the U.S. the UNIVAC was the first computer to compute ballistic tables, in other words, to improve the accuracy of artillery. In that respect it isn't very different from other technologies such as rocketry.

To take a more current example: it is very clear that modern weapons, particularly the most destabilizing weapons such as the cruise or Pershing missiles, would be impossible without computers. The cruise missile finds its way to its target on the basis of the kind of map stored in the missile itself. This map is compared with the ground over which it flies. Moving at very nearly the speed of sound and at a very low altitude, its "vision" has to be fairly accurate in order to make the comparison and the connections between the map that it has stored and what the actual terrain looks like.

This is not, however, the only involvement of the computer in the cruise missile. One could question how these maps are obtained—for example, maps of the Soviet Union—and the answer is, of course, that they are obtained from satellites. Such satellites would be impossible to put into place, and the signals they send back would be impossible to analyze, without very large computing power.

The connection between the computer and the military has been present all the time and continues to this day. I think it is safe to say that the majority of research and development in computers—and, to a

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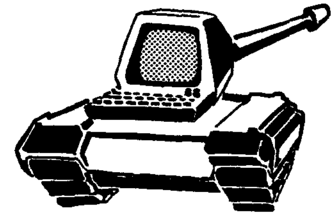
This article is adapted from a talk at a recent Science for the People forum in Boston.

As I see this autonomous combat vehicle, it is sort of a traveling "free fire zone."



large extent, in computer science—is being funded and in many ways directed by the military. An example of this that is close to home here at MIT and is, in a certain sense, prototypical, is the research and development of artificial intelligence (AI).

The term "artifical intelligence" was coined by a conference in Dartmouth, New Hampshire, in the mid 1950s. What happened was that a number of people working in an area that today would be identified as AI, recognized that they had been doing something in common, and held a conference. When it actually happened and they went through with it, they saw that there was indeed "something there," and it was clearly something that the world should be told about. The question was where might it be published. Someone suggested the *Bulletin of Cognitive Science*, or some such thing, and that this work be made a branch of cognitive theory. One of the people attending the conference, Tom McCarthy, pointed out at this juncture that if that were done, the funding for this research for the next ten years would be on the order of $10,000 -20,000 per year. They needed a much "jazzier" name, he said; he coined the term "Artificial Intelligence," and it was certainly a very lucky thing for the field that he did so.

From the beginning, AI proved attractive to the military—to the Department of Defense (DOD). It was fairly generously sponsored for quite a long time, especially at MIT, but certainly also at other places like Stanford and Carnegie Tech (now Carnegie-Mellon). At the time, the "horizon"—so to speak—at which something had to be delivered was fairly large. It was not the case that AI researchers had to deliver something recognizably "artificially intelligent" in, say, three or four or five years, let alone delivering something that might by of military use. The promises that were made to generals and admirals about such a potential of what might be developed were sufficient to keep the work going for a long time. Some years later—some ten or fifteen years ago now—the DOD decided it had forgotten its major objectives for funding AI, and there was a terrible letdown and great pessimism, which was of course felt here at MIT.

Something had to be done. Tom McCarthy's trick came to mind, as he had previously decided to rename the field. It was called "Cognitive Science," and the money flowed again. Unfortunately, that didn't last very long, because psychologists and philosophers and people like that began to take the term seriously. They began to work on it and to siphon off a lot of the money that the government was spending on it, and things looked very, very dark.

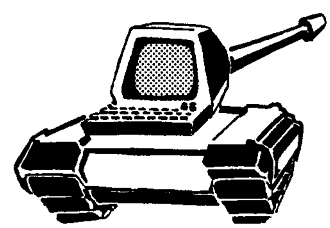
Then the Japanese launched their so-called "Fifth Generation" project. This is a project to develop very fast computers on a very large scale—to have their society pervaded by these computers. All communications would be mediated by these computers. All of this would be done using very heavy doses of AI. This made it possible to cry "Sputnik" again and to say that "if we don't get on this right away, they're going to beat us"—the threat being that "we" will become an inferior nation. This approach has been enormously successful, and is essentially responsible for the flowering of AI all over the world, and certainly in the U.S.

This history is important because of the impact of military funding on the scientific subdiscipline of AI. When AI first started, the fundamental idea was to build machines to do things which would be recognized as intelligent, if humans did them. Even more important was that the machines do these things in the way that humans do them.

The best example is chess playing. The idea was that one could go to a chess master and ask how he would make the next move or how he would think about it. Then, one could take the protocol and what the chess master said and program it into a machine. If you do a lot of that you will have, first of all, a machine that plays chess masterfully, and secondly, you will have understanding about certain kinds of human thinking. This mode of operation of AI was known in those days as *theory mode*, in which the idea is to learn something about human thinking by playing with machines and making analogies.

Then there is another aspect which is called *performance mode* and this is to get machines to do clever things—ever more clever things—and without regard to whether the machine did them the way a human being would do them. In fact, what happened with chess is that it got so interesting and machines got bigger and faster and so on, that it didn't take very long before those people working in chess—in theory mode so to speak—got tempted by the various "tricks" they could exploit with the machine to get the machine to play chess very well without paying attention to whether there was any logical basis for the methods behind these tricks. Hence, today we have very good chess-playing machines which tell us nothing

The military sponsors nearly all research in artificial intelligence, and the horizon for delivery of products has become much shorter.

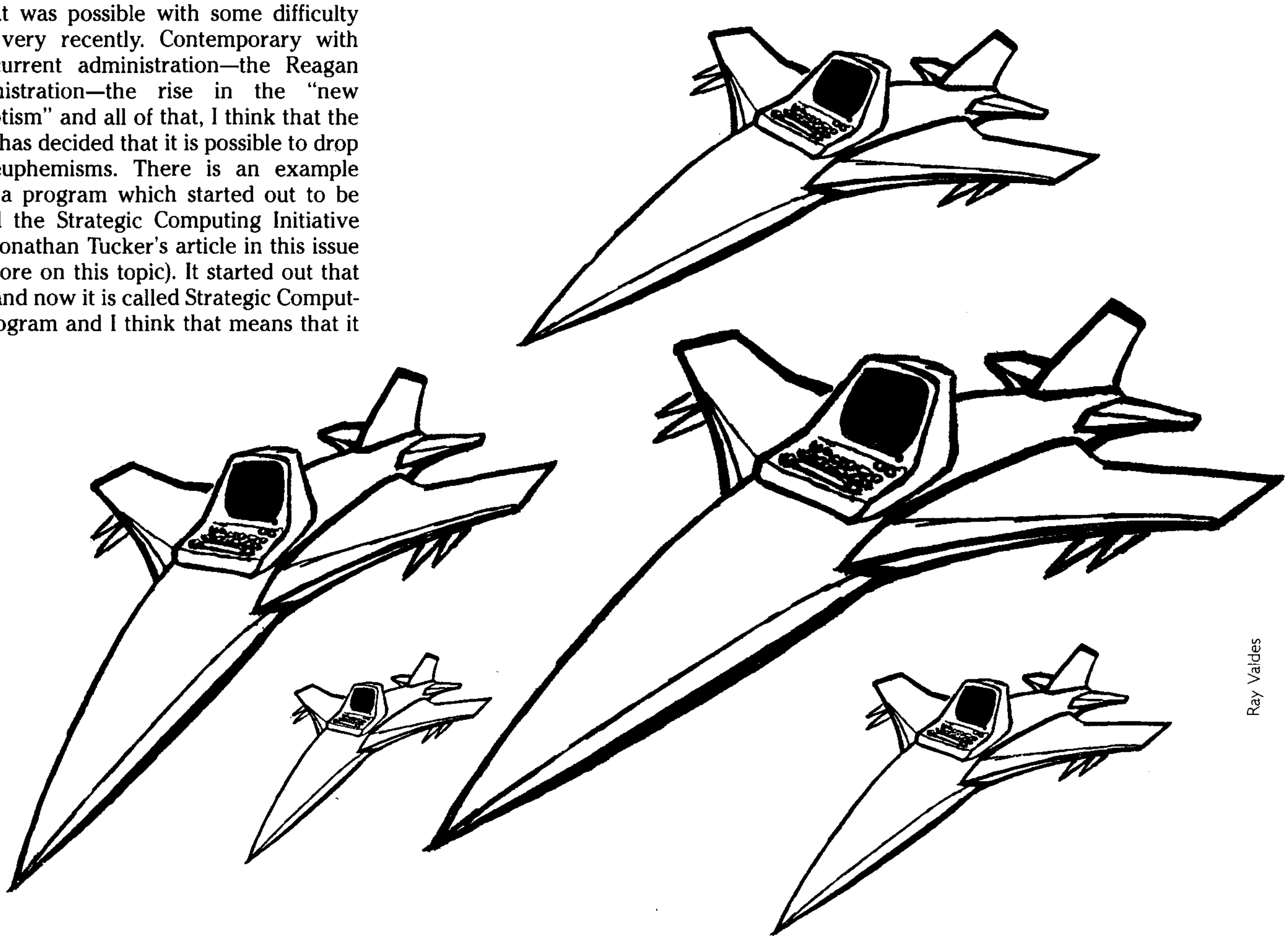


about the way the human mind works. In a certain sense, I feel that failure is a great crime.

I bring this up because today the Department of Defense—I don't like that name, I prefer to say the military—sponsors nearly all research in AI, and the horizon for delivery has become much shorter, that is to say ten years. In other words, something which fits into a weapons system should come out at the end of ten years. So consequently, what has happened now is that the whole field of AI has been skewed all together to performance mode. No work in theory mode is going on—certainly not by people that would identify themselves as doing so. There are people, such as linguists, etc., who are studying the material that AI might have studied, but they are not AI people.

I should say one more thing. Until recently, even until around four years ago, researchers in the field of computer science in general, and AI in particular, could say with some justification (not much, but some justification) that this work which was being sponsored by the DOD did not tell them what to do, or direct what they wanted to do. They could say, essentially, "I'm not working on a weapons system, so if this stuff happens to be used in a weapons system, well, that's not my concern; I'm working purely on science, that's all."

That was possible with some difficulty until very recently. Contemporary with the current administration—the Reagan administration—the rise in the "new patriotism" and all of that, I think that the DOD has decided that it is possible to drop the euphemisms. There is an example now, a program which started out to be called the Strategic Computing Initiative (see Jonathan Tucker's article in this issue for more on this topic). It started out that way and now it is called Strategic Computer Program and I think that means that it has been funded. The plan is to spend $600 million in five years on AI research of a very specific kind. What will happen, by the way, is that $600 million will be spent in a very few universities. It is not going to be spread over 30, 50 or 80 universities, but will be given to the principal three which conduct AI research, that is Stanford, Cornell, and MIT, and a few others. That is an enormous amount of money and the plan is described without any euphemisms. Basically, it calls for three weapons systems.



Ray Valdes

One is called a "battle management system" for an aircraft carrier fleet. You have to understand that an aircraft carrier is surrounded by many ships with submarines underneath and airplanes above and all that. The idea is that in a real battle things happen much, much too fast for human beings to monitor the information so that therefore we need a computer system with AI capabilities to make all the important decisions. That is what a battle management system is. But AI also has applications for land battles as well.

One of these is a so-called autonomous vehicle. You may imagine it is a very large tank which instead of having people inside has AI inside. It gets its instructions, such as "go out there and if you see something that looks like this then blast it down, and if it is like this, then do the following and whatever." In any case a lot of degrees of freedom are left over to this vehicle. To those of you who recall the terminology of the Vietnam war, and now the terminology of El Salvador, you may remember "free fire zones." As I see this autonomous combat vehicle, it is a sort of traveling free fire zone.

The third project is called a pilot's assistant. There are of course many computer-type systems today which assist pilots, but this is special. This is for a combat aircraft that is loaded with electronics and again, things happen much, much too fast for a single pilot to keep track of. Such airplanes today are staffed by two or three people, but here the idea is to have one person who has as his or her assistant this wonderful AI machine that can manage anything that might need to be managed. Furthermore, the progress of information between the pilot and this machine would also be done in natural language, in speech in other words.

If you ask yourself how it is that computers which used to fill rooms can today be put onto little chips, the answer is a need on the part of the military.

Now what this means is essentially that these three systems make it possible to justify almost every branch of work in AI:

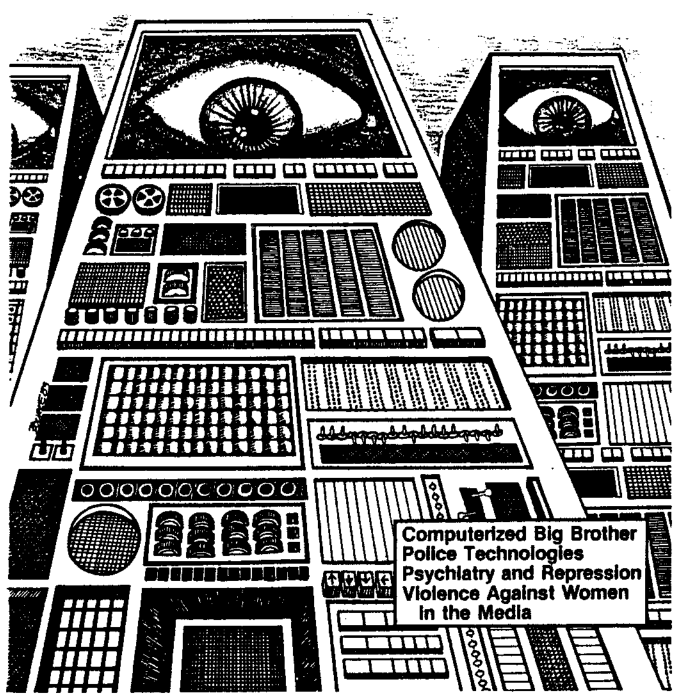
What we get, like little dogs sitting under the table, are spinoffs like wristwatches.

robotics for example, speech recognition, vision and so on and so forth and therefore it is becoming harder in my view for people in the field to maintain the rationale that their work has no direct military applications. But that's a secondary point. The primary point is that with so much money invested in a fairly restricted field like AI, the rarest resource of all, which is to say human intelligence, is all soaked up by all that money.

For example, if a student were to come to an AI laboratory and were to want to work on something that couldn't be justified in these terms, that had nothing to do with these things I have been speaking of, it is not that the money couldn't conceivably be found, but that the supervisors couldn't be found because the whole laboratory is already soaked up by this enormous effort. This is an example of something I feel is quite important. Let me say it this way: we often talk about the impact of computers on society, but the important thing is quite the other way: it is the impact of society—how we are organized, what we do to science and technology and how it develops.

If you ask yourself how it is that computers which used to fill rooms like this can today be put onto little chips, if you ask, "did this happen naturally; would this happen in any society; would it happen on Mars if there were computer scientists up there," the answer is clearly, no. The rapid progress to increasingly smaller and smaller computer chips has happened because there was a need on the part of the military to have computers get very much smaller and very much lighter and so on so that they could be used in situations as I have just described, and more particularly having to do with our missiles, with rocketry, etc.

What we get, of course, like little dogs sitting under the table feeding on the bones that our masters drop, very occasionally what we get is wristwatches and things of that kind. And, somehow, we think that this is a natural process. I think that what has to be remembered is that in the end these things are the fallout of gigantic efforts to make it possible to kill more and more people ever more efficiently. And it is very sad that our society's priorities continue in this fashion.



CONTROL DATA AND APARTHEID

by Thomas Bartholomay

Control Data Corporation (CDC) has stated that it has a plan for South Africa. The plan devised by this U.S. computer company involves the sale to the South African government of an enormous, multi-million dollar computer-based education system called PLATO. CDC claims that theirs is a plan to assist blacks in their struggle for equality. The evidence indicates, however, that the apartheid regime in South Africa, having purchased the CDC's computer system, is using it to control, rather than educate blacks, and that CDC is deliberately taking advantage of the government's security goals to make profits it could not realize marketing PLATO solely for educational purposes.

PLATO — originally "Programmed Logic for Automated Teaching Operations," but later changed by CDC to stand for "Personal Learning and Training Opportunity" — was developed over a sixteen-year period at the University of Illinois with primary funding from the Department of Defense and the National Science Foundation. In 1976, CDC purchased the marketing rights for PLATO and its language TUTOR.

Since then the company claims to have sunk $900 million into PLATO, and in the process has created the largest and most sophisticated computer-based education system sold on earth. In fact, PLATO has become a behemoth. Literally thousands of remote terminals can access its mainframe, making PLATO a centralized tool for education, communication, and research that CDC's chairman, William Norris, describes as "nearly limitless in its versatility." PLATO's software is designed to do everything from instructing students in mathematics to teach-

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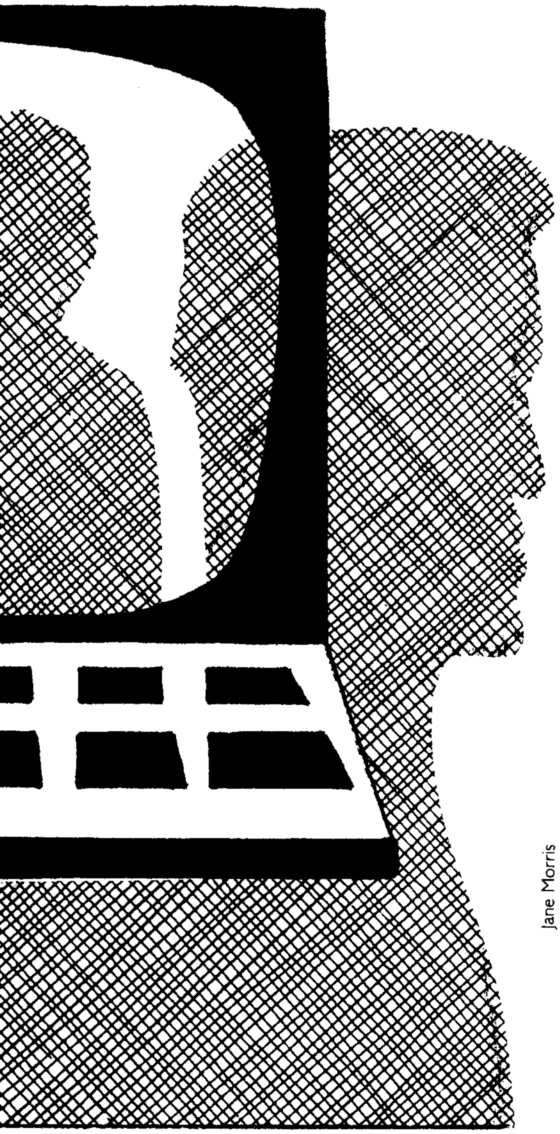
Thomas Bartholomay is a freelance researcher and writer based in Minneapolis, MN. This article comes from a longer report to be published this year by Africa World Press *of the Africa Research and Publications Project, Box 1892, Trenton, NJ 08608.*



Jane Morris

plan to assist blacks ity. The evidence ne apartheid regime CDC's computer han educate liberately taking ent's security goals to realize marketing nal purposes.

ing decisionmaking and even to modifying its users' attitudes, values, and behavior patterns. In addition to its educational capabilities, PLATO performs administrative functions, such as monitoring finances and maintaining personnel records. All this information can be accessed from any terminal with the correct access code.

But, despite its supermarket array of functions, and CDC's persistent promotion of PLATO as a useful educational tool, schools and government agencies have been reluctant to purchase the system. Critics contend that students don't retain the lessons taught through PLATO[1], but the bottom line is that PLATO is too expensive; its capabilities far exceed the needs of standard education. Consequently, CDC, unable to turn a profit on PLATO in what it had anticipated to be its largest market, found itself with a $900 million monkey on its back. It was at this point that CDC's plan for PLATO in South Africa began to take shape. But to understand the progression of events, it is important to explain further the special needs of the South African government.

The South African Government's "Total Strategy"

After the alarming Soweto riots in 1976, the government announced that it was engaged in a "total war" for national security. To help determine the regime's most effective course of action, in 1979 Premier P.W. Botha launched what was probably the most extensive state-funded and coordinated social research program outside the Communist Bloc. Botha doubled the size of the Human Sciences Research Council (HSRC) to act as a national research coordinator for the program. By 1982, the HSRC employed almost one fifth of South Africa's social scientists. The HSRC researched ten priority areas that one Cape Town University official feels reflect "the major anxieties of the ruling group." The number one item on the agenda was education; the second, labor.[2]

Until recently, South Africa's industry has survived on skilled white labor from other countries, enabling it to limit the admittance of blacks into the white power structure. The demand for expensive foreign skills has grown rapidly, sapping the country's capital and the shortage of skilled labor has driven inflation up.[3] Consequently, the apartheid government is seeking to create a skilled black labor force that does not threaten apartheid policy.

The HSRC concocted a "total strategy," described by Thomas Conrad, a specialist in security computers, as:

> a prescription for the militarized national security state which has integrated all branches and all levels of government, the country's industry and businesses, the educational system and other institutions into the struggle to preserve white political control.[4]

The "total strategy" has four general goals: to tighten stringent controls on black mobility from the homelands to the white cities, using the homelands as containers for the increasing black population; to relax some urban black restrictions, thereby regionalizing government policy for special treatment of particular groups; to increase control through police power, laws and surveillance, using new computer developments; and to educate and train a select group of non-whites to meet the needs of industry, through the creation and co-optation of a so-called "stable black middle class."[5] By implementing these policies, the government hopes to streamline and strengthen the apartheid system.

Education and training are fundamental to the regime's strategy. If an acquiescent "black middle class" can be produced, not only will industry be satisfied, but the effects will also diminish domestic and international anti-apartheid pressures. The key for the regime is to maintain close control not only over what is taught in the schools but more importantly over which blacks are put in upper level positions.

The regime's educational campaign has consisted of both expanding basic educational facilities and developing methods of compiling and transmitting information gathered from schools to government agencies. The first aspect of this campaign, the expansion of educational resources, has been unequalled in South Africa's history. Yet this growth has been riddled with school crackdowns, teacher firings, and student detentions, all of which indicate the government's determination to flush out threatening influences. The exclusion of students and teachers from participation in the government's decisions has exacerbated the already unrestful state of academia.

The second and more menacing aspect of the government's campaign, the centralization of surveillance information, has required the expansion of data processing equipment throughout the educational system. To meet this challenge the South African government established an apparatus for greater monitoring and control of schools, and CDC found the lucrative use of PLATO it had been looking for.

PLATO's use is not limited to schools. Its capabilities appear to be aiding a government effort to monitor and control the type of black entering the job market.

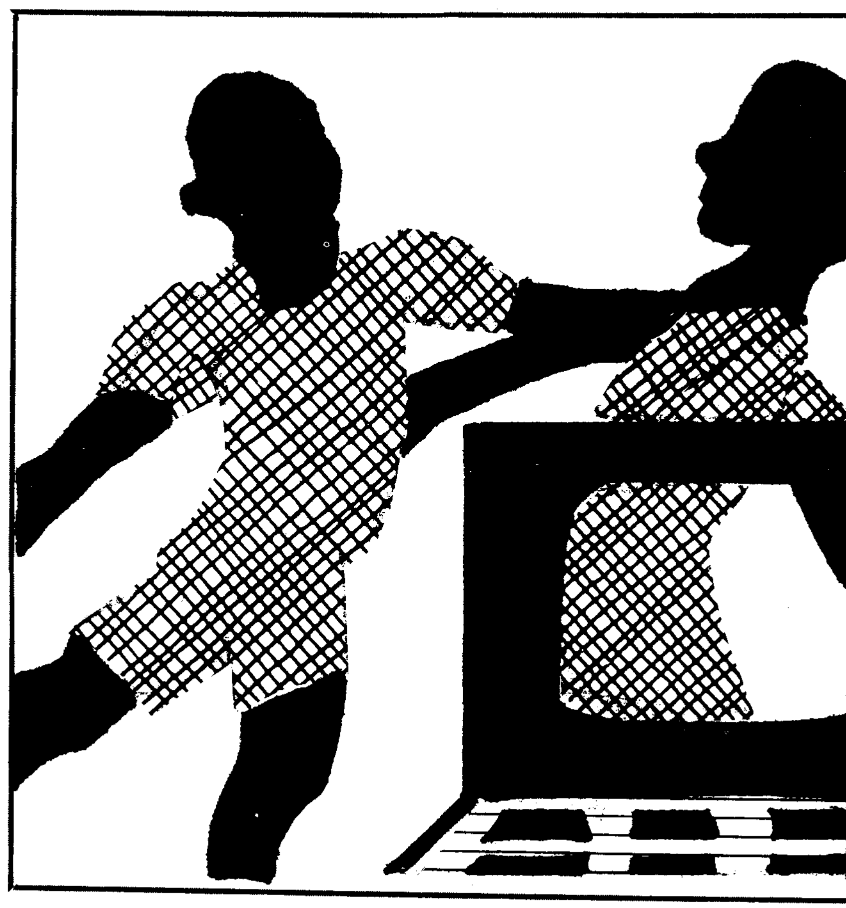
PLATO's Role in the "Total Strategy"

The key to the exceptional compatability between South Africa and PLATO lies in the system's extra-educational capabilities, capabilities which had been explored and developed by one of the system's primary funders, the U.S. military. Beyond its capacity to provide basic instruction in subjects ranging from jeep repair to simulated war games, the system has been especially useful in modifying the behavior and attitude of company commanders. "This particular type of training," explains a military report, "would be impossible without an interactive device like the PLATO system."[7] This interactive quality includes programmed analysis of its user's responses to courseware. Analyses such as these produce an extensive file listing the "negative" and "positive" characteristics of its user.

The size and sophistication of PLATO is equalled only by its potential for abuse. Recognition of this potential prompted an alarmed James Gallagher, the technical consultant for the U.S. Subcommittee on Domestic and Int'l Planning to enquire during the 1977 hearings on Computers And The Learning Society:

> . . . am I correct that in building this futuristic network you speak about wiring together a complete city with homes, factories, and businesses, and a school population and then perhaps interlinking cities? . . . who controls all this? Who picks the peer reviewer? Who picks the evaluator? I think there will be alot of debate on this on the floor.[8]

Concerns like Gallagher's have inhibited PLATO's development in the U.S. Although supporters of PLATO claim that democratic safeguards in the U.S. make abuses of the system unlikely, CDC is well



Jane Morris

aware that PLATO's cost-effectiveness, and thus profitability, depends on the use of its more Orwellian capabilities. And it is precisely those capabilities that the Pretoria regime hoped could address its dire economic straits and growing security needs.

CDC's involvement with the South African Government has been long and intricate. In 1979, when PLATO was first made available to South Africa, CDC Data hired a man named Donald Lomax as Senior Education Consultant for their PLATO marketing efforts. A specialist in educational psychology, Lomax initially arrived in South Africa from England in 1977 for work on a pilot computer-based education system called Cybercom, a system remarkably similar in size and capabilities to PLATO. At the University of Witswatersrand, Lomax researched the potentials of this system for psychological testing in an educational setting. A year later Lomax enthused in a research paper:

> An interesting technological innovation is enabling members of the Education Department at the University of Witwatersrand to investigate the attitudes and aspirations of their students more effectively than has been possible in the past.[9]

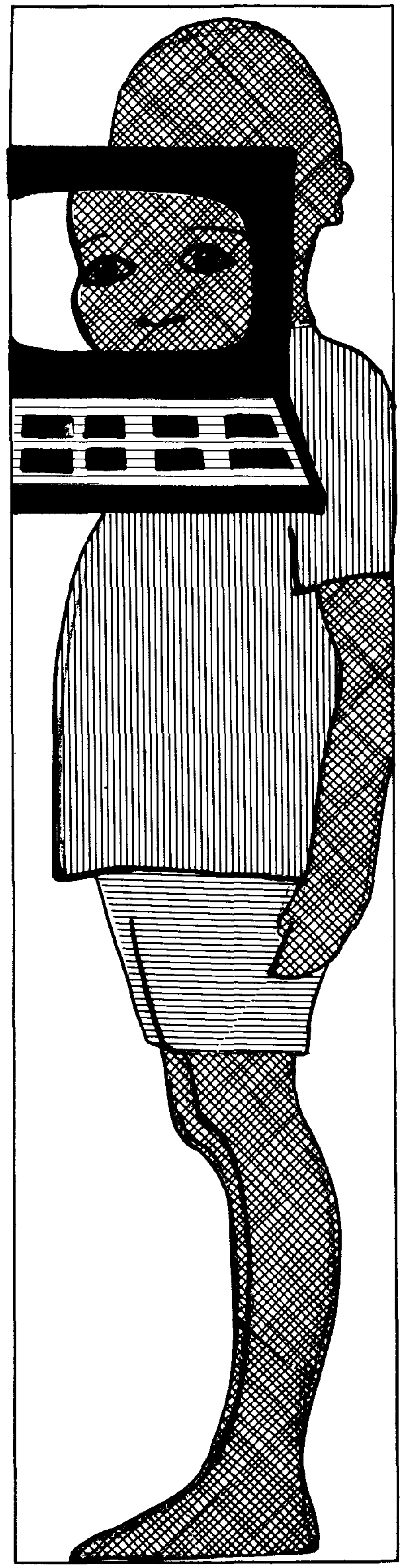
This computer-based education system, with the full name of Cybercom Multimode Education System is surrounded by mystery. The system appears nearly identical to that of PLATO. The construction of this very large centralized "education system" in 1976 curiously follows the beginning of CDC's South African advertising of PLATO in 1975 (CDC only obtained the marketing rights for PLATO in 1976). A number of CDC's mainframes, called Cyber systems, have been operating for several S.A. government agencies and now make up the nucleus for PLATO's programming in South Africa. The coincidences between the Cybercom's name and timely development points toward a real possibility that the Cybercom is basically a PLATO system under a different name, which was and still is used for testing software that would meet the design and needs of the South African government. This would explain the government's abrupt willingness to commit themselves to PLATO's capabilities in 1979.

The powerful potential Lomax saw in such a system was made clear in 1979 when, after joining CDC and beginning work with PLATO, he laid out his vision for the role that computer-based education could play in South Africa:

> ... recognition that the individual's learning capacity is profoundly influenced by environmental events, encourages the search for ways in which these experiences may be scientifically controlled ... It is also our desire to establish important attitudes towards study. work, leisure, the self and society ... We do have ... long term goals, such as that of producing well-adjusted adults who can accommodate the pressures of complex modern societies, and manifest the ability to assimilate our adult culture ... If we are to go further and establish an ideal model then we may imagine that parents, local communities, schools, colleges, universities, and the armed forces, commerce and industry may cooperate in the application of a systems approach. The orchestration of the enterprise is probably a task for central government ... it may be imagined that educators might make a greater contribution to the achievement of national goals, help nations to maintain themselves internally and assist all citizens to adapt to their environment.[10]

Not long after Lomax made this statement, CDC promoted him to National Academic Program Manager for PLATO in South Africa. The man that CDC chose to oversee its entire computer-based education program in South Africa has a vision clearly much more in line with the regime's security than the company's purported plans to promote "equal participation of all people in South African society." CDC's interest in bringing security-minded personnel to their PLATO staff was even more starkly evidenced when they hired John Brett in 1978 to be a senior public relations representative for the PLATO system. Brett, too, had unique qualifications to further CDC's intent to improve the lot of black people in South Africa. Before being hired by CDC he had spent over

Individual destinies under this system would be determined not by actions, but by a standardized selective system that classifies some people as "good" (acquiescent) and others as "bad" (radical).



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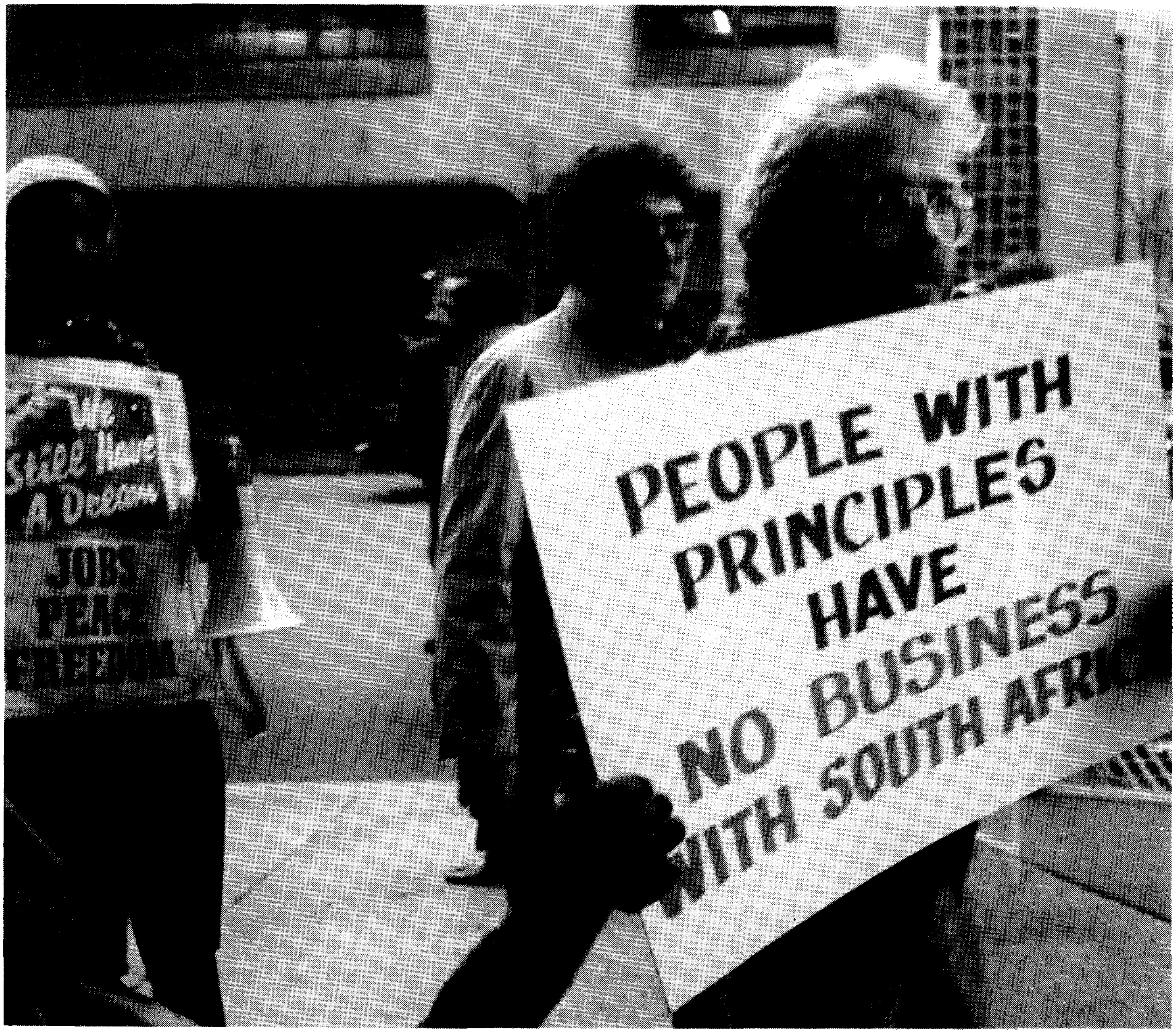

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twenty years as an agent for South Africa's notorious intelligence agency, formerly known as BOSS. As an employee of CDC, Brett brought his expertise to such tasks as spearheading fundraising efforts within the country and escorting and monitoring blacks on U.S. promotional tours.

PLATO System Spreads

The extraordinary applicability of the PLATO system to the regime's needs is evident by its rapid growth in South Africa. Within two years of its introduction to the market, a training center (Control Data Institute) was established in Johannesburg; software and hardware were made available to businesses and government. The University of the Western Cape had purchased from CDC the third largest computer-based education system in existence, and plans were underway for a mammoth computer network to encompass the entire Natal/Kwazulu region.

This proliferation and its frightening potentials have not gone unnoticed in South Africa. Many educators are concerned. One instructor who trains teachers in the Natal region expressed her fears over the PLATO center there:

> They have the student's names, home addresses, ages, date of birth, all the courses the students are doing, the individual lessons the student has done, and at the click of a few buttons you can receive all of the information. I feel a great concern because there is no telling that there are not say 100 terminals somewhere else in the country that are collecting information on us just like spying on people . . . They could get information in five minutes that would take half a year to put together in other ways.

PLATO's use, however, is not limited to schools. Its capabilities appear to be aiding a government effort to monitor and control the type of black entering the job market. A government organization that researchs black labor, the National Institute for Personnel Research (NIPR), purchased an unannounced number of PLATO terminals in 1980. This organization is a division of the Center for Computing Services, the principal component of the notorious Council on Scientific and Industrial Research which services military and security needs. Prior to 1980, the division was researching the psychology of black labor, studying, for example, the needs and attitudes of blacks in industry, and the role of the black technician.[11] But more pertinent, this division began focusing much of its resources on personality and temperament research, including psychological testing using a computer resembling the PLATO.

This movement toward personality testing has permeated the educational system. Unless the government can "understand" black motivations and culture and select desirable blacks for upper-level positions, their absorption into the workplace could prove fatal to apartheid. In 1981 the Department of Education and Training reported that it was collaborating with the Human Science Research Council (HSCR) in a variety of experimental programs that included several intelligence tests and personality questionaires. In 1982 a "computerized vocational guidance programme" was applied to 35,708 pupils at 312 schools.[12] CDC has said they would aid this effort by establishing "a comprehensive, flexible program with testing to identify interests and skills with counseling leading to a job goal." The information that is derived by the education department is available to other government agencies.

The NIPR's parent, the Center for Computing Services, is coordinating this research with the development of a government-controlled computerized employment placement program. As early as 1978 the department was processing 20,000 jobs per month. "It may be forseen that a large proportion of all jobs in the future will be initiated from terminals, remote job entry stations or minicomputers linked to central computers," explained the Center.[13] According to Thomas Conrad, the government announced in 1980 (when the NIPR purchased its PLATO terminals) that it was considering a plan that would reduce unemployment "by providing instant information on where jobs are and where workers are who can do the jobs." The program would be managed by the Department of Manpower Utilization. The same program would, Conrad maintains:

> expand computer surveillance of blacks by establishing a national network linking the Administration Boards and the police to a central computer in Pretoria . . . personal details fed into the computer would include educational qualifications, test results, employment histories, criminal records and ethnic origins of urban blacks and their status under influx control laws . . . The computer network would [also] be programmed for 'message input' by the police to pinpoint people who are required for questioning.

CDC, unable to turn a profit on PLATO in what it had anticipated to be its largest market, found itself with a $900 million monkey on its back. It was at this point that CDC's plan for PLATO in South Africa began to take shape.

The widespread implementation of the PLATO system in South Africa could provide the government with files containing everything from a delineation of a person's behavior and career orientation to an analysis of his or her attitude and temperament. The possession of such files could vastly strengthen the hand of the apartheid regime. Individual destinies under this system would be determined not by actions, but by a standardized selective system that classifies some people as "good" (acquiescent) and others as "bad" (radical). Persons could be carted off for questioning, denied education, shut out of the job market, restricted in mobility, or even imprisoned, merely under the suspicion of a computer's character indictment.

What CDC claims to be a PLATOnic solution to black inequality in South Africa seems, in fact, to be a solution to the regime's present shortage of skilled labor, its conflict with increasingly politicized students and educators, and its self-preservatory need to centralize and augment security information. In a country where black teachers seldom have more than an eighth grade education and black students must struggle to buy textbooks and supplies (whites are provided them free of cost), it is ironic that millions of dollars are being spent on computer equipment for schools. Having no cure for a national uprising, the South African government is resorting to computer surveillance and control for its prevention. CDC, with its $900 million stockpile of high-tech medicine, is providing a timely fix for the regime's security ailments and is gaining for itself a long-awaited return on its PLATO investment. Black South Africa, however, is shut out of this neat compact, its destiny increasingly directed by the white regime through the pulse of wires and content of micro-chips.

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WHOSE COMPUTER IS IT ANYWAY?

by Sarah Michaels, Courtney Cazden, and Bertram Bruce

There are now approximately 300,000 microcomputers in schools in the U.S. with most school districts scrambling to purchase more. The intensity of this interest in school computers is at least in part attributable to parental concerns about future job prospects for their children. Computer hardware and software makers have tended to reinforce such commonly held, but little substantiated, beliefs about children and computers. Nevertheless the growing evidence is that the high-tech society has a greater need for low paid, semi-skilled factory workers than for high paid systems analysts.

There are questionable assumptions being made about why computers should be in schools, but it is true that there may well be considerable benefits to having them there. Computers can in principle be used to make educational resources more equitably distributed (e.g., through network access to data bases and library resources), to facilitate more active student involvement in and control of learning (e.g., through the use of computer tools such as text editors and programming languages), and partially to address the needs of students who are victims of educational neglect.

Unfortunately, the progressive potential of the computer is all too often unrealized. As is so often the case with new technologies, computer use is more apt to reinforce existing patterns than to change them. In many ways the introduction of computers appears to maintain or even increase existing inequalities in education, inequalities which predated the availability of computers.

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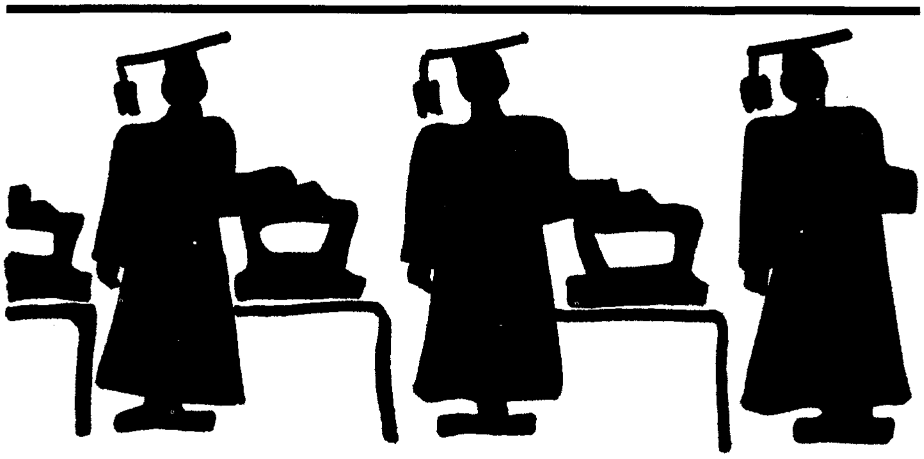

Jane Morris

While these inequalities were not caused by computers, they may well be reproduced and even accentuated by their use. We examine here three areas in which these problems arise: hardware, software, and classroom use. We present more examples on the third area because it is more apt to be overlooked in discussions of equity in computer use, and because the process by which inequalities are produced is more subtle.

Inequalities of Access

"There is a persistent and substantial inequality in the access to new technologies among both schools and school children." So said Tarr-Whelan, the President of the National Education Association, before the House Subcommittee on Science, Research and Technology this spring. The inequality is in computer/student ratios among categories of schools. Not surprisingly, urban schools with a high proportion of poverty-level families have fewer computers than either suburban or rural schools.

One of the bills on computer education now before Congress — the Computer Education Assistance Act introduced by Senator Frank Lautenberg — reserves 50% of the Federal funds for hardware purchases by poverty area school districts. But even if that bill should become law, which seems unlikely, it will only alleviate inequality at one level of the education system, and there are other ways in which computers aggravate existing inequalities rather than reduce them.

Inequalities of Software Usage

Even if urban schools should catch up in the number of computers owned and if access to some kind of computer should become equalized from school to school, there may still be substantial educational inequality. The number of computers in a school is a poor indicator of the quality of the educational experiences that students get when they sit down at the terminal. Here, too, inequalities are already apparent:

> While middle class students, especially those who are in advanced programs (e.g., Gifted and Talented Education) receive instruction which encourages learner initiative (programming and problem solving), low income and ethnic minority students recieve instruction which maintains the control of learning within the program (computer aided drill and practice).[1]

continued on page 43

TAKING CONTROL OF EDUCATIONAL TECHNOLOGY

by Bertram Bruce

There is no such thing as a *neutral* educational process. Education either functions as an instrument which is used to facilitate the integration of the younger generation into the logic of the present system and bring about conformity to it, or it becomes "the practice of freedom," the means by which men and women deal critically and creatively with reality and discover how to participate in the transformation of their world.

—Richard Shaull[1]

One of the central debates in education is how to prepare students to meet the needs of a technologically-oriented society. A companion question concerns the ways technology should be used in teaching traditional subjects. These issues are usually discussed in terms of the efficiency of one teaching method versus another or in terms of how the limited time within the curriculum should be allocated. But prior to addressing those questions, we need to consider a more basic question about the role of computers in education: Will computers make education more of an instrument for bringing about conformity or can they assist "the practice of freedom?"

To address this question, this article takes a practical approach, by considering what computers are and how they might be used most productively in education. The examples show, among other things, that the distinction between learning about computers and learning other subjects through the use of computers is not that useful. More importantly, these examples are intended to suggest some ways to think about both progressive uses of computers in education and the creation of social and political environments in which such uses are more easily realized.

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R. Crumb, Courtesy Whole Earth Review

What Role Should Computers Play in Education?

Many people see computers as ideal for the present educational system, in that they can smooth some rough edges: they can protect against "cheating," they can ensure that children don't read materials they are not ready for, they can monitor student progress along pre-defined lines, limit the impact of the "teacher variable" (i.e., the power and importance of the individual teacher), and, perhaps most importantly, they can reduce costs (assuming teachers can be replaced by machines).

The alliance of these considerations with the profit motive has resulted in a tremendous push for computers in schools. Last year, for example, major computer manufacturers, led by Apple Computer, sought substantial tax breaks in return for massive installation of computers in schools. Large school districts are now purchasing computers *en masse*. Boston, for instance, recently reached an agreement with IBM to purchase 800 computers for its schools.[2] Much of this momentum has occurred with little understanding of the eventual uses and consequences of computers in schools.

Parents' legitimate concerns about jobs for their children have also fueled the current computer mania. Many parents believe that if their children learn how to program they will automatically become eligible for high-paid, high-tech jobs, not realizing that most of the employment in the high-tech field is low-paid, non-union factory work.

In contrast, others, such as the Crabapple group, have taken decidedly negative positions about the current push for computers in schools. They argue that there are societal needs far more pressing than turning every classroom into a high-tech center. Moreover, they see the emphasis on computer programming as a misleading promise about jobs that will not be there. They also see computers as emphasizing piecemeal learning, rather than supporting more holistic, critical or creative education.

Finally, some feel that the use of computers in schools needs to be encouraged precisely because it does foster progressive education. For example, the International Council for Computers in Education (ICCE), an Oregon-based group that publishes *The Computing Teacher*, promotes the use of computers in education. While critical articles are published (the April 1984 issue, for example, focuses on equity), the general thrust is not to question but rather to encourage greater use of computers in schools. At various conferences on computers in education, many speakers go far beyond the ICCE in insisting on the value, even the need, for computers in schools. They lament the "resistance" that others in education still profess.

The problem with all of these views is that they tend to locate the source of the computer's power to affect education in the computer itself. Thus we hear that "Computers will teach children to read," or "Computers will turn schools into assembly lines." In fact, computers *per se* do nothing; they are simply tools which can amplify the power people have and the social relations they engage in. In that sense, the positive or the negative consequences realized by computers will be caused by people making use of computers to accomplish ends for change in education.

What Kind of Tool is a Computer?

Although we often associate computers with numbers and the repetitive calculations needed by banks, insurance companies, manufacturers, and so on, the essence of the digital computer lies not in adding columns of numbers but in its function as a tool for creating, manipulating and communicating symbols, in short, as a tool for language and thinking. Many teachers have begun to see this and to use the computer as a tool for expanding children's opportunities to solve problems (using programming languages such as Logo), to develop ideas (using "microworld" simulation programs), to gain

access to information (using computer networks and public databases), to explore scientific questions (using statistics programs and computers connected to measuring devices, such as thermometers), to write and to share their writing (using text editors, publishing programs, and networks). This view of computers as a symbol tool emphasizes the creation of contexts in which meaningful activities are encouraged and supported. Specific skills are then learned first in the contexts in which they are most appropriate.

The prevalent view of computers for the classroom, however, still seems to be one in which the computer "teaches" by controlling information and managing student efforts. Such uses limit rather than expand children's possibilities for learning. Within this restricted view, computers are seen as useful solely for teaching specific concepts or skills: punctuation, spelling, simple arithmetic calculations, state capitals, subject-verb agreement, etc., or for managing the process of instruction. If we are to go beyond this view we need to rethink some assumptions about how to use computers in the classroom.

The biggest impact of computers in classrooms may be in terms of the ways they contribute to the social organization of the classroom rather than on how they teach specific concepts.

One study found that teachers who had a chance to study computer software for use in the classroom argued for software that allowed the student to use the computer as a tool for learning rather than for software that put the computer in the dominant role, with the student pressing buttons on cue. The "teachers saw the enormous pedagogical differences between apparent user control and real user control, between answering questions and formulating them, between recognizing someone else's ideas and creating your own."[3]

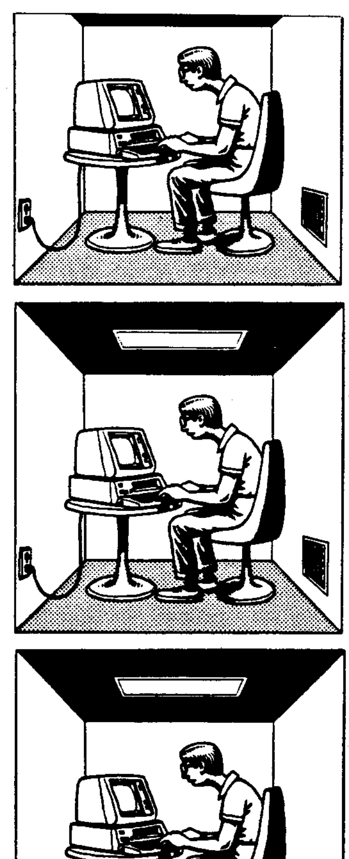
Why then do so many classrooms use the computer as a manager or a drill master? One reason, of course, is that much of the pressure to install computers in schools comes from a desire to automate the classroom, to make it more "efficient." This means, in the view of the computer's proponents, that the teacher's role must be diminished and circumscribed; new management controls need to be introduced. Thus, the computer becomes a device to channel student efforts, to measure and control what students do in school. A corollary of this is that teachers are kept out of the decision-making that directly affects them and the students in their classrooms.

Some Ideas for Putting the Computer in its Place

The attempt to make computers into the shop foremen of the classroom has not been universally successful. But there is little support from the educational system or the available software, books, and articles to use computers in more creative and open-ended ways. By using the computer only in the most restricted ways we let the computer become the center of attention rather than the student. Below are some observations about how computers relate to education that might help teachers, parents, or learners redress this imbalance and put the computer in its place. One component of these observations is that choosing among specific software products is far less important than understanding categories of programs and their contexts of use. As a result, endorsement of specific programs here has been avoided and only a few programs are named where necessary.

The Computer's Effect on Learning: We often discuss computers in terms of their technological aspects—speed, memory size, functions, etc. and neglect to consider how they fit into a social context. Yet the biggest impact of computers in classrooms may be in terms of the ways they contribute to the social organization of a classroom rather than on how they "teach" specific concepts.

For example, it is often asserted that the use of word processors by children will help them become better writers. The argument is that since good writing depends on developing revision skills, a tool which makes revision easier will encourage children to practice revision more. This may well be true, but careful observations of classrooms where word processors are in use have revealed that other factors are also at work.[4]



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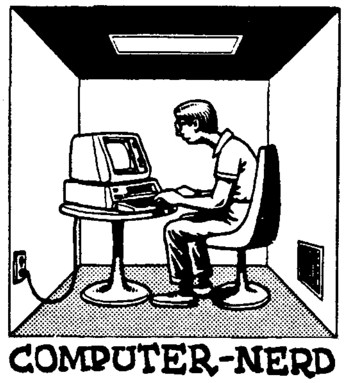


R. Crumb

These uses of the computer were successful because they grew out of real classroom needs and were not restricted to the suggestions for use given by the teacher's guide.

In a classroom in Hartford, Connecticut, a great amount of revising did occur. But the reasons were not purely technological. Because the computer was a limited resource, students tended to "mill around" the computer waiting for their turn to use it. During that waiting period they would read what others had written and decide to modify their own early drafts. Also they tended to value highly what was written on the computer and felt it was worth the effort to revise. Both of these factors—the opportunity to read others' writing and the value placed on computer writing—contributed to an increased amount of revision, which may, in the end, have helped the children become better writers. Understanding the process that was occurring in that classroom, a teacher might conclude that overall the computer had a positive impact on learning. But it would be important to remember that it was not the computer alone which brought about the changes, but rather the way the teacher and the students organized themselves for learning.

The major prerequisites for successful use of the computer are not characteristics of the software or hardware, *per se*, but of the classroom, the teacher, the principal, and the curriculum. Teachers who have a clear idea of what they want to have happen in the classroom can find software that facilitates it, but choosing software without thinking of educational goals and particular classroom needs first is likely to be ineffective at best.

Expert Advice:

The software evaluations published by various organizations, such as the Educational Products Information Exchange (EPIE), and the reviews in magazines such as *Classroom Computer Learning* and *Electronic Learning* provide useful information but should never be taken as the sole guide for selecting software. The problem is not just that the expert may have a different educational philosophy and sensibility about computers. Nor is it just that every expert has a limited sample of the thousands of programs currently available. The core problem is that evaluations of software do not begin to take into account all the ways that software might be used. The recommendations of experts can be useful for assessing a program's potential as well as its limitations, but the real worth of a program is determined by how it is used in a particular classroom.

The Floppy Disk Cover:

Programs are not always successful at teaching what the disk cover claims, and some of those that are successful tend to focus on rapid performance of skills out of context without helping children in any significant way to become better problem solvers or users of language. A basic problem is that most software is produced to meet profit goals first, and educational goals second, if at all. Most software designers are not educators and may have poor intuition about how children learn. Educators who design software may likewise do a poor job if they are not familiar with what a computer can do. Thus, what appears from the cover to be a useful program for teaching may be of no use at all.

On the other hand, some programs not presented as "educational" may be ideal for teaching. For example, general communications tools (often catalogued as "administrative aids"), such as data base programs, text editors, and electronic mail can give students the chance to use language in expanded ways for real communication. Programs that plot data or help in constructing tables may be useful in learning scientific methods even though they are not strictly defined as educational. And, general purpose programming languages can be used for purposes other than developing "computer literacy." For example, a language such as "Logo"[5] can be used to study language structures or mathematical relationships (as well as to draw pictures, its major claim to fame).

Finally, a program that appears to be useful for one educational task may have unsuspected uses. There is a text editor now being marketed which comes with a speech synthesizer than can say each letter or word as it is typed.[6] The justification for the program is that it helps young children learn to read and write. But a teacher of older students might find that such a program would be useful in teaching the concept of symbol-to-sound rules. This could be valuable in learning a foreign language or might be a useful adjunct to teaching general linguistics.

Creating Computer Learning Activities:

Teachers who are not programmers can nevertheless create their own computer learning activities in a variety of ways. They may, as suggested above, find new ways to use existing software, especially the more open-ended variety. But equally important, teachers can use general purpose software, such as word processing programs, to mimic many of the packaged programs being marketed. For example, one new program is a game in which one student inserts a sentence into a preexisting text and a second student tries to guess the added or "suspect" sentence. This game helps students become more sensitive to such things as textual coherence and authors' style.

A teacher—or better yet, a group of students—could devise a procedure for using a text editor which retains the significant aspects of this language game. (It is relatively easy with most text editors to insert a sentence and reformat the paragraph so that it is not obvious that a sentence has been added.) Having the students select texts to use and devise scoring procedures could be as educationally beneficial as playing the game itself.

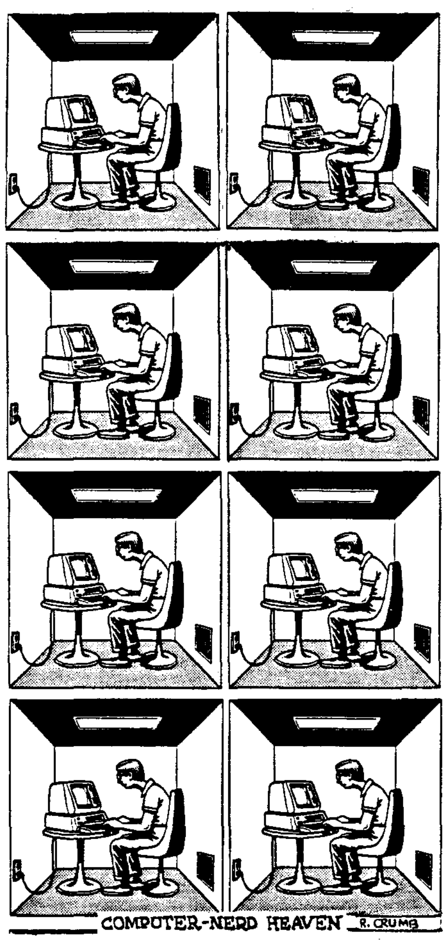
Recommended Uses:

Experience with "Quill"[7], a program for teaching composition, reveal in a direct way how decisions about the use of computers in schools must be informed by the needs of students and teachers. For example, a group I helped to lead designed a part of Quill to assist the planning aspects of writing. We saw it as a tool to help in organizing a first draft of a piece of writing. Although it has been successfully used in that way, we've found that some teachers have used the same program more productively in ways we only dimly anticipated.

One teacher had students use it as a tool to create interview forms. The students used these forms in doing community studies—interviews with elderly residents about food, clothing and housing needs. (They could use the computer to revise the forms easily as needed.) Another teacher used the program to create a tool for doing science lab reports. Students then used the computer to record data (from a table-top greenhouse project) using diagrams in their science textbooks to help analyze what was happening. The computer became a tool for facilitating the connection between their real world observations of plant growth and the abstractions of their books. These uses of the computer were successful because they grew out of real classroom needs and were not restricted to the suggestions for use given in the teacher's guide. If we had assumed that our vision alone was sufficient, we might have stifled creative, classroom appropriate uses of the computer.

Students can also use programming languages to create their own learning activities such as science simulations, bulletin boards, adventure games[8], and so on. This last approach has the added value of narrowing the artificial gap now established between learning about computers and learning other subjects through the use of computers.

The computer is a powerful educational tool. It can be used to limit children's access to information, to control the way they read and write, and to restrict their modes of learning, or it can allow children to communicate easily with others and to access information in a way that greatly expands their world. If computers are to be worthwhile tools, we must never let computer needs or faulty educational ideas embodied in computer programs come before the needs of children.



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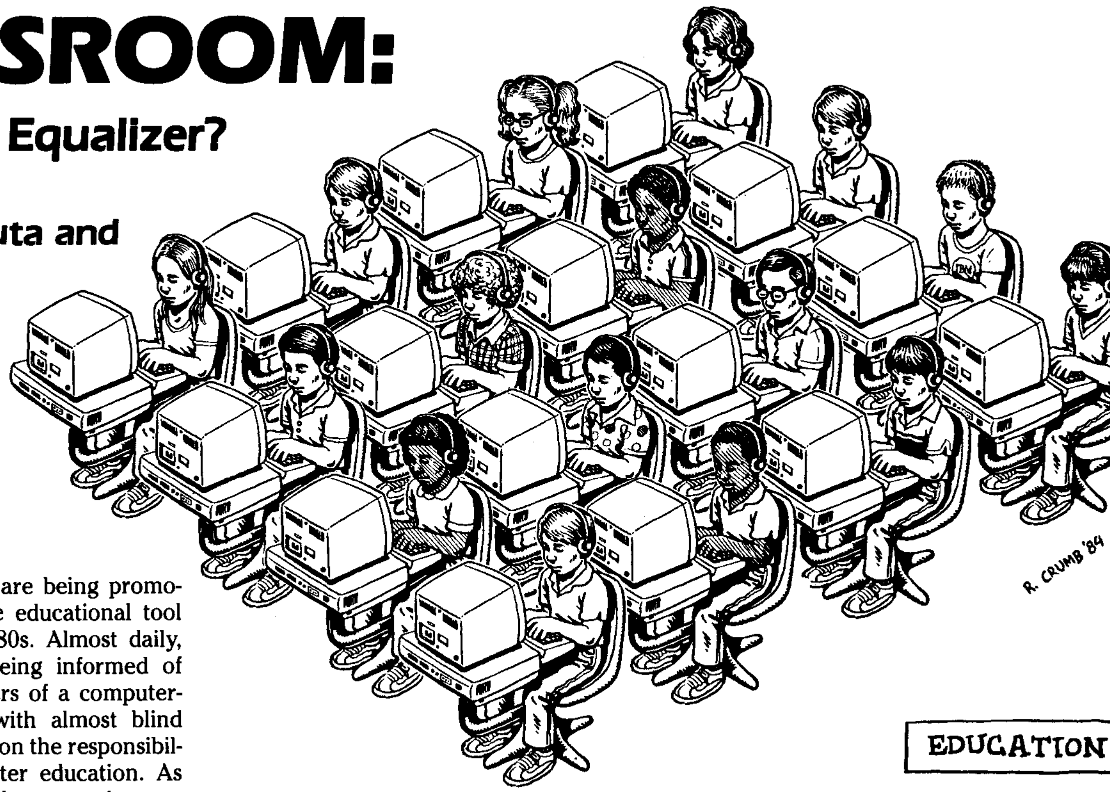
COMPUTERS IN THE CLASSROOM:

Stratifier or Equalizer?

by Marcia Boruta and Hugh Mehan



Whole Earth Review

EDUCATION

Computers are being promoted as the educational tool of the 1980s. Almost daily, we are being informed of the dangers of a computer-illiterate society, and with almost blind faith, schools are taking on the responsibility of supplying computer education. As history has shown us, however, innovations in social systems often have unforeseen consequences for those systems.[1] As schools acquire and use computers for educational purposes several major questions arise:

- Will students from different strata of society obtain equal access to computers?
- Will students from different strata of society be taught similar or different uses of computers?

In order to get some sense of the relationship between the numbers of computers in schools and students' access to computers, we observed computers being used in 21 classrooms in five Southern California school districts.

We did not select these schools according to a formal sampling procedure; we capitialized on personal contacts to facilitate access. Since our schools were not sampled randomly, care must be taken when generalizing from the information that we obtained. Likewise, we did not randomly sample the people to be interviewed. If there is a formal term to characterize our approach to interviewing, it would be called the "snowball technique." We started with the teacher, resource person, or whomever we could find who knew about computers in the school. When an interview was completed, we asked that person for the name of others involved in computer use, and interviewed them. We continued this procedure until there was no one left to interview.

Our observations and interviews were guided by a common set of orienting questions regarding the relationship between the characteristics of schools, the students they educate and the policies and practices of computer use in the five districts we studied. We found a very strong relationship between (1) the rationale for computer use, (2) the source of funding for computer acquisition, (3) the type of students who are educated using computers, and (4) the type of instruction presented to students.

The Rationale for Computer Use

We asked school officials why they were introducing computers into the school curriculum. Educators' answers included: "we want kids to feel comfortable with computers;" "we want students to learn programming . . . it is an important skill;" "students can gain control of the medium by learning to program it;" "computers can help teach academic subjects;" "computer awareness; "we need to raise test scores . . . we think computers can help us do that."

We often found that different educators in the same district had inconsistent answers to our questions. Initially, we treated these responses as indicating the novelty of computers in education which creates discrepancies in the reasons cited for their use. Subsequently, we found that educators' reasons for acquiring and using computers were not randomly distributed. They lined up with the sponsorship of computers and the students who used them.

Funding for Computer Acquisition

The school districts we observed spent very little of their own money to acquire computers, which is not the prevailing national norm. (This finding may be unique to the districts we studied, or it may be a function of Proposition 13, the tax initiative which reduced the money available to school districts in California.) Funds from the state of California and the Federal government purchased 93% of the computers in these districts, by the way of moneys available for education of "gifted and talented" youngsters (GATE), "economically and culturally disadvantaged" students (Chapter 1 of the Educational Consolidation Act of 1981), School

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Marcia Boruta and Hugh Mehan are members of the Computer Use Study Group of the University of California, San Diego, which undertook the study they describe.

Improvement Programs (SIP), and the desegregation effort. Private funding, most notably donations from PTA groups, accounted for 5% of the computers acquired. PTA groups sold land, sponsored "jogathons," collected aluminum cans in order to acquire computers. One enterprising teacher had a local computer store "sponsor" her classroom in exchange for the loan of microcomputers.

Student Access to Computers

The stated policy of many schools that have computers is to give all students equal access to computers for instructional purposes. However, the disparities between stated policy and observed practice point to the potentially statifying effects of computer use.

We also found that boys and girls had differential access to computers, especially in secondary schools. In elementary schools with central lab facilities, boys and girls had equal access. However, observation of voluntary time on computers (for example, at lunch and recess) revealed more boys than girls using computers in their spare time. The statification of boys and girls on computers coincides with the curricular divisions of boys and girls in math and science subjects.

We also found that there is a relationship between the source of funds used for computer acquisition and the students who had access to these computers that has a stratifying effect. Chapter I and SIP funds were used primarily to educate ethnic minority and lower class students on computers, while GATE and private funds were used primarily to educate middle and upper middle class students.

For example, Chipotle School, established as a computer "magnet" school to attract white families to an inner city ethnic neighborhood, functioned almost as two separate schools. It provided self-paced computer classes for each of its six grade levels and supporting activities in math and science. Ethnic minority students from the local neighborhood (who were not part of the magnet program) only had contact with computers in Math and English Skills Labs. The Skills Labs stress basic skills using the computer for drill and practice and a specialist for tutoring. Most of the white students in the magnet had access to the computers for programming and problem solving activities. Likewise in the Piquin School District, which has a "multiple use" policy, there are differences in student access to the computers. In the schools where computers are assigned exclusively to GATE (Gifted and Talented Education) classrooms, each GATE student averages 60-80 minutes per week on the computer, and other students have no access to the computers at all.

Computers fortunately were not limited to the groups for which they were acquired originally. After a year or two, computers acquired for GATE students began appearing in regular classrooms. In the schools that rotate computers between GATE classrooms and other classrooms, each GATE student has 40 minutes per week on the computer, and other students have 20 minutes per week on the computer. Clearly not all students in regular education gain access to the computer under this arrangement. Even in the schools where teachers who ask for computers can get them, not all teachers do ask. Thus, where computers are being used in regular (that is, not GATE, Special Education, or Chapter I) classrooms, it is because teachers are highly motivated or highly knowledgeable.

Instructional Applications of Computers

We found that the instructional applications of computer use were differentially distributed. Ethnic minority and lower class students received a different kind of instruction on computers than their white middle class and ethnic majority contemporaries. While white middle class students, especially those who were in GATE programs, received instruction which encouraged learner initiation (programming and problem solving), lower class and ethnic minority students, especially those in Chapter I programs, received instruction which maintained control of learning in the machine (computer-aided drill and practice.)

Computers were primarily used for basic skills instruction and computer literacy. When computers were used for basic skills instruction, students were given computer-aided drill and practice on material which supported instruction they received in their classrooms. When students were exposed to computer literacy, they were taught how to program computers, mostly in BASIC. Computers were used for writing, music, and art far less often than they were used for CAI (Computer Aided Instruction) and programming.

Using computers for drill and practice or computer literacy represents educational policy that should be examined for several reasons. The full power and range of computers is not being exploited when they are used for drill and practice in basic skills. There is little evidence to suggest that computers can deliver basic skills better than conventional techniques such as workbooks or flashcards, and their utility diminishes when their high cost is taken into consideration.[2]

The use of computers for computer literacy emphasizing programming does not match the needs of the world of work. While it is true that computers are being introduced into a vast number of jobs, the largest number of jobs will continue to be in the service sector.[3] Few of the computer jobs will require high levels of programming skill and computer knowledge. In fact, many jobs are simply being eliminated by computers, while others become less creative. The jobs that are being transformed by computers include (1) those which involve computers but require no knowledge of computer programming by the worker (e.g. supermarket checkers), (2) jobs that require minimal knowledge of computer programming (e.g. text editing, spread sheet analysis and data retrieval), and (3) jobs that require both knowledge and computer use and programming (e.g. systems analysis). This third category is the smallest in scale and hardly justifies organizing entire educational curricula with computer programming at the pinnacle.

Thus the use of computers makes a difference in a way that well-intentioned educators have not considered. By even tracking students from different socioeconomic backgrounds through different computer-based curricula, and by encouraging curricular division between boys and girls, the computer can be used as a tool to contribute further to the stratification of our society. Unless educators become more familiar with the strengths and limitations of computers and establish the uses of computers based on sound educational objectives, then we will be faced with a system of stratification based on technological capital that will make the one based on economic and cultural capital look pale by comparison.

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Whose Computer?
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For example, Rand Corporation researchers conducted an intensive study of 40 elementary and 20 secondary teachers in California who were nominated as exemplary computer users in mathematics and science instruction.[2] Four patterns of computer use emerged from their analyses: orchestration — with the widest variety of uses directly linked to the regular curriculum; enrichment — which familiarized students with computers as a separate subject; adjunct instruction — that selectively augmented math and science lessons; and drill and practice in basic skills. On the question of equity, they conclude:

> classrooms with students above average in ability and low in numbers of minorities tended to be found with teachers characterized as "orchestrating" . . . [Whereas] the five classrooms with a high percentage of minority students low in ability employed computers to deliver drill and practice (p. 62).

No one claims that computers have created this disparity in educational experiences, but they certainly appear to reinforce it.

Some studies have found greater access to and use of computers by boys than by girls, especially at the high school level and during electives and after-school periods.

> Boys outnumber girls 2 to 1 in high school programming courses and 3 to 1 in attendance at computer camps. Girls have less access to computers at home and are less likely to participate in free time (out of class) computer use at school.[3]

But here, the type of computer software and computer use makes a difference. Studies of computers used for writing by upper elementary school children have not found girls to be at a disadvantage. In our own study of computers with writing software in two urban sixth grade classrooms,[4] we found that girls were as likely to be star computer users as boys. And while some boys in each class were prolific writers on the computer, the girls overall did more computer writing than the boys. Moreover, when students were ranked by amount of computer writing done, and relative ranks were compared across time, girls in both classrooms tended to move up in rank over time while boys tended to move down.

The fact that computers seem to reinforce rather than change existing patterns still appears. If pre-computer stereotypes of male mathematicians vs. female writers exist, those patterns (orchestration for the rich/drill for the poor; greater access for boys; stereotypical use, etc.) are not necessary in any absolute sense. They occur because existing social and political relationships take precedence over issues of fairness or general educational value. The patterns of inequity persist unless they are deliberately and systematically countered.

Inequalities Within a Classroom

We know from studies of student-teacher interaction that students within any single classroom receive differential treatment from the teacher. Considered positively, this differential treatment is called "individual instruction." Considered negatively, it is a source of discrimination and self-fulfilling prophecies. Computers are very different from teachers in one way, and like them in another. The difference — often mentioned by advocates of computer instruction for minority children — is that computers don't see the color of a children's skin or hear their non-standard speech. Teachers form expectations on the basis of unconscious reactions to cues such as these; computers do not. That is an important difference.

But the similarity is that a computer, like a teacher, is a scarce resource, and in the allocation of this resource within a single classroom, the gap between the haves and the have-nots can be widened. In our observations of two urban sixth grade classrooms, each with a computer used for writing, we have seen teachers integrate the computer very differently into their writing programs. These observations have led us to raise some general questions about the relationship between computer use within a classroom and students' access to computer time and expertise.

If the computer is used in the final stage of writing to produce a neat, typewritten copy (rather than as a text-editing tool), the speed with which a student writes a first, hand-written draft often determines his or her number in line to enter text on the computer. Students who start out writing better and quicker often are rewarded by a prompt turn, which allows for a prompt (and probably more meaningful) connection between what they wrote on paper and what they entered into the computer.

If access to the computer is strictly controlled by the teacher (so that students have scheduled times or have to have their writing checked and OK'ed by the teacher before writing on the computer), then absenteeism is likely to influence how much time a student has on the computer. Students who are absent often (for whatever reason) are more likely to miss their turn or be denied their turn while making up other assignments. This is often the case with students who are pulled out of the classroom for special tutoring (such as students with diagnosed learning disabilities or Title I status). Thus students who have the most to gain from time on the computer are often kept off because of institutionalized absenteeism (known as "pull-out" programs). Alternatively, some teachers have found that by making use of innovative approaches such as peer tutoring, students do not necessarily fall behind just because they miss a lesson.

Another kind of access to the computer comes through students' knowledge of text-editing commands used for inserting, deleting, and rearranging text. Different teachers have different strategies for teaching their students text-editing skills. If a teacher becomes fully versed in the commands, groups and individualized instruction is possible, so that the entire class can be given basic information, and advanced instruction can be provided to those students who seem "ready" for it. If a teacher does not become proficient with the commands, access to necessary skills becomes more problematic.

As an example, one of the teachers in our study did not fully master the text-editing commands. Instead, she selected one student — a boy who seemed interested in and facile with the computer — to become the classroom "expert." She had another teacher (who was herself an expert) give this student individual instruction, and then directed the other students to consult him with questions about computer commands. By the end of the school year, only this student had mastered all the basic text-editing commands and fully understood the mode orientation of the text editor. Two other students knew a few commands, both of whom were close friends of the student-expert.

In this classroom, voluntary grouping at the computer was allowed when students had free time. As a rule, groupings at the computer divided along sex lines (as did groupings in the lunchroom and on the playground). Not surprisingly, the student-expert's knowledge of text-editing commands diffused narrowly in this classroom, and did not cross sex lines. *Not a single girl in the class knew how to insert or delete text.*

Thus how information about the computer is made available to students (via wall charts, formal instruction by the teacher, or informal teaching by a student expert) and how information is passed from student to student (through voluntary grouping or assigned pair work) limits or enlarges students' command over the technology.

Conclusion

Many children are effectively denied access to new educational technologies because they live in the wrong school district. Others are able to use computers, but only in the most limited ways. Our classroom study suggests that in addition to these inequalities in educational access, the same computer with the same software may be used very differently by different teachers, even in the same school and with the same student population. For this reason, if was are concerned about equity of computer distribution and use, we must have ways to evaluate the actual usage in real classrooms. Before asking what impact a computer with a particular kind of software will have on student learning, and whether it is good or not, we must ask what impact the classroom (and in particular, the teacher) will have on the way the computer is used. How will students get a turn? How is computer related information made available to students? These classroom specific factors, overlaid on system-wide factors such as computer and software availability, ultimately determine a student's access (or lack of access) to computer related learning opportunities.

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Health Hazards

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increased from about 1 billion pounds in 1940 to 30 billion in 1950 and 300 billion in 1976.[17]

This rapid increase in the quantity and variety of new chemicals paralleled the development of the microelectronics industry. Unlike older industries that developed when resources were more limited and naturally occurring, the high-tech industry capitalized on new solvents such as ethylene, toluene, benzene, and styrene, complex halogenated hydrocarbons like trichloroethylene and methylene chloride, and various new ketones and resins.

Second, many of the hazards in microelectronics production are derived from long-term exposure to toxic chemicals, the consequences of which may not be experienced for years after the exposure. Such latency periods are always common with cancers and frequently with other severe problems such as organ damage, cell damage, or reproductive disorders. Among the chemicals commonly used in microelectronics production there are suspected carcinogens, teratogens and mutagens, and chemicals adversely affecting major organs. Some of these substances have been known to be hazardous for centuries, but many of the newer chemicals used in microelectronics have had little effective testing or long-term observation experience. Finally, workers in the industry are often exposed not simply to one chemical, but to a multitude of substances. Workers exposed to chemicals above standards set for individual chemicals may be in significant jeopardy because of synergistic effects among chemicals or because some chemicals may inhibit the body's normal resistance to the toxic effects of other chemicals.

Third, the large number of firms in the industry with a wide variability in production makes government regulation difficult. The microelectronics industry is composed of thousands of highly competitive firms, and production is, thus, spread among them. For instance, the top 26 printed circuit board producers account for only 41% of the market.[18] With many small competitive firms, the emphasis in production is on innovation and experimentation. Because competition is fierce, innovation and proprietary knowledge are often key determinants to success.

This highly experimental and competitive environment means that hundreds of chemicals are used in the industry with relatively little experience and testing. Competitive advantage means that such chemical inputs, quantities and methods are closely guarded trade secrets. The variability of production and products and the trade secret protections make it quite difficult for health professionals, industrial hygienists, toxicologists, and public inspectors to know or predict what chemicals are used where and in what manner and quantity. Government regulation is, thus, very difficult to effectively create or enforce.

Fourth, workers in the industry, those most predisposed to show strong concern over chemical hazards, are seldom organized in unions and, thus, have little capacity to protest or defend themselves without risking their employment. Unionization among the high-tech work force is decidedly low. Of the roughly 1.8 million workers in high-tech firms, no more than 5 to 8% are organized. The American Electronics Association counts no more than 90 contracts among its 1900 member firms.[19] Without contract protections workers are cautious about protesting working conditions. The Occupational Safety and Health Act, and various state regulations set standards for exposure and provide inspections, but enforcement is often predicated upon workers knowing enough to raise questions and taking the initiative in calling for inspections.

Workers in microelectronics plants who work the assembly lines and lab benches or who work in maintenance and services are often the least knowledgeable about toxic chemicals and are the least likely to protest. All of these conditions are typically worse where microelectronics firms have established production operations in Third World countries where regulations are more lax, workers are less educated and unions are discouraged, sometimes brutally.

What are the Hazards?

Much of microelectronics production involves chemical interactions, chemical cleaning and various light and radiation exposure. Most work is completed on an assembly line and at a very fine scale of detail and precision. Hazards range from acute and chronic exposures to toxic chemicals to radiation and electric shock and to stress and fatigue. In general, hazards can be categorized as resulting from exposure to solvents, alkalis, and metals, exposure to gases and vapors, and exposure to radiation and workplace stress.[20] The table on health hazards in this article displays the range of exposures that are presented by various production processes.

Solvents, alkalis and metals. These are the basic materials of many production operations including electroplating, etching, stripping, soldering and degreasing. Substances range from common trichloroethane and methyl alcohol to lead, arsenic, cadmium, sulfuric acid and nitric acid. Many of these substances can irritate or burn the skin where exposed, but their more serious effects are derived from either inhaling or ingesting small quantities on one's fingers or lips. Once in the lungs or stomach, these substances can cause breathing difficulties, cramps and headaches. Prolonged inhalation or ingestion can lead to various kinds of blood or organ damage, cancer and reproductive difficulties. In 1979, an acid vat explosion at Fairchild Instrument in San Jose hospitalized three workers and sent fourteen home sick.[21].

Gases and vapors. Gases are used in doping, cleaning, decomposing or inhibiting oxidation. Vapors arise from uncontaminated solvents. Most can cause eye, skin and nose irritation. Prolonged exposure to gases like phosphine, arsine or phosgene can lead to respiratory damage and blood disorders. High-dose exposures can be immediately lethal. The build-up of gases in tight work rooms can lead to combustion and explosions. In June 1982, 61 employees at a Massachusetts Analogic plant were hospitalized for overexposure to methylene chloride from leaking storage tanks. Later testing proved that the chlorinated solvent had been mixed with 1,1,1-trichloroethane, a suspected carcinogen.[22]

Radiation. Both ionizing and non-ionizing radiation are found in the microelectronics industry. X-rays are often used in quality control, microwave radiation is used in etching and lasers are used in masking and cutting. Standards have not been established for radiation, but eye and organ damage can result from direct exposure and burns and skin irritation can result from prolonged indirect exposure.

Stress. Stress results from detailed, repetitive, monotonous work done under time pressures. Stress is increased by shiftwork, overtime and speedups. Microelectronics production and assembly conditions often involve such conditions. Stress can result in fatigue, irritability, muscle aches and over long time periods can lead to ulcers, high blood pressure, diabetes, heart attacks and strokes.

A good example of a high-tech health hazard is the arsine gas used in gallium arsenide chip production.[22] It was this overexposure that led to Jay Zemotel's death at M/A-Com. Gallium arsenide is increasingly being substituted for silicon oxide as a base for chips because of its more rapid conductivity.[24] It is purported to be advanced by the Defense Department because it will better withstand nuclear radiation.[25] Arsine gas is used as a dopant in gallium arsenide chip production. Inhaled arsine is rapidly dissolved in body fluids and degraded to trivalent arsenic, which is a well-established carcinogen. Recent studies of the current Occupational Safety and Health Administration (OSHA) standard for arsine — 200 milligrams of arsine per cubic meter of air — report it may be too high to prevent chronic toxicity.[26]

M/A-Com's Burlington facility is one of five semiconductor manufacturing firms in the Boston area using gallium arsenide. In March of 1984, Robena Ried, a lab technician, began to raise criticism about the mishandling of chemicals in the lab. At first management was resistant, but after she complained to the state Division of Occupational Hygiene for an investigation, the company's insurance agent conducted its own investigation.[27] The result of these investigations led to the closing of one laboratory found to have an excessive level of airborne arsenic.[28]

Another outcome of these investigations was the discovery of an elevated level of arsenic in the urine of several lab workers, including Jay Zemotel. Zemotel, whose urine analysis was reported to be three times the "occupational threshold," was removed from the lab until April, when his arsenic levels had returned to normal.[29] Working on a late night shift on June 10, 1984, Zemotel apparently entered a closed lab and, alone in the lab, opened a locked cabinet and was exposed to arsine gas stored there in a tank. Twelve days later he died.

Who Can Protect Workers?

The hazardous conditions of microelectronics production continue as a result of the particular work relations of the industry. The absence of union organization means that workers must consider and negotiate their safety as individuals. The individual worker-manager relations mean

A SERPENT IN THE HIGH-TECH GARDEN OF EDEN

by Michael Eisenscher

Little remains of the orchards which gave Santa Clara County the reputation as the "Valley of Heart's Delight." Outside of some older natives who recall the more tranquil years when agriculture was Santa Clara County's dominant industry, most of the county's 1.4 million residents know it only as the "Silicon Valley," undisputed Chip Capitol of the world.

Today one of every four wage earners in Santa Clara County takes home a paycheck from an electronics industry job. 70% of all manufacturing work in the county is in the electronics industry. More than 1400 high tech firms, the greatest concentration of electronics companies in the nation, now call the area home. More than 200,000 workers are employed in every facet of high tech work, from computers to medical equipment to consumer goods.

A tarnish on the industry's reputation first appeared in the wake of the revelations that underground chemical storage tanks installed over the last two decades have leaked thousands of gallons of toxics into the Valley's ground water. Contamination was discovered in 1981 when an underground chemical waste storage facility at Fairchild Camera & Instrument Company in South San Jose was found to have leaked 58,000 gallons of 1,1,1-trichloroethane (TCA) over a period of about 18 months. Tests revealed that levels of TCA were 30 times the levels considered by the State to be a health risk.

TCA is a suspected carcinogen and reproductive hazard. But pressure by the solvents manufacturing industry resulted in an earlier, more restrictive standard being relaxed to 200 parts per billion (ppb). Tests at the Great Oaks Well #13, which serves 700 people in the area, revealed 5,800 ppb and the well was removed from service. Later tests showed the levels of TCA had risen to 8,800 ppb.

Contamination of Epidemic Proportions

News of the Fairchild leak sent a shockwave through the Valley. Industry interests and government agencies, spurred by growing public outrage and fear, launched a survey of other area underground storage sites. By the end of the winter of 1981-82, 21 other leak and spill sites had been discovered. By September 1984, another 71 sites were identified as contaminated either by leaking underground tanks or accidental spills or purposeful discharges onto the ground which had seeped into the ground water. More sites have since been discovered.

Tests performed at both public and private water wells revealed many to be contaminated. Toxic leaks at the giant IBM facility in South San Jose (traced back to 1979) have, to date, contaminated 24 wells, five of which have been completely shut down.

The toxic plume from the IBM site has now migrated more than five miles in the underground aquifier which serves a huge portion of San Jose. Unchecked, it will ultimately migrate to the Bay.

At its heart, semiconductor manufacturing involves a series of complex chemical processes utilizing a host of highly toxic caustics, solvents, acids and gases. A large chip manufacturing facility might have as many as 3,500 such chemicals and gases stored in underground, above-ground, and in-plant containers. It is a *chemical intensive* industry.

The sheer quantity of hazardous chemicals and gases used annually by the industry gives some clue to the potential for environmental and occupational disaster. A 1980 California Industrial Relations Department survey of 42 Silicon Valley semiconductor companies revealed that they used:

- more than one-half million gallons of solvents;
- more than two million gallons of acid;
- more than one-half million gallons of caustics;
- more than one and one-half million cubic feet of cylinder gases, including highly toxic arsine, phosphine, and diborane.

Three Times the Cases of Occupational Illness

A 1980 survey by the California Dept. of Industrial Relations found that the electronics industry had a rate of occupational illness that was *three times* the rate of all manufacturing in the State; 18.6% of all cases that resulted in lost time from work were caused by occupational illness. 46.9% of all occupational illness cases that management's only obligation in designing work settings is meeting government standards, which are frequently vague, absent or unenforced. Thus, all that really protects workers from toxic exposure is the good will of management.

The U.S.-based electronics industry employs two quite distinct classes of workers. One group includes highly skilled engineers, scientists and managers who are most often well-paid white men with advanced education. While these elite employees are not absent from hazardous work settings, they do have significant flexibility and job mobility and, often, enough training to be aware of hazardous conditions. In the Massachusetts high-tech industry, this group makes up about 40% of the work force.[30]

The other 60% in Massachusetts make up the second worker group. This group includes production, maintenance, service workers, and clerks. These workers are more likely to be women or young men, often non-white, sometimes non-English speaking, and typically with limited education. Almost 30% of the craft workers in Massachusetts are of minority background, and over 70% of the operatives are women.[31] It is workers in this second class who are exposed to hazardous work settings and who have the least access to information and the least capacity to protest chemical exposure. Without unions, worker protection must depend on governmental regulations and enforcement. OSHA is the primary federal agency setting standards on workplace exposure to toxic chemicals. In the decade following the creation of OSHA, the agency promulgated hundreds of regulations and set as many standards for exposure. But an aggressive OSHA was considered by much of industry to be a restraint on business development, and few agencies were more directly targeted for destruction by the incoming Republican administration in 1980. Between 1980 and 1982 OSHA inspections dropped by 17 percent.[32]

The gutting of OSHA at the federal level

among semiconductor employees involved systemic poisoning from exposure to toxic materials . . . twice the rate among workers in other manufacturing industries.

The rates of occupational illness and systemic poisoning cited above are even more alarming in light of the fact that there are many in the industry who do not come into contact with these chemicals (about 45% of all semiconductor corporation employees are engineers, managers, administrators, sales, and clerical employees, and thus these illness rates disproportionally affect the remaining workers).

In the wake of the hazardous chemical leaks in South San Jose, a significant cluster of congenital cardiac birth defects appeared in the area. After pressure mounted from angered and frightened community residents, a study of birth defects was commissioned in South San Jose.

The study, released in mid-January of this year, reveals that miscarriages and birth defects occur at 2-3 times the normal rate in the neighborhood surrounding the Fairchild chemical leak site. This is the neighborhood served by the now closed Great Oaks water well, contaminated by 1,1,1-TCA.

Model Toxic Storage Ordinance

Leaders of local fire departments and firefighters' unions demanded access to heretofore restricted data on just which chemicals and gases were stored at local manufacturing facilities. They argued, justifiably, that in an emergency, they would have no way to protect themselves or properly respond if they did not know what hazards they might encounter.

The Silicon Valley Toxics Coalition was organized to bring to bear public pressure on local government and industry for a program of demand which supported the firefighters and went further to call for double containment of all underground storage tanks, installation of mandatory monitoring systems on underground containers, hazardous material inventory maintenance, and community right-to-know.

SVIT rallied labor unions, community groups, and environmental organizations and ultimately succeeded in forcing the adoption of the nation's first Model Hazardous Materials Management Ordinance, which was enacted by 11 municipalities in Santa Clara County.

Santa Clara's Toxic Storage Ordinance served as a basis for development of federal legislation which ultimately was enacted by Congress and signed by President Reagan as the Resource Conservation & Recovery Act.

The Coalition organized community response to the news of widespread contamination of the ground water, forcing the Environmental Protection Agency to conduct community town hall meetings to hear from the public. Under intense pressure, EPA listed 19 of the Silicon Valley sites on its Superfund list, giving Santa Clara County the dubious distinction of having the most Superfund sites of any county in the nation.

The Santa Clara Center for Occupational Safety and Health (SCCOSH) was an early pioneer in developing and disseminating information to electronics industry employees about occupational safety and health hazards in the industry. SCCOSH operated a successful hot-line which fielded hundreds of calls from electronics workers who sought information about toxics with which they worked. SCCOSH also helped organize Disabled Workers United, which, like its predecessors in textile and coal, has begun organizing the victims of chemical and other disabilities in the electronics industry.

Industry Keeps Its Track Record a Secret

While public awareness in the Valley is mounting, the industry continues to promote itself across the nation in one community after another, in state after state, as the "hope for tomorrow." Local governments are asked for variances, abatements, waivers, subsidies or other concessions. Communities are encouraged to compete with one another in elaborate schemes to obtain the lowest cost site for industry expansion.

Most job-hungry communities are unaware of the lessons learned in the Silicon Valley, and are unprepared to cope with the host of problems which hide behind the squeaky clean high-tech facade. The industry, which brags of its civic responsibility in developing new guidelines in the Silicon Valley, does not go out of its way to volunteer information to new communities it has targeted for expansion and certainly does not propose adoption of Silicon Valley-style regulations and ordinances developed in the wake of its poor track record here.

The lessons of Bhopal and Love Canal are the same and should tell us that Silicon Valley is a toxic disaster waiting to happen.

has turned occupational health activists' attention to the state level. One result of this has been a renewed effort to pass "right to know" laws in state legislatures. Right to know laws are intended to provide workers with health hazard information about toxic chemicals they may be exposed to. While various state laws differ, most require that containers of toxic chemicals be effectively labeled and that workers' requests for health hazard information be adequately met with manufacturers' data sheets and various kinds of education and training.

The struggle for passage of state right to know laws has been heavily resisted by industrial lobbyists. Among the most ardent opponents has been the high-tech industry. The Semiconductor Industry Association forcefully opposed the passage of local right to know ordinances in California, and in Massachusetts the Massachusetts High Tech Council was an active lobbyist against passage of a statewide right to know law.

High-tech executives pride themselves on good worker-management relations. It is not uncommon to hear of company picnics, stock options, flex time and tuition reimbursement. Work relations occasionally include "quality circles" and other forms of employee participation. There is a kind of paternalistic attitude to many of these programs, particularly in the face of a strong anti-union management attitude.[33]

In general, high-tech management has taken a defensive and critical posture toward health and environmental critics. Health and safety is considered a company-by-company responsibility although the Massachusetts High Tech Council, the industry lobby, is quick to point out that many high-tech firms have won national awards for setting standards.[34] The Council as well as various business executives such as James Bothwell at M/A-Com have argued that critics are only interested in using the health hazard issue to organize unions in the industry.[35] The callousness underlying management attitudes was expressed rather bluntly to Robena Ried at M/A-Com who reported that the company responded to her complaints by stating, "No one has been killed yet. Why bother with precautionary measures if no people are dying?"[36]

Are Communities at Risk as Well?

Hazard exposure at high-tech plants not only affects employed workers, but also can affect local residents. The classic case occurs where OSHA inspectors recommend that high levels of chemical contaminants in laboratory air be remedied by installing stronger ventilation systems. Such ventilation, of course, only transfers airborne toxins from the workplace to the local community.

The Silicon Valley groundwater contamination provides further evidence of problems for the local community. Fairchild Instrument first discovered leaks in underground solvent waste tanks in December of 1981. Company tests at the site soon revealed that 1,1,1-trichloroethane had seeped into a public drinking water well some 2000 feet away. While the well company immediately closed the well, neither the company, state officials, nor Fairchild notified the 16,900 households that were serviced by the well. It was not until late January that the *San Jose Mercury* acting on an anonymous tip broke the story to the local community.[37] It was this story that led June Ross and her neighbors to a dismaying explanation for the perceived high incidence of miscarriages in their neighborhood. Within a year the problem of groundwater contamination by high-tech firms had been revealed in a report by the Regional Water Quality Board to be common throughout the Silicon Valley.

Revelations about other cases of leaking storage tanks under high-tech property soon led Ross, her neighbors and a group of health and legal activists to form the Silicon Valley Toxics Coalition. By the summer of 1984, the Coalition had identified over 70 cases of leaking underground storage tanks and in June public health officials closed some 125 private drinking water wells found to be contaminated by various computer chip degreasing agents. In October, the EPA added 20 new sites in Silicon Valley to the Superfund national priority program. Of these, 18 were high-tech firms.[39]

ROADS TO HIGH-TECH ORGANIZING

Health and safety protections are best guaranteed by the collective vigilance of workers organized into unions. Yet, the high-tech industry has on the whole been resistant to union organizers. What limited success unions have achieved in organizing high-tech workplaces has been confined to older aerospace and communication companies. Between 1977 and 1982, unions won only seven out of 44 organizing campaigns in high-tech firms. These statistics reflect an overall decline in all private sector organizing where the number of representation elections has declined by 70% since 1977. Yet, there are factors here specific to high tech as well.

In the high-tech industry, the primary obstacle to traditional organizing has been the two-faced response of management. On one side is a benign and paternalistic attitude that may offer profit sharing, flextime, job posting and on-site recreational facilities. Management may also look kindly towards quasi-union forms of organization like personnel representatives and limited grievance procedures, or management participation schemes like "quality of work life circles." On the other side, however, is a sharp and vindictive attitude where employees found actively confronting management or encouraging unionization are subject to harrassment or quick termination. These practices have a particularly "chilling" effect on workers' willingness to organize, especially in light of the diminishing protections provided for workers by the National Labor Relations Board (NLRB). A recent Government Accounting Office report found that in 1982 one out of every twenty workers who participated in an NLRB representation election was fired for advocating unionization.

If high-tech workers are going to effectively organize and act more collectively in advancing their interests, less traditional approaches to organizing will need to be pursued. One promising approach is industry-wide worker associations. Others include the extension of existing union organizations to include interested high-tech employees as associate members and the development of worker-community councils in local high-tech regions.

Industry-wide worker associations are already emerging. In Boston, a group of high-tech employees organized the High Tech Workers Network in 1982, and since then have been presenting forums, producing a newsletter and distributing educational flyers to co-workers in a variety of high-tech firms. In both California and Massachusetts, high-tech employees have formed professional associations for peace and disarmament. High Tech Professionals for Peace now lists organizing contact

The environmental contamination of Silicon Valley may be an early warning for other high-tech centers. Recent cases of groundwater contamination have occurred in Virginia and Massachusetts. In Manassas, Virginia, the site of the Manassas IBM plant was placed on the Superfund priority site list in September 1984. This story began in 1970 when engineers at IBM discovered tetrachloroethylene, a suspected carcinogen, seeping into groundwater under the Manassas plant from underground storage tanks. Monitoring wells drilled around the site have shown movement of the contamination toward the boundary of the site and toward a major aquifer nearby.[39]

In May 1979, elevated levels of trichloroethylene forced the closing of two municipal wells in Burlington, Massachusetts. A study completed by a local consulting firm identified the source of the contaminant to be leakage from corroded sewer lines in a nearby industrial park containing over thirty high-tech firms. Once in 1972 and again in 1982, the town of Burlington was forced to replace asbestos sewer lines destroyed by chemical discharges from high-tech firms in the industrial park. Four firms including M/A-Com agreed to pay damages for the sewer replacement, yet to date no costs have been recovered for the polluting of the well field and several of the wells continue to provide occasional drinking water to the municipal system.[40]

In a recent report in Massachusetts, *High Tech Toxics: Communities at Risk*, evidence was gathered showing that high-tech firms produce about 20% of the hazardous waste in the state, some of which has shown up in the state's worst dump sites. The report also documented a wide range of violations of air and water discharge permits by high-tech firms.[41]

people in eighteen cities across the country. Associate membership of high-tech workers in traditional unions on an individual basis may provide these workers with additional benefits in the absence of collective bargaining agreements or formal recognition from an employer. Associate Membership could provide individual access to group insurance benefits, union health and legal services, discount programs for consumer goods, and special job information and training. A program like this could build union credibility and help establish a nucleus of activists who could form the basis for future organizing committees.

The close collaboration of the Silicon Valley Toxics Coalition and the Santa Clara County Central Labor Council on environmental contamination suggests the opportunity for other types of community-labor alliances that would benefit high-tech workers. Because of the tight concentration of high-tech firms in relatively few communities, direct parallels exist between worker and resident welfare. Local neighborhood organizations in high-tech communities might include and work with high-tech employees. For example, an effort to inventory toxic chemicals by applying "right-to-know" laws might also advance worker interests in improving job protections and workplace conditions. A recent collaboration between High Tech Professionals for Peace and the Bay State Center for Economic Conversion in Massachusetts have brought peace groups and high-tech workers together to focus on military contracts and the war products of high-tech firms.

Perhaps the most dramatic vision of future organizing models is unfolding in the biggest nonunion high-tech firm of them all: IBM. Several years ago, an "underground" network, IBM Workers United, emerged in IBM. The organization quietly circulated newsletters with some success, but was unable to develop any substantial or open membership base. While here in the U.S., IBM is "union free," European and Japanese workers have organized in six of IBM's facilities. Following an international meeting of 300 IBM unionists last May in Japan, American representatives of IBM Workers United returned to their plants to come "above ground" here in the U.S. Since then, IBM Workers United has been growing rapidly as an unsponsored employees' association with members in several of the domestic plants. Ironically, as high-tech firms increasingly move production facilities "off shore" for cheaper labor or to avoid union organizing efforts, they may be running into unions more than running away from them.

Ken Geiser, Professor, Tufts University
Rand Wilson, Organizer, Communications Workers of America

What Can Be Done?

With increasing evidence mounting on both coasts that implicates the microelectronics industry as a significant source of environmental and health risk, the clean image cannot long endure. The crumbling of this dangerous myth is the first step to a broader set of strategies to protect workers and community residents from the hazards of microelectronics production. Once it is clear that this industry is not unlike other more mature industries, and once workers, community residents, health professionals, managers and policy makers realize that the benefits of high-tech employment must be balanced with precautions about health and environmental risk, then there are several avenues for effective action.

• There is a significant need for more research. As stated above, there is a near absence of credible occupational health and epidemiological studies of the microelectronics industry. While health activists warn of serious exposures and consequences and the industry responds with denials and victim blaming, there is no solid research of any real standing. The 1981 California study is a beginning, but more comprehensive research that focuses on priority chemicals and traces health histories of previously exposed workers would begin to build a more effective data base for setting public policy and alerting health professionals.

• Education and training are critical to alerting workers, health professionals and management to the possible consequences of chemical exposure. Unions need to develop effective educational packages. Community colleges and vocational schools need to develop strong occupational health programs. Public development programs, like Massachusetts' new Microelectronics Center, must parallel skill training with health training. Management-sponsored training should be encouraged as well, but only where management no longer seeks to gloss over the risks of chemical exposure.

• Workers organized into unions still provide one of the best mechanisms for guaranteeing a safe and healthful work environment. Firms organized by national unions such as the Communication Workers of America at Western Electric, and the International Brotherhood of Electrical Workers at Raytheon provide some of the best health and safety records. Union organizing will not be easy in an industry so hostile to collective bargaining. Still there are important efforts at pre-union formations emerging in the industry, such as the Massachusetts High Tech Workers Network, that should be encouraged and supported.

• Right to know legislation provides unorganized workers with the best opportunity for learning about health hazards. Right to know laws need to be enacted in all states. Since 1980 it has been common to include right to know provisions for local community people as well as workers. Not only does this form a powerful alliance for legislative campaigns, but it also links people working inside plants with people in local neighborhoods. This is important so that management innovations that reduce exposures for one group do not raise risks for the other.

• The most effective long-term solution to toxic chemical exposure is to reduce the use of toxic chemicals in production. The first step in any such effort is to inventory all chemicals used in individual plants. The next step is to reduce human exposure by improving management and disposal practices, by automating certain production operations, and by improving containment and shielding devices. The longer-term strategy must be the gradual phasing out of various toxic substances and substituting less toxic and more environmentally compatible ones. Particularly in industries like microelectronics, such significant process changes are practical, because, as noted, the development of the industry itself is requiring frequent process innovations now. The market will not naturally dictate that those changes be health- and environment-regarding. That is a role that must be played by organizations of workers and local community groups.

Jay Zemotel, June Ross, Robena Ried, and many others, who today would be considered health victims of the microelectronics industry, provide early indications of the kind of tragic toll that may emerge, if the high-tech industries are not more carefully studied, monitored, and reengineered. High-tech industries can set the standard for the kind of workplaces we all would like, but the industry and the government cannot be left to do it alone. People, organized and conscious of their rights, must be a constant catalyst for change. The talent, expertise and resources to implement such changes do exist in the microelectronics firms. It is time these corporations lived up to the promise of their yet-to-be-proven clean image. ☆

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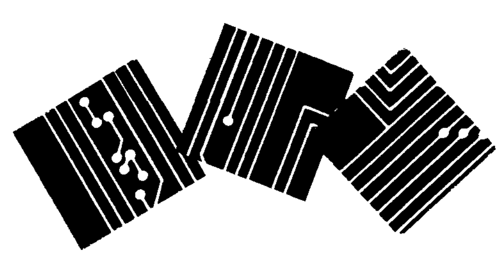
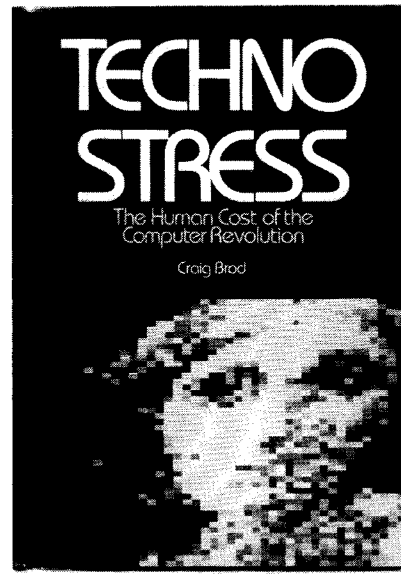


Technostress: The Human Cost of the Computer Revolution
by Craig Brod, Addison-Wesley, Reading, MA 1984.

by Gary Keenan



The social and psychological impact of the explosive growth of computer occupations is the subject of *Technostress: The Human Cost of the Computer Revolution*, by California psychotherapist Craig Brod. A welcome contrast to the rose-tinted VDTs found in many popular computer books, Brod uses anecdotes drawn from his consultations with patients, as well as his own experience as an industrial psychologist, to illustrate the problems of people facing the introduction of computers into everyday life.

As more workplaces adopt computer technology, the speed and precision of the microprocessors become guiding factors in the organization of work. Brod finds managers' attitudes toward the workers similar to those of a foreman toward blue collar crews: denying the psychological and social aspects of the labor process. This is the prime source of the syndrome he has dubbed "technostress," the individual's inability to cope with computer technology in a reasonable way.

Brod defines two types of manifestations of this syndrome: "technoanxiety" and "technocenteredness." The technoanxious person resists adoption of the technology. His or her symptoms may include chronic backache, eyestrain, refusal to learn requisite skills, sleep loss, persecution fantasies featuring computers, or any strategy which allows avoidance of computer work.

> Janice is a nurse in an intensive care unit. Recently, her hospital bought a computer system and now many of her record-keeping tasks have been computerized. For her, learning . . . the system was a difficult and slow process . . . she has mixed feelings about the new technology . . . She is plagued by nightmares in which she watches herself being swallowed up by a machine.[1]

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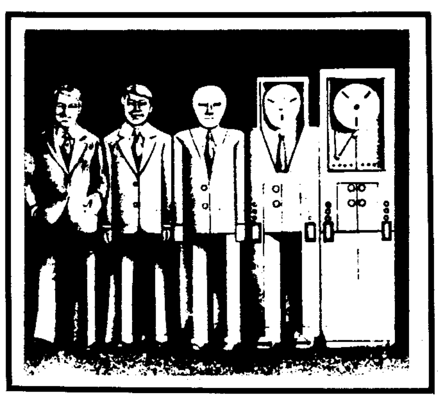
Such technoanxiety, Brod notes, most often appears in people who feel forced to use or accept computers by "employers, peers or the general culture."[2]

At the other extreme are those who whole-heartedly embrace computers — the technocentered type whose personality and interactions began to resemble computers themselves. This type suffers from overidentification with the technology and related activity. He or she will organize life patterns along the criteria of a computer program, valuing clarity, efficiency and quantification. Students or



"professional" workers are often victims of this repressive syndrome. Brod's list of symptoms includes "a high degree of factual thinking, poor access to feelings, an insistence on speed . . . lack of empathy . . . and a low tolerance for the ambiguities of human behavior."[3] The technocentered person loses touch with the rhythms and texture of human relations.

Brod examines the manifestations of technostress at work, at home and in schools. His chapter on the current generation of "whiz kids" is particularly good at debunking the popular image of children who get a computer for Christmas and quickly master several languages, sell a few programs, tap into Citibank's mainframe and become stars of movies like "War Games." Brod's young clients offer a chilling look at tomorrow's technocrats in their formative years.

> You know, a computer is more like real life . . . something that's actually happening. In a way books are real life because you're thinking about them while you're reading, but in a computer you're actually doing it instead of reading about something that's happening; you're there in a computer . . .[4]

Brod blames this tragic loss of fantasy on parents who foist career-oriented "hobbies" on their children, and an education system too eager to adopt an industrial model for the classroom. In such a childhood, fantasy and imagination are repressed as inefficient, ambiguous activities. Unfortunately, Brod doesn't ask why this assault on childhood is taking place, or who might benefit if a whole generation of middle and upper class youth are trained to obediently sit at terminals hours at a time tapping in "commands." In such a scenario, people become oriented to the technical fix. Life becomes a quest to acquire and apply technology, and the corporatizing of human culture reaches its most intimate level, the psyches of our children.

But while Brod is quite effective at portraying some of the "human costs" of computerization, his suggestions for alleviation of the problems are limited and at times naive. He bemoans management's short-sighted applications of technology, but his view of the workplace is perhaps the most frustrating aspect of *Technostress*. Most of his solutions are directed toward management. Attempting to encourage a more enlightened attitude. He writes of the conflict of psychologist vs. technician, the former being the agent of "more humanistic strategies within the corporate structure." It is questionable whether lasting, progressive change in working conditions can take place without input from those who perform the work. Brod doesn't show how a high-tech therapist can represent the long-term interests of anyone save whoever pays the consulting fee.

Brod does make a strong case against the practice of monitoring computer workers, an issue many unions are taking to the bargaining table. He details the harm to productivity such intrusion causes. He is quick to point out that productivity isn't everything, recommending extra break time and maximum, rather than minimum work quotas for information workers. But organized labor's role is a minor one in Brod's outline of reforms. In his entire book, only one page (p. 190) mentions that employers sometimes "need prodding" and that the clerical union 9 to 5 calls for an anti-routinization clause in contracts. Little is said about the de-skilling aspect of computer-automated work (less than 25% of high tech positions require detailed knowledge of the technology used).[5]

Brod wants to see retraining programs for those who lose their jobs in the transition from a manufacturing to an information economy. If one accepts that the transition is desirable in the first place, this makes some sense. There are some dissenting voices, such as MIT's Bennet Harrison, who has shown that New England high tech companies employ only 3 percent of the region's displaced mill workers. Massachusetts wage rates have not recovered, the state is heavily dependent on defense contracts, and Boston has become "one of the lowest-paying regions for computer-related workers."[6] Retraining for poorer paying jobs is not a remedy for such a complex issue.

The book's naive, incomplete portrayal of labor-management conflict, particularly in the Reagan era, undermines the credibility of Brod's proposals, many of which have some merit. His vision of a human-centered workplace, where those who use technologies have a say in planning its development, is appealing. But when executives of major corporations are anticipating the day when blue and white collar labor will be contracted out, unfettered by pensions or benefits, by a corporate structure relieved of middle management by computers,[7] one has to wonder how open such executives will be to sharing their right to manage.

Perhaps the most valuable insight in *Technostress*, one not fully developed but underlying most of the book, is that the consequences of computerization include emotional side-effects. This suggests a new area for study and struggle, alongside traditional concerns about wages, job security and physical health and safety. In the largely unorganized hightech industries, and for office workers in the service sector, traditional organizing campaigns have not done well. If there is one over-reaching reason to recommend *Technostress*, it is for the role it could play in helping those workers identify common hazards and mutual interests.

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The Rise of the Computer State

by David Burnham, Vintage Books, New York, 1984.

by Joseph Regna

How do the powerful, the ruling class, maintain their hegemony over society? Although his goal is not to answer this question, David Burnham, in his gripping account *The Rise of the Computer State*, does provide insight into one avenue of that control: computers and the vast, growing network of telecommunications systems that are enmeshing society in a web of information, surveillance, and centralization of power.

Certainly one of the greatest concerns of people in the age of computers is the destruction of personal privacy, but this is not, to Burnham, the central issue that computers raise. Rather, his focus is that computers are greatly accelerating the centralization of power of the major institutions of society. Although Burnham—the same reporter Karen Silkwood was to meet with on the night of her death—does not provide as critical an analysis as many might like to see, he does elucidate in clear language not only the ways in which computers are enhancing the concentration of power in the dominant institutions, but also how the ideological basis for the acceptance of computers allows the hastening of that concentration.

The problem begins with the fact that huge files of data, with minute details of people's lives, exist in easily manipulable and retrievable form. Who collects and uses these vast repositories of information? Among government agencies, the IRS, Social Security Administration, CIA, FBI and the National Security Agency hold some of the largest collections of computer files into which personal information has migrated. In the corporate sector, data banks exist in such hands as credit reporting companies, banks, insurance companies, hospitals, and universities. The powerful assure us not to fear, but even the appearance of mistakes in these files can have drastic effects on people's lives.

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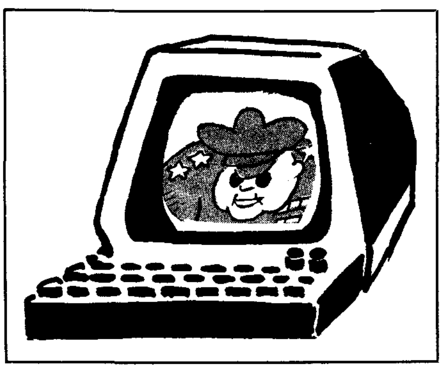
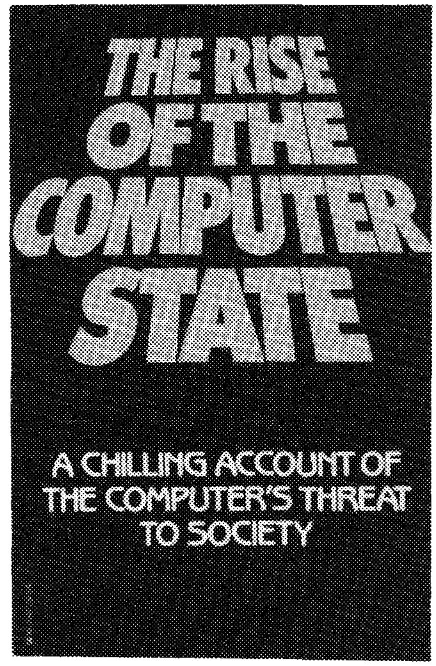
Yet it is not the mistakes, with the people being denied credit, an apartment, a job, or their freedom, but the intentional use of computers by the controllers of society and their agents that has had, and will continue to have, the greatest potential for manipulation, control, and repression. A benign-sounding, computer-powered technique called Geodemographics profiles all the U.S. census tracts by social class and enables political pollsters and market researchers to come to know the attitudes and preferences of, and to eventually manipulate the entire U.S. population based on a small, but statistically significant, number of polled telephone calls. Certain "susceptible" constituencies can thus be selectively and aggressively targeted for the latest hair shampoo, corporation public relations pitch, or senatorial candidate.



On the government side, Army spying in the 1960s led to the creation of files loaded with political and personal information on tens of thousands of individuals who were politically active; blacklisting was often the result. One of its victims, then Congressperson, now Judge Abner Mikva, has stated:

> The harm comes . . . when the ordinary citizen feels he cannot engage in political activity without becoming a "person of interest," without having his name and photograph placed in a file colloquially, if not officially, labeled "subversive."



Not only have the FBI and CIA been involved in the collection and computerization of such personal information, but the IRS has been too. The IRS has monitored politically active people through both the creation of new files and its own computer tax records. Its Taxpayer Compliance Measurement Program uses computers to track taxpayers and to focus punitive actions where they will have the greatest yield. The IRS also runs what is called the Audit Information Management System (AIMS), which is in effect a computerized boss monitoring IRS employees in order to make sure they stick to their "quotas." A new computer will give the U.S. attorney general a similar capability, previously unknown in American history: to instantaneously scrutinize the behavior of the U.S.'s various district attorneys to ensure that central policy is being followed.

Insurance companies collect information such as whether a person sees a psychiatrist, what drugs she or he is taking, whether there is a drinking problem; schools hold the financial records of students and their parents; and corporations collect a staggering variety of information. The sheer ability to locate, analyze, and communicate all this data, almost at the speed of light and even around the world, is the most important corollary to the axiom that information is power.

But the problem goes deeper. Not only do computers collect what Burnham calls "transactional information"—phone calls, financial transactions, car rentals, but, in addition, a vast web of electronic highways allows these data bases to communicate with one another. This latter reality enables data collected for one purpose to be used for another, commonly called "computer matching." For example, HEW tapped IRS data banks to intercept the tax refunds of "runaway fathers" in order to decrease the amount of money it had to pay in child support. AT&T used its own transactional records on phone calls to monitor and spy on companies who had switched to its competitor MCI.

In addition, Ma Bell performs secret surveys of telephone usage in geographical areas for marketing purposes, information which can also develop so-called signatures of classes of people. These signatures are of obvious interest to an agency such as the FBI which not only has "interacted" with AT&T's phone lines on numerous occasions, but also has its eyes on the creation of a master "crime file," the Interstate Identification Index (III) which would enable police information on an individual from anywhere in the country to be available anywhere else.

The collection and storage of transactional information is particularly troublesome, especially because of the obvious interest in it by the police, the FBI, CIA, and other organs of the state. (For an in-depth discussion of some of these issues, see *SftP*, March/April 1983.) AT&T, for instance, can profile a person just by how she or he uses the telephone: the number, time of day, length of call, location, patterns over time, friends, associates, political activities. Rent-a-car records, banking files, and airline and lodging reservations can similarly serve to track down a "person of interest." Further, what are the implications of the fact that one of the customers of TRW, the huge multinational company with transactional credit information on tens of millions of people, is the CIA?

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One of Burnham's most intriguing chapters is on the super-secretive National Security Agency (NSA), an organization he labels "the ultimate computer bureaucracy." In operation since the issuance of a secret presidential directive in the early 1950s, and with virtually no operating restrictions from anyone, the NSA not only operates the "largest and most advanced computers now available to any bureaucracy on earth," but also provided the "single largest source of federal research dollars spent in the development of advanced computers." With its immense array of computers, earthbound listening posts, and satellites—and with its ostensible purpose being intelligence protection and collection, the NSA can monitor any electronic communication, spoken, written, or otherwise.

With this as its potential, the NSA can turn against virtually anyone. It is the agency that allowed the FBI to tap phone to monitor political activists during the civil rights and antiwar activities of the 1960s. It is the agency that, from 1945 to 1975, undertook, with the cooperation of RCA, ITT, and Western Union, a totally illegal surveillance program of international telegrams and developed files on 700,000 Americans, some of which found their way into the CIA's Operation Chaos files, which themselves "profiled" some 300,000 Americans active in the antiwar movement. In addition to these activities, the NSA plans private communications networks, such as cable television, to suit its needs: suppresses patents and controls research conerning cryptographic devices that could keep electronic information secret from it; and exercises censorship on articles relating to such research.

Again, most and perhaps all of these activities—whether undertaken by the NSA, the FBI, AT&T, Mobil Oil, or the IRS—might have been accomplished with manual effort. After all, Japanese Americans living in the western U.S. during WWII were rounded up only with the aid of a crude computer-like machine that handled punched cards. But the point is that the existence of the computer and its availability to such wealthy organizations makes everything that much easier. The question must then be asked: what are the implications for a limited notion of freedom in light of the existence of such computer-powerful forces, which were repressive even before the advent of the computer? Further, all of these activities are being enhanced by the growth of laws, Supreme Court decisions, and executive orders—particularly those of the Reagan administration—which facilitate the collection, use, and control of information by the powerful. Recent regulations have facilitated classifying information as secret indefinitely, protecting the identities of intelligence agents, lifting restraints on the FBI, allowing the CIA to conduct covert operations within the U.S. borders, preventing government officials from speaking out, and granting more power to the NSA.


Ellen Shub

Burnham sees the problems that have already occurred and that will undoubtedly occur, compounded immensely by new systems presently being implemented or just coming into existence. The Federal Reserve Board is creating a massive, central Electronic Funds Transfer (EFT) system that may make cash obsolete. Such a network would greatly extend what today's automatic teller machines (ATM) do by making more information available about what people do—instantaneously: not just bank transactions, but buying habits, political activities, physical movements, and other aspects of human life. Two-way interactive television, like the Qube system in Columbus, Ohio, can allow for monitoring of messages, electronic mail, books bought and borrowed, programs watched, travel arrangements, financial transactions and purchases, and personal movements. Even if this use of computers could conceal personal identity, collective behavior, such as that obtained with Geodemographics, could be monitored. Burnham correctly points out that this system is a prime example, because of the expense, of computers widening the information gap, between information haves and information have-nots. Further, speech recognition can "lead to more wiretapping and bugging by reducing the economic barriers to eavesdropping," and artificial intelligence (AI) could result in that ultimate lever of control sought by the powerful.

AI provides the epitome of what Burnham sees happening to the way we think as a result of the massive computerization of life. Burnham's concepts of what produced the ideological justification for the current situation borrow heavily from those of Jacques Ellul. Ellul proposed that people have forgotten—or have been made to forget—the ends of their actions and, instead, are absorbed in the means—what he calls "technique." In other words, there is not much concern about the implications of our actions; rather, the emphasis is to do the job the most efficiently and productively possible. Computers increase efficiency, so they are welcomed without question. Apprehending the criminal, for example, translates, in this line of thinking, into turning the entire society into a police state. In the words of Abraham Maslow: "When the only tool you have is a hammer, everything begins to look like a nail." Also, and as an important part of his analysis, Burnham indicates the impact of computers on how people have begun to think of themselves, epitomized by the comments of Joseph Weizenbaum: "Society is beginning to think of human beings as merely another species of the genus information processing system." In the end, the computer dehumanizes us, Burnham asserts, because it serves to limit our interaction with one another.

The major drawback of the book is what is lacking in the analysis, and this is evident throughout, even with Burnham's recommendations for technical, legal, institutional, and social policy changes. By attacking bureaucracies, Burnham is both radical and correct, but by not analyzing the underlying pathological economic and political relationships of both capitalism and nationalism, upon which these bureaucracies sit, he loses a major opportunity to enlighten us as to why the trends and realities he so astutely details will not reverse unless those central economic and political questions are dealt with.

In Brief

BOOKS

The left in the U.S. has published only a relatively small amount of analysis of computer technology. This is particularly unfortunate in light of the massive amount of hype and disinformation that the industry and right-wing political organizations have unleashed on a hapless public in recent years.

In particular, the right wing in the U.S. has made great strides in usurping the high ground of high tech for its own purposes. The Republican slogan, "High tech, not high taxes," was one of many factors contributing to the Reagan reelection victory.

While the right wing continues to fight the ideological battle for the public mind, there has also been myth making of a more benign nature. A flock of books have recently appeared which examine the computer industry from various mainstream pop-sociological perspectives. Some of these books are worth examining for a few kernels of truth and insight, or as sociopolitical phenomena in the process of shaping public opinion about technology.

Fire In The Valley: The Making of the Personal Computer

by Paul Freiberger and Michael Swaine

Osborne/McGraw-Hill, $9.95

A chronicle of the wild and crazy early days of the personal computer industry in the U.S. The book gives a detailed record of the earliest mythical garage days of people and companies that now loom large in the corporate landscape. It is instructive to know that the diverse mix of entrepreneurs included various flavors of political radicals and populists, along with the familiar crew of egomaniacs, hustlers, space cadets, and EST devotees.

The Soul of a New Machine

by Tracy Kidder

Atlantic Monthly Press, 1981, $13.95

This book was the first in the current wave of pop computer culture books. The author uses a "Right Stuff" journalistic approach in chronicling the design of a new computer by a team of engineers. The book succeeds in lending drama and excitement to a task that is usually incomprehensible or boring. Kidder paints a picture of how a technology gets developed that is different from the widespread myth of careful, methodical, professional engineering work. Instead, the hurried "seat-of-the-pants" approach is depicted as the industry norm. Unfortunately, the author lapses into hero worship in his depiction of the characters involved. Partially because of this, the book can have the opposite impact, causing the reader to lose confidence in other products of our technological society, like nuclear power plants or missile systems.

Hackers

by Steven Levy

Anchor Press/Doubleday, 1984, $17.95

The hacker ethic, as described in a review of this book in *InfoWorld* magazine, is as follows: "All information should be free. Mistrust authority, promote decentralization. Hackers should be judged by their hacking, not on bogus criteria such as degrees, age, race or position. You can create art and beauty on a computer. Computers can change your life for the better."

This book describes three generations of computer hackers as they moved from isolated and marginal groups of obsessed individuals playing with technology for its own sake, to an elite guild of money-coveting technology artisans. The pure, fiercely-held principles of the early hacker ethic should prove interesting to political radicals of all stripes.

The Spirit of Enterprise

by George Gilder

Simon & Schuster, $17.95

This new manifesto by reactionary supply-sider George Gilder seeks to strengthen the link in the public's mind between far-out rightist ideology and the much-admired leading U.S. computer technology companies. The book covers American entrepreneurs in all industries, but has a special place for those in the computer industry. In the *InfoWorld* review of this book, John Barry says, "Much of [Gilder's] theorizing is simplistics and naive."

Whole Earth Software Catalog

Edited by Stewart Brand

Quantum Press/Doubleday, 1984, $17.50

This book has to sell 540,000 copies to justify the $1.3 million advance to Stewart Brand's outfit from the publisher. A collection of many short, sometimes provocative, impressions/reviews of different software products for personal computers by a diverse group of reviewers. Results are mostly successful and informative, although not consistently so.

"Computers as Poison"

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Edited by Stewart Brand

Whole Earth Review, Box 27956, San Diego, CA 92128.

A follow-up to the *Whole Earth Software Catalog*, above. The theme of the issue is "All panaceas become poison." A number of authors of different temperaments and political persuasions examine the effects of computers on our work, our social relationships, the economy, social institutions and the environment. The analysis is critical, serious and sometimes radical, though not at all Marxist.

The Second Self: Computers and the Human Spirit
by Sherry Turkle
Simon & Schuster, 1984, $17.95

Research and speculation by a psychologist on the ways in which computers are changing our ways of thinking, learning and viewing of the world. Based on six years of field work interviewing computer users of every variety, Turkle's book may be short on political analysis, but she does let her subjects do much of the talking, which proves in turn fascinating and alarming.

PERIODICALS

Reset: News on Activist and Grassroots Computing
c/o Mike McCullough
90 East Seventh St., Apt. 3A, New York, NY 1009
$1.00 per issue

Reset reads like a computer bulletin board in newsletter format. It's full of resources, activity updates from networks and organizations around the world, running commentary and queries from subscribers, debates about computer use, announcements, reports and articles about progressive computer projects. While the layout and muddy dot matrix type make *Reset* a bit hard to read, it's defintely worth the effort.

Processed World
55 Sutter St. #829, San Francisco, CA 94104
$10/year

A journal of radical politics, humor and art which focuses on people working in the information processing industry. A low-budget, mostly volunteer effort which results in an uneven but fascinating mix of political theory, biting satire, poems and stories on being an alienated, marginal worker in the New Information Order and Techno-State.

ORGANIZATIONS

Community Data Processing

CdP is a relatively new organization, but the founders are all veterans of the Silicon Valley. CdP offers data-processing and consultation services to nonprofit groups, and is itself a nonprofit organization. CdP computers are available for use in their office or by phone. Services include mailing lists, word processing, computer training and virtually any other sort of data management. Principal goals of CdP are to demystify technology and promote self-sufficiency. Contact CdP at P.O. Box 60127, Palo Alto, CA 94306, 415/322-9069.

Computers for Peace

This is a Santa Cruz group which is preparing literature for nonprofit groups on computer use. They have interviewed over 60 people to determine which systems work best for the purposes of this community. Their book includes discussions on the use of computers, reviews and recommendations of particular hardware and software, and a discussion of various pitfalls and how to avoid them.

Public Interest Computer Organization

PICA offers computer assistance to over 90 groups in the Washington, DC area through classes, consulting and its newsletter *Nexus*. They are planning to open a large nonprofit computer training center. PICA is also working on development of a nonprofit accounting software system, a job bank for computer jobs in the public interest, and curriculum for their learning center. Contact PICA at 122 Maryland Ave. NE, Washington, DC 20002, 202/544-4171.

DATABASES

The Arms Control Computer Network

The ACCN is a consortium of seven peace and environmental groups (Friends of the Earth, SANE, Physicians for Social Responsibility, Greenpeace, Lawyers Alliance for Nuclear Arms Control, the Freeze Campaign, and the Coalition for a New Foreign and Military Policy) who have a computer system dedicated to a legislative database and a common "action alert" mailing list. The ACCN legislative database has information on every Member of Congress, his or her votes, committees, and staffers on military issues, recent and upcoming election information, and more. Although currently their database is available for use only by the member organizations, the ACCN has expressed some interest in opening up their information for other users. Contact ACCN at 711 G St. SE, Washington, DC 20003, 202/546-7100.

The Grassroots Peace Directory

Martha Henderson has begun to enlist computers in her quest to compile and make available information on grassroots activity of peace groups. The Topsfield Foundation has been supporting her efforts over the last few months to collect data in ten states. If they expand their project to map the whole United States, they should have some 10,000 groups listed, with organizational information on each. This could be used by local groups to coordinate or publicize work, by national groups to channel aid to swing districts, by interested individuals to find resources in their area, and by foundations interested in making grants in particular areas. The Grassroots Peace Directory is being stored and developed at the Stanford Public Information Retrieval Services (SPRIRES), which is available to nonprofit groups at less than commerical rates.

Resources

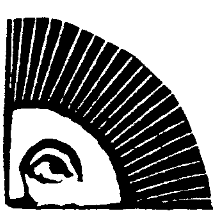
BOOKS

Health Hazards of VDT s, ed. by B.G. Pierce, Toronto: Wiley, 1984.

Computer Reliability and Nuclear War, a bibliography which includes entries on reliability in general, computer-science in the USSR, command, control, and communication, military simulations, and nuclear weapons' computer failures. CPSR Inc., Box 717, Palo Alto, CA 94301, $1.00.

Crucible of Hope, study guide on Central America. Topics include an overview of the region's crises and the plight of refugees. Individual sections are also devoted to El Salvador, Nicaragua, Honduras, and Guatemala, and recent attempts to ease tensions in the region. Sojourners Book Service, Box 29272, Washington, DC 20017, 148 pp., $4.75.

Acid Precipitation: An Annotated Bibliography, compiled by the US Geological Survey, contains 1660 entries, spanning a variety of scientific disciplines from mid-1800s through 1981. USGS Circular 923, Eastern Distribution Branch, USGS, 604 S. Pickett St., Alexandria, VA 22304, 282 pp., no charge.



Research Briefings 1984, annual attempt by the White House Office of Science and Technology and the NSF to find where "important payoffs" might result from increased federal R&D spending. This years' topics include: Computer Architecture, Information Technology in Precollege Education, Process Engineering for Biotechnology, and a list of "Opportunities in Physics". National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418, 116 pp., $9.95.

Disarming the Reactors, by Mobilization for Survival, examines how the U.S. nuclear energy program supports its nuclear weapons program. MFS, 85 Broadway, Rm. 2109, New York, NY 10003, 4 pp., no charge.

ORGANIZATIONS

Computer Professionals for Social Responsibility, educational alliance of computer professionals dedicated to the development and public presentation of expert analyses of society's use of computer technology, particularly as it contributes to the threat of nuclear war. CPSR Inc., Box 717, Palo Alto, CA 94301.

Jobs With Peace, national campaign to redirect funds from the military budget to domestic needs and socially-productive industries. Through education, referenda, and cultural activities, the campaign is working to reverse the arms race and reclaim our tax dollars for an economy based on peace. Has a bimonthly publication. JWP National Network, 76 Summer St., Boston, MA 02110.

Apple Computer's Community Grant Program, donates Apple 2E's to nonprofit community groups with budgets of $5000,000 or less. Application deadlines: March 15, July 15, and Nov. 15, 20525 Mariani Ave., Cupertino, CA 95014, Mail Stop 23L.

Volunteers in Technical Assistance, provides information on how complex issues of development (e.g., computer technology) relate to low-income, Third World peoples. Publishes newsletter focusing on the transfer of technology to developing nations and is currently working on a satellite communication project for the Third World. VITA, 1815 N. Lynn St., Suite 200, Arlington, VA 22209.

Telecommunications Cooperative Network, cooperative of nonprofit groups to gain computing and electronic network power. Distributes Interlink Press Service, a Third World news organization. 370 Lexington Ave., Suite 715, New York, NY 10017.

Information Technology Institute, regional organization studying the role of computers, telephones, and telecommunicators in the nonprofit sector. Holds public forums on computer use, conducts classes on computer literacy and the social implications of computers, and offers a computer camp for nonprofit managers. ITS, 0245 SW Bancroft St., Portland, OR 97201.

Scientific and Technical Aid for Nicaragua

Last summer, Science for the People put out a call for science educators willing to teach in Nicaragua, and asked for help in implementing educational exchanges between the U.S. and Nicaragua. The Nicaraguan National Council on Higher Education is seeking teachers in health, technology, agriculture, science teaching, basic sciences, math and statistics. Science for the People also hopes to sponsor Nicaraguans who want to come to the U.S. for science training. Contact SftP if you have any interest in these science education projects.

Following is a list of organizations engaged in technical and material aid to Nicaragua:

Technical Support Project to Nicaragua (tecNICA)
110 Brookside Dr., Berkeley, CA,
(415) 654-7768

In conjunction with ministries and agencies of the Nicaraguan government, tecNICA offers workshops, classes and consultation by computer professionals who have expertise in economics, statistics, engineering and related fields. Participants work on specific projects as designated by the Nicaraguan government—teaching computer classes at the University of Central America, project and systems analysis for banking operations, software development, electronics and computer repair.

Nicaragua Medical Aid Campaign
1151 Massachusetts Avenue,
Cambridge, MA 02138

Sponsored by regional Central America health rights committees and Humanitarian Aid to Nicaraguan Democracy, this coalition of nurses, doctors, other health workers and students is raising funds to purchase medical equipment, collecting supplies, journals and research material for Nicaragua, and educating the American

CONTACTS

NATIONAL OFFICE: Science for the People, 897 Main St., Cambridge, MA 02139. (617) 547-0370.

CALIFORNIA: Bay Area Chapter, c/o Dave Kadlecek, 2014 Colony, #18, Mountain View, CA 94043.

DISTRICT OF COLUMBIA: Walda Katz Fishman, 6617 Millwood Road, Bethesda, MD 20817. (301) 320-4034. Miriam Struck and Scott Schneider, 806 Houston Ave., Takoma Park, MD 20912. (301) 585-1513.

FLORIDA: Bob Broedel, Progressive Technology, P.O. Box 20049, Tallahassee, FL 32316. (904) 576-4906.

IOWA: Paul C. Nelson, 604 Hodge, Ames, IA 50010. (515) 232-2527.

MARYLAND: Pat Loy, 3553 Chesterfield Ave., Baltimore, MD 21213.

MASSACHUSETTS: Boston Chapter, 897 Main St., Cambridge, MA 02139. (617) 547-0370.

MICHIGAN: Ann Arbor Chapter, 4318 Michigan Union, Ann Arbor, MI 48109. (313) 761-7960. Alan Maki, 1693 Leonard St. N.W., Grand Rapids, MI 49504.

MISSOURI: Peter Downs, 4201 A Russell, St. Louis, MO 63110.

NEW HAMPSHIRE: Val Dusek, Box 133, Durham, NH 03824. (603) 868-5153.

NEW YORK: New York City Chapter, c/o Red Schiller, 382 Third St., Apt. 3, Brooklyn, NY 11215. (212) 788-6996. **Stony Brook Chapter,** P.O. Box 435, E. Setauket, NY 11733. (516) 246-5053.

NORTH CAROLINA: Douglas Bell, 2402 Glendale Ave., Durham, NC 27704. (919) 471-9729.

OREGON: Sheila Smith, 925 NW Merrie Dr., Corvallis, OR 97330.

RHODE ISLAND: Carolyn Accola, 245 President Ave., Providence, RI 02906. (401) 272-6959.

TEXAS: Ed Cervenka, 3506 Manchaca Rd. #211, Austin, TX 78704. (512) 477-3203.

VERMONT: Steve Cavrak, Academic Computing Center, University of Vermont, Burlington, VT 05405. (802) 658-2387; 656-3190.

WASHINGTON: Phil Bereano, 316 Guggenheim, FS-15, University of Washington, Seattle, WA 98195. (206) 543-9037.

WISCONSIN: Rick Cote, 1525 Linden Drive, Madison, WI 53706. (608) 262-4581.

AUSTRALIA: Lesley Rogers, Pharmacology Dept., Monash University, Clayton, Victoria 3168, Australia. Janna Thompson, Philosophy Dept., La Trobe University, Bundoora, Victoria, Australia. Brian Martin, Applied Mathematics, Faculty of Science, ANU, P.O. Box 4, Canberra, ACT 2600, Australia. Tony Dolk, 17 Hampden St., Ashfield, NSW, Australia.

BELGIUM: Gerard Valenduc, *Cahiers Galilee,* Place Galilee 6-7, B-1348 Louvain-la-Neuve, Belgium.

BELIZE: Ing. Wilfredo Guerrero, Ministry of Public Works, Belmopan, Belize, Central America.

CANADA: Ontario: Science for the People, P.O. Box 25, Station "A," Scarborough, Ontario, Canada M1K 5B9. **Quebec:** Doug Boucher, Dept. of Biology, McGill University, Montreal, Quebec. (514) 392-5906. Bob Cedegren, Dept. of Biochemistry, University of Montreal, Montreal 101, Quebec, Canada. **British Columbia:** Jim Fraser, 848 East 11th Ave., Vancouver, British Columbia V5T 2B6, Canada.

DENMARK: Susse Georg and Jorgen Bansler, Stigardsvej 2, DK-2000, Copenhavn, Daneland 01-629945.

EL SALVADOR: Ricardo A. Navarro, Centro Salvadoreno de Tecnologia Apropriada, Apdo 1892, San Salvador, El Salvador, Central America.

ENGLAND: British Society for Social Responsibility in Science, 9 Poland St., London, W1V3DG, England. 01-437-2728.

INDIA: M.P. Parameswaran, Parishad Bhavan, Trivandrum 695-001, Kerala, India.

IRELAND: Hugh Dobbs, 28 Viewmont Park, Waterford, Eire. 051-75757.

ISRAEL: Dr. Najwa Makhoul, Jerusalem Institute for the Study of Science, 6 Bnai Brith St., Jerusalem 95146, Israel.

ITALY: Michelangelo DeMaria, Via Giannutri, 2, 00141, Rome, Italy.

JAPAN: Genda Gijutsu-Shi Kenkyo-Kai, 2-26 Kand-Jinbo Cho, Chiyoda-Ky, Tokyo 101, Japan.

MEXICO: Salvador Jara-Guerro, Privada Tepeyac-120-INT, Col. Ventura Puente, Morelia, Mexico.

NICARAGUA: New World Agriculture Group, Apartado Postal 3082, Managua, Nicaragua, Central America. Tel. 61320.

SWITZERLAND: Bruno Vitale, 8 Rue Des Bugnons, CH-1217, Meyrin, Switzerland. Tel. (022) 82-50-18.

WEST INDIES: Noel Thomas, Mt. Moritz, Grenada.

WEST GERMANY: *Forum fur Medizin Und Gesundheitpolitik,* Gneisenaustr., 2 Mehnighof, 100 Berlin 61, West Germany. *Wechsel Wirkung,* Gneisenaustr., D-1000 Berlin 61, West Germany.

public about healthcare in Nicaragua and the effects of the *contra* war on the Nicaraguan people. They are asking Americans to protest and investigate the kidnapping of the Vice Dean of the medical school in Managua, Dean Gustavo Saqueira, by contacting the Costa Rican and Honduran embassies in Washington, DC, and by writing to Secretary of State Shultz, 2201 C St. NW, Washington, DC 20520.

Humanitarian Assistance Project for Independent Agricultural Development in Nicaragua (HAP-NICA)
Peter Rosset, 4096 Natural Science Building, University of Michigan, Ann Arbor, MI 48109 (313) 764-1446

A project of the New World Agriculture Group and Humanitarian Aid for Nicaragua, HAP-NICA is coordinating aid for Nicaragua's agricultural sector. They are organizing material aid, such as tractor parts, pumps, seeds, fertilizers; technical aid, such as short courses on alternatives to pesticides, university teaching and development project consultation; and research and development of alternative technologies appropriate to Nicaragua's agricultural economy.

Technical Aid Project for Nicaragua
American Public Health Association Occupational Health and Safety Section, c/o Northern California Ecumenical Council, 942 Market St. 7th Floor, San Francisco, CA 94102

NTAP is conducting a material aid campaign for the Nicaraguan Occupational Health and Safety Department. They have produced an excellent slide show, which is available for public viewing. They are also looking for an industrial hygienist or occupational health and safety specialist to work in Nicaragua.

Nicaragua Appropriate Technology (NicAT)
c/o Mira Brown, 45 Cherry St. #3, Somerville, MA 02144

NicAT has launched a material aid project for CITA-INRA, the Center for the Study of Appropriate Technology in Esteli, Nicaragua. They have also produced a slide presentation about appropriate technology and development in Nicaragua.

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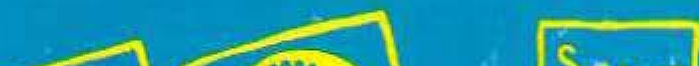

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