THE CULT OF
INFORMATION
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The Folklore of Computers and the True Art of Thinking

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INTRODUCTION

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The little boy in the fairy tale who blurted out the embarrassing truth that the emperor was wearing no clothes did not necessarily mean to say that the emperor deserved no respect at all. The poor man may have had any number of redeeming qualities. In his vanity, he had simply weakened to the appeal of an impossible grandeur. His worst failing was that he allowed a few opportunistic culprits to play upon his gullibility and that of his subjects.

This critique of the computers in our lives, and especially in our schools, has much the same limited scope. It is not part of my purpose to dismiss the computer as worthless or malevolent. I would hardly be in the position to draw that conclusion. The manuscript for this book was typed on a word processor; at numerous points, the research for the text made extensive use of electronic data bases. I approach this study with a healthy respect for the many helpful things computers can do, and not from a position of doctrinaire technophobia. I do, however, want to suggest that the computer, like the too-susceptible emperor, has been overdressed in fabulous claims. Further, I believe these claims have been deliberately propagated by elements in our society that are making some of the most morally questionable uses of computer power. The glowing promises with which they have surrounded that power need to be challenged if the computer is not to be delivered into the wrong hands.

As this should make clear, my interest in these pages is not in the technology of computers, but in their folklore: the images of power, the illusions of well-being, the fantasies and wishful thinking that have grown up around the machine. Primarily, my target is the concept to which the technology has become inextricably linked in the public mind: *information*. Information has taken on the quality of that impalpable, invisible, but plaudit-winning silk from which the emperor's ethereal gown was supposedly spun. The word has re-

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ceived ambitious, global definitions that make it all good things to all people. Words that come to mean everything may finally mean nothing; yet their very emptiness may allow them to be filled with a mesmerizing glamour. The loose but exuberant talk we hear on all sides these days about "the information economy," "the information society," is coming to have exactly that function. These often-repeated catchphrases and clichés are the mumbo jumbo of a widespread public cult. Like all cults, this one also has the intention of enlisting mindless allegiance and acquiescence. People who have no clear idea what they mean by information or why they should want so much of it are nonetheless prepared to believe that we live in an Information Age, which makes every computer around us what the relics of the True Cross were in the Age of Faith: emblems of salvation.

Information has had a remarkable rags-to-riches career in the public vocabulary over the past forty years. It was surely among the least likely candidates to achieve the exalted status of a godword, but so it has become, and not by accident. Beginning with its esoteric redefinition by the information theorists during World War II, it has come to be connected with a historic transition in our economic life, one which unites major corporate interests, the government, the scientific establishment, and at last draws in the persuasive rhetoric of advertisers and merchandisers. If only as a unifying theme that holds so many powerful social forces together, the concept would be worth critical attention. But the Information Age has now entered the educational curriculum in an aggressive and particularly insidious way which could distort the meaning of thought itself. That is the special concern of this study.

Two distinct elements come together in the computer: the ability to store information in vast amounts, the ability to process that information in obedience to strict logical procedures. Each of these will be taken up in turn in Chapters 5 and 6 and explored for its relationship to thought. There we will see how the cult of information fixes upon one or the other of these elements (sometimes both) and construes its intellectual value. Because the ability to store data somewhat corresponds to what we call memory in human beings, and because the ability to follow logical procedures somewhat corresponds to what we call reasoning in human beings, many members of the cult have concluded that what computers do somewhat corresponds to what we call thinking. It is no great difficulty to persuade

the general public of that conclusion since computers process data very fast in small spaces well below the level of visibility; they do not look like other machines when they are at work. They seem to be running along as smoothly and silently as the brain does when it remembers and reasons and thinks.

On the other hand, those who design and build computers know exactly how the machines are working down in the hidden depths of their semiconductors. Computers can be taken apart, scrutinized, and put back together. Their activities can be tracked, analyzed, measured, and thus clearly understood—which is far from possible with the brain. This gives rise to the tempting assumption on the part of the builders and designers that computers can tell us something about brains, indeed, that the computer can serve as a model of the mind, which then comes to be seen as some manner of information processing machine, and possibly not as good at the job as the machine.

The burden of my argument is to insist that there is a vital distinction between what machines do when they process information and what minds do when they think. At a time when computers are being intruded massively upon the schools, that distinction needs to be kept plainly in view by teachers and students alike. But thanks to the cultlike mystique that has come to surround the computer, the line that divides mind from machine is being blurred. Accordingly, the powers of reason and imagination which the schools exist to celebrate and strengthen are in danger of being diluted with low-grade mechanical counterfeits.

If we wish to reclaim the true art of thinking from this crippling confusion, we must begin by cutting our way through an undergrowth of advertising hype, media fictions, and commercial propaganda. But having done that much to clear the ground, we come upon the hard philosophical core of the cult of information, which is as much the creation of the academies and laboratories as of the marketplace. Gifted minds in the field of computer science have joined the cult for reasons of power and profit. Because the hucksters have enlisted so many scientists in their cause, there are tough intellectual questions as well as political interests that need to be examined if we are to understand the full influence of the computer in our society. In a very real sense, the powers and purposes of the human mind are at issue. If the educators are also finally swept into the cult, we may see the rising generation of students seriously hampered in

its capacity to think through the social and ethical questions that confront us as we pass through the latest stage of the ongoing industrial revolution.

The so-called information economy may not be what its major boosters would have us believe. It is not the futuristic utopia so long prefigured by science fiction. It is, however, a significant and exciting transition in our industrial history. No technology has ever unfolded its potentialities as swiftly as computers and telecommunications are doing. It is understandable that those of us who are witnessing this whirlwind transformation should find ourselves dizzied by the rush of innovation, the sudden influx of new technical powers. But we have seen too many technologies of the past go wrong to let our critical attention be misdirected by the computer enthusiasts. Information technology has the obvious capacity to concentrate political power, to create new forms of social obfuscation and domination. The less prepared we feel to question the uses to which it is put, the more certain we are to suffer those liabilities.

Ultimately, this book is as much about the art of thinking as it is about the politics and technology of information. There is an obvious humanist agenda running through the critique. I work from the assumption that the mind—and not only in the form of human intelligence—is as close to being a wonder of nature as any miracle revered by the religions of the world. To reflect on the powers of the mind, to probe its secrets, these are among the time-honored pursuits of philosophy. It is quite another matter, however, to teach children and tell the public that the secrets have all been revealed and the powers harnessed—and to offer a collection of semiconductors in a metal box as proof. Measured against that claim, even the most ingenious computer is bound to look ludicrously inadequate in the eyes of thoughtful people—more of a joke than an achievement. As critical as this book may be at many points in challenging the status of the computer in our society, it includes among its purposes that of saving this remarkable invention from the inordinate claims that its enthusiasts are making for it. Unburdened of vainglorious ambition, dressed in more modest but palpable working clothes, the computer, like the emperor in the fairy tale, may yet become a reasonably valuable public servant.

THE CULT OF INFORMATION

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"INFORMATION, PLEASE"

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INFORMATION OLD-STYLE

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When I was growing up in the years just before World War II, information was nothing to get excited about. As an intellectual category, it held a humble and marginal status. Few people would have conceived of it as the subject of a "theory" or a "science"; it was not associated with an advanced technology that lent it glamour as well as extravagant financial value. Probably the most common public use of the word was as part of the phrase "Information, please." That was how you asked the operator for telephone numbers before we had 411 to dial. There was also, through the 1930s and 1940s, a popular radio program by that name which challenged listeners to stump a panel of experts by sending in unlikely questions about assorted trivia. Who was the shortest president of the United States? What grand opera contains the longest duet? What mammal reproduces by laying eggs?

That was the way most people thought about information in those days: disjointed matters of fact that came in discrete little bundles. Sometimes what was in the bundles was surprising, sometimes amusing, sometimes helpful. Most often it took the form of a number, name, date, place, event, or measurement that answered a specific question beginning with who, what, when, where, how much. Such matters got talked about in ordinary words; they did not require esoteric mathematical formulations or a special technical

vocabulary. Occasionally information might be urgently important —like knowing where to press to stop the bleeding—but it was not regarded as something for which there was an insatiable public need. Certainly nobody would have credited it with the status it has acquired in our day—that of a billion-dollar industrial commodity that we should want to see produced in limitless quantities.

Of course, everybody knew there were certain businesses and professions which needed to keep lots of files filled with information. There were the accountants, the lawyers, the engineers. The standard white collar occupations—banking, insurance, brokerage houses, real estate—were characterized by rooms filled with olive-drab filing cabinets and patrolled by busy platoons of file clerks. Above all, there was the government, which, as census taker, tax collector, law enforcer, had always been the record keeper par excellence since the earliest days of civilization. Steadily, since the beginning of the nineteenth century, the governments of the industrially advanced societies had found themselves being drawn into ever more administrative responsibilities, until the task of minding official data threatened to become an end in itself. Duties like supervising the economy, keeping track of the work force, handing out the dole, allocating jobs, revenues, resources, were taking up more and more of the attention of political leadership in the urban industrial nations. For some early social scientists like Max Weber, this expanding paper reality of social statistics represented one of the worst vices of modern society: the bureaucratization of life, the conversion of experience into numerical abstractions.

By and large, the data processing responsibility of all these professions, public and private, was more bemoaned than celebrated. It was seen as a dispiriting necessity that could be left to low-status, usually poorly skilled office help. The familiar image of the office worker that we find in the stories of Dickens and Gogol is that of pale, pinch-faced scribes shuffling through overflowing ledgers, soulless statisticians and actuarials totaling up endless columns of figures, undernourished office clerks digging through dusty files to find an elusive memo. These were the people at the bottom of the bureaucratic ant heap. Herman Melville caught something of the general perception of these unfortunates in his famous tale of "Bartleby the Scrivener," the neat and efficient clerk whose relentlessly dispiriting toil finally turns him into a zombie.

The image of data keepers got no brighter even when their occupation passed beyond the pen and pencil stage and finally entered the machine age. It was in order to save time and office space for the government and the white collar industries that business machines came into existence during the early years of this century. The key punch, the comptometer, the collator, the addressograph—all these were information processors. But nobody would have seen them as anything more than ingenious sorting and counting contraptions, of about as much intellectual interest as the air brake or the dry cell battery. Their inventors are hardly remembered; the companies that manufactured them were of no great weight in our industrial economy; those who operated them remained low-level clerical help. For the most part, the data minders of the economy were "office girls" who might have been trained in high school or at business college and who toiled at their monotonous jobs without hope of promotion. If anything, the work they did was still usually seen by more humanistic sensibilities as a sorry example of the ongoing massification of modern life.

In Elmer Rice's bitter Broadway satire *The Adding Machine* (1923), the protagonist is an office clerk aptly named Mr. Zero. He is a pathetic nonentity, a "poor, spineless, brainless boob" who is lost in a wasteland of filing cabinets. At the end of the play, he is offered a "superb, super-hyper-adding machine"; it is the most spectacular business machine that can be imagined. Even so, the play finishes by identifying Mr. Zero as a form of life lower and less useful than a serf. He is "a slave to a contraption of steel and iron," and the work he does is portrayed as the epitome of dehumanization. At the hands of Mr. Zero and his kind, people are reduced to statistical phantoms; yet those who perform the deed possess neither power nor status. They are themselves mere ciphers in the system.

In my youth, I had a taste of this dingy subservience. In the early 1950s, I worked as a file clerk for a major insurance company whose windowless basement was a honeycombed cavern of coffin-black filing cases and bound records shelved to the ceiling. Along with a score of lads fresh out of high school, I ran interoffice mailers and bulging sheaves of memos around the building from department to department. We were treated like so many slaveys. From time to time our supervisor, trying to boost our flagging morale, would remind us that we were the life's blood of the company. Without us, even

the top executives could not make a move. But we knew we were the lowest of the low. The work was a fatiguing bore, and we got paid the flat minimum wage. None of us stuck with the job longer than we had to.

ENTER UNIVAC

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The best known relic of Mr. Zero's era, the paleolithic period of the early business machines, was the Hollerith punchcard, which dates back to the 1890s. Eventually, it would become an emblem of human alienation in an increasingly bureaucratized world. Somewhere in the early 1960s, its familiar injunction would be elaborated into a popular appeal for human understanding: "I am a human being. Do not fold, spindle, or mutilate."

But by the time that plea was voiced, the punchcard was all but obsolete, replaced by far superior means of tracking data. At the hands of innovative firms like Sperry-Rand, Control Data, and Digital Equipment Corporation (IBM was actually quite laggardly in the field until the early 1960s), the business machine was undergoing an unexpected and rapid evolution. Spurred along by military necessity during World War II and afterward by the needs of the Census Bureau, it was maturing in the direction of becoming an electrical filing device that assigned a numerical address to the data it held and could then perform a variety of rapid calculations and transformations with those data. And that, in its most rudimentary form, is a computer: a device that remembers what it counts, counts what it remembers, and retrieves whatever it has filed away at the touch of a button. The woeful young women who once tended the cumbersome key punch in the back office would surely have been amazed to know that someday there would be "information scientists" who regarded their clanking and clacking machines as the distant ancestors of a form of mechanized intelligence possibly superior to the human mind.

The word *computer* entered the public vocabulary in the 1950s, when the most advanced models of the device were still room-sized mechanical dinosaurs that burned enough electricity to present a serious cooling problem. The first computer to enjoy a significant

reputation was UNIVAC, the brainchild of John Mauchly and J. P. Eckery, with important contributions from the famous mathematician John von Neumann.[1] UNIVAC was the first stored-program computer; it was based on military research done at the University of Pennsylvania during the war. Its later development was helped along by contracts from the National Bureau of Standards and Prudential Insurance; finally it was bought by Remington Rand in the 1950s for a variety of data services. But UNIVAC's public debut was little more than a media gimmick. The machine was loaned to CBS television to make polling predictions in the 1952 elections. This number-crunching behemoth (it contained 5,000 vacuum tubes, but used a new, compact magnetic tape system rather than punchcards to store data) was programmed to analyze voting statistics for CBS in key districts and to compare them with early returns on election night. By doing so, UNIVAC gave a projection that quickly calculated which candidate would most likely win.

There is an amusing anecdote about UNIVAC's introduction to the American public that evening. At CBS election headquarters, the esoteric machine, which the anxious electronic engineers were coddling like a spoiled child, was regarded as a mere sideshow attraction. So when UNIVAC, drawing upon a mere 5–7 percent of the popular vote, began projecting a landslide for Dwight Eisenhower, the CBS experts refused to report its prediction. The worried technicians then agreed to adjust the machine to keep it in line with the network pundits. Still UNIVAC insisted on an Eisenhower sweep, even in the solid Democratic South. Finally, when its predictions proved accurate, the experts conceded, publicly confessing that UNIVAC had indeed outguessed them and that the machine's apparent inconsistencies that night were due to human interference. UNIVAC had predicted an electoral vote for Eisenhower of 438; he finished with 442, within 1 percent of UNIVAC's startling prediction. This was an impressive display of what an advanced data processor could do, so impressive that for a short period the brand name UNIVAC bid fair to displace the generic name *computer*.

White collar work was one of the last occupations to enter the machine age. Well after the mines, the factories, the farms had been mechanized, office workers were still scribbling away with pen and pencil, hand-filing their papers in cabinets and loose-leaf binders. Even the typewriter (which appeared in the 1880s and did so much to bring a new generation of women workers into the offices) was a

low-level manual tool, the technological equivalent of the long-defunct hand loom. Until well into the twentieth century, one looks in vain in magazines for advertisements that feature any sort of data processing equipment, let alone for books and articles celebrating their inventors and manufacturers. Compare this with the situation today, when the slickest, most futuristic ads in print and on television are those touting computers for the office, and you have a striking measure of how information has risen in status. The technology of the humble data keepers has finally outmatched the rolling mills, the dynamos, the railroads.

"Today," a leading telecommunications firm anounces in an imposing full-page advertisement, "information is the most valuable commodity in business. *Any* business." In times past, one would have thought of information as more of a lubricant that helped get commodities produced, or perhaps the upshot of a service like a doctor's diagnosis or a lawyer's legal opinion. And its value would not be constant (let alone universally or invariably supreme) but would vary with its accuracy and applications. But these days information is freely called product, resource, capital, currency. There is no limit to how high the rhetoric may be aimed. In a 1984 TV spot commercial, Frank Herbert, author of *Dune*, a work which at once invokes the vistas of science fiction, intones a small hymn to technological progress for Pacific Telephone's Infosystems. "The real revolution of the Information Age," he announces, "will not be one of hardware, but of the human spirit. It will be the chance to be more than human." Seemingly, a promise of godlike possibilities at hand. The product he is pitching is simply another electronic office system, one of several on the market. Yet, as the extravagant language suggests, the transition to the computer has come to be seen as more than a matter of new machines replacing old. The new machines have the look of something like an evolutionary leap forward in the history of industrialism. They are a new species of technology, one which has seemed from its first appearance to be flirting with the mysteries of the mind itself.

CYBERNETICS AND THE SECRET OF LIFE
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In my own life, there was a book that did more than UNIVAC to revise my understanding of information and the machinery that manipulated it. In 1950 the mathematician Norbert Wiener wrote a pioneering and widely read study called *The Human Use of Human Beings,* a popularized version of his classic 1948 work *Cybernetics.*[2] For the general reading public, this engaging and provocative little book landmarked the appearance and high promise of "cybernation," the word Wiener had coined for the new automative technology in which he could discern the lineaments of a second industrial revolution. In the pages of his study, the computer was still an exotic device without a fixed name or clear image; he quaintly refers to it as "an ultra-rapid computing machine." But even in its then primitive state, that machine figured importantly in what was for Wiener one of the key aspects of cybernation: "feedback," the ability of a machine to use the results of its own performance as self-regulating information and so to adjust itself as part of an ongoing process.

Wiener saw feedback as far more than a clever mechanical trick; he regarded it as an essential characteristic of mind and of life. All living things practice some form of feedback as they adapt to their environment; here then was a new generation of machines reaching out toward the status of a sentient animal, and so promising to take over kinds of work that only human intelligence had so far been able to master. And not only work, but certain kinds of play as well. Wiener was much impressed by the research then under way to build chess-playing machines; this served as further evidence that machines would soon be able to process data in ways that approach the complexity of human intelligence. "To live effectively," he concluded, "is to live with adequate information. Thus, communication and control belong to the essence of man's inner life, even as they belong to his life in society."

Wiener was claiming nothing less than that, in perfecting feedback and the means of rapid data manipulation, the science of cybernetics was gaining a deeper understanding of life itself as being, at its core, the processing of information. "It is my thesis," he wrote, "that the physical functioning of the living individual and the oper-

ation of some of the new communications machines are precisely parallel in their analogous attempts to control entropy through feedback."

Some five years after Wiener's book was published, a new field of study based on his thesis announced its presence in the universities, an intellectual hybrid of philosophy, linguistics, mathematics, and electrical engineering. It was called artificial intelligence, or AI. The key assumption of AI was clear from the outset; in the words of two of the discipline's founding fathers, Alan Newell and Herbert Simon, "the programmed computer and human problem solver are both species belonging to the genus 'Information Processing System.' "[3]

A few years further along (1958), and Newell and Simon were pitching their hopes sky high:

> There are now in the world machines that think, that learn and create. Moreover, their ability to do these things is going to increase rapidly until—in the visible future—the range of problems they can handle will be co-extensive with the range to which the human mind has been applied.[4]

At the time they made the prediction, computers were still struggling to play a creditable game of checkers. But Simon was certain "that within ten years a digital computer will be the world's chess champion."[5]

Wiener himself may or may not have agreed with the glowing predictions that flowed from the new study of artificial intelligence, but he surely did not endorse its optimism. On the contrary, he regarded information technology as a threat to short-term social stability, and possibly as a permanent disaster. Having invented cybernetics, he intended to function as its conscience. *The Human Use of Human Beings,* as the phrase itself suggests, was written to raise public discussion of the new technology to a higher level of ethical awareness. Automated machines, Wiener observed, would take over not only assembly line routine, but office routine as well. Cybernetic machinery "plays no favorites between manual labor and white collar labor." If left wholly in the control of short-sighted, profit-maximizing industrialists, it might well "produce an unemployment situation, in comparison with which . . . even the depression of the thirties will seem a pleasant joke."

Two years after Wiener issued that warning, the first cybernetic anti-utopia was written. In *Player Piano,* Kurt Vonnegut, Jr., who had been working in the public relations department of General Electric, one of the companies most aggressively interested in automation, imagines a world of intelligent machines where there is "production with almost no manpower." Even the barbers have been displaced by haircutting machines. The result is a technocratic despotism wholly controlled by information technicians and corporate managers. The book raises the issue whether technology should be allowed to do all that it can do, especially when its powers extend to the crafts and skills which give purpose to people's lives. The machines are slaves, Vonnegut's rebellious engineer-hero insists. True, they make life easier in many ways; but they also compete with people. And "anybody that competes with slaves becomes a slave." As Vonnegut observes, "Norbert Wiener, a mathematician, said all that way back in the nineteen-forties."

MESSAGES WITHOUT MEANINGS
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In the same year Wiener produced his study *Cybernetics,* Claude Shannon of Bell Laboratories published his ground-breaking paper, "A Mathematical Theory of Communication," which established the discipline of information theory, the science of messages. Shannon's work is universally honored as one of the major intellectual achievements of the century. It is also the work most responsible for revolutionizing the way scientists and technicians have come to wield the word *information* in our time. In the past, the word has always denoted a sensible statement that conveyed a recognizable, verbal meaning, usually what we would call a fact. But now, Shannon gave the word a special technical definition that divorced it from its common-sense usage. In his theory, information is no longer connected with the semantic content of statements. Rather, information comes to be a purely quantitative measure of communicative exchanges, especially as these take place through some mechanical channel which requires that message to be encoded and then decoded, say, into electronic impulses. Most people would have assumed that information had to do with what happened in the understanding of a

speaker and a listener in the course of a conversation. Shannon, working out of Bell Labs, was much more interested in what might be happening in the telephone wire that ran between speaker and listener. In his paper, the fundamental concepts of information theory—noise, redundancy, entropy—are rounded up into a systematic mathematical presentation. Here, too, the "bit," the binary digit basic to all data processing, first appears to take its place as the quantum of information, a neatly measurable unit by which the transmitting capacity of all communications technology can be evaluated.

One can see how useful such a calculus of communications traffic is for electrical engineers dealing with the problem of channeling signals over phone wires or from space satellites, and wanting to do so with the greatest possible economy and clarity. But from the outset, Shannon was beset by the understandable confusion that arose between his restricted use of "information" and the conventional meaning of the word. From his point of view, even gibberish might be "information" if somebody cared to transmit it. After all, a message translated into a secret code would appear to be gibberish to anyone who did not know the code; but it would be well worth sending by anyone who did. The early information scientists easily fell into thinking this way about messages and their transmissions; many of them had served as cryptographers during the war. Still this was an odd and jarring way to employ the word, and Shannon had to admit as much. Once, when he was explaining his work to a group of prominent scientists who challenged his eccentric definition, he replied, "I think perhaps the word 'information' is causing more trouble . . . than it is worth, except that it is difficult to find another word that is anywhere near right. It should be kept solidly in mind that [information] is only a measure of the difficulty in transmitting the sequences produced by some information source."[6]

For a time, Shannon considered dropping the word and using another—like communications theory. With a name like that, the new field would have had more distance from the need for meaningful content which we associate with information. For example, a disease can be "communicated"—a transmission of great consequence but without intelligent content. At one point, John von Neumann suggested—not very helpfully—that Shannon use the word *entropy*. But information became the word, a choice which Fritz

Machlup has called "infelicitous, misleading, and disserviceable"— the beginning of the term's history as "an all-purpose weasel-word."[7]

What we have here is an example of something that has happened many times before in the history of science. A word that has a long-standing, common-sense meaning is lifted from the public vocabulary and then skewed toward a new, perhaps highly esoteric definition by the scientists. The result can be a great deal of unfortunate confusion, even among the scientists themselves, who may then forget what the word meant before they appropriated it. The way physicists use the words *motion, time, gravity, simultaneity* has only a tenuous connection with commonplace, everyday experience. The word *order* in thermodynamics has a specialized application that at certain points diverges markedly from its normal meaning. Perhaps the most notorious example of such confusion involves the word *intelligence* as it has been reshaped by the psychologists. Among the IQ testers, "intelligence" is whatever certain highly eccentric academic tests measure. The result is a neat, numerical score: high scores mean high intelligence, low scores mean low intelligence. But neither the tests nor the scores may have any relationship to what we regard as real intelligence (or its absence) as we judge things in the midst of life.

In much the same way, in its new technical sense, *information* has come to denote whatever can be coded for transmission through a channel that connects a source with a receiver, regardless of semantic content. For Shannon's purposes, all the following are "information":

$$E = mc^2$$

Jesus saves.

Thou shalt not kill.

I think, therefore I am.

Phillies 8, Dodgers 5

'Twas brillig and the slithy toves did gyre and gimble in the wabe.

And indeed, these are no more or less meaningful than any string of haphazard bits (x!9#44jGH?566MRK) I might be willing to pay to have telexed across the continent.

As the mathematician Warren Weaver once put it, explaining "the strange way in which, in this theory, the word 'information' is used. . . . It is surprising but true that, from the present viewpoint, two messages, one heavily loaded with meaning and the other pure nonsense, can be equivalent as regards information."[8]

One might expect that anyone reading through the list of items above would immediately note that each stands on a markedly different intellectual level. One statement is a moral injunction; one is a mathematical formulation; one is a minor point of fact; one is a theological teaching; and the last is deliberate (though charming) nonsense. But once they have all been transformed into electrical bits, and once the technicians have got us into the habit of labeling them all information, these vital differences—which it would, for example, be rather important to draw out for children as part of their education—cannot help but be obscured.

To be sure, Shannon's work is highly technical and therefore largely inaccessible to the general public; nevertheless, its influence has been enormous. As information theory has come to be widely applied in our high tech economy, it has had a twofold impact upon our popular culture.

First of all, once "information" had been divorced from its conventional meaning, the word was up for grabs. Following the lead of the information theorists, scientists and technicians felt licensed to make ever broader and looser use of the word. It could soon be applied to any transmitted signal that could be metaphorically construed as a "message"—for example, the firing of a nerve impulse. To use the term so liberally is to lay aside all concern for the quality or character of what is being communicated. The result has been a progressive blurring of intellectual distinctions. Just as it is irrelevant to a physicist (from the viewpoint of the purely physical phenomenon) whether we are measuring the fall of a stone or the fall of a human body, so, for the information theorist, it does not matter whether we are transmitting a fact, a judgment, a shallow cliché, a deep teaching, a sublime truth, or a nasty obscenity. All are "information." The word comes to have vast generality, but at a price; the *meaning* of things communicated comes to be leveled, and so too the value.

The effect is similar to that which the mathematical theory of games had upon people's thinking in the 1950s and 1960s. From the viewpoint of games theorists, chess, poker, business investments, arguments between parents and children, collective bargaining, thermonuclear war came to be seen as "games"—in the sense that certain general strategies could be applied to all of them. This was a valuable insight into many forms of competition and negotiation, but it was gained at great cost. Around the theory of games, a literature and discourse of military strategy grew up whose authors felt licensed to discuss the annihilation of the human race as casually as one might discuss a hand of cards. For, after all, these were simply different kinds of "games." On balance, the result of this intellectual sleight-of-hand was a lamentable bamboozling of the public, who came to see arguments made in this esoteric terminology (all decked out with many numbers) as intimidatingly authoritative.

Secondly, information theory *worked*. In its own field of application, it provided the electrical engineers with a powerful tool that contributed significantly to rapid innovation. With UNIVAC, the original vacuum tube computer had reached the limit of its development, and still the machines were too big and slow to carry out truly sophisticated programs. In the course of the 1950s and 1960s, however, these limitations were overcome by the development of the transistor and integrated circuit. These highly miniaturized conductors allowed the computer to be compacted and its processing functions to be vastly accelerated. At the same time, thanks again to Shannon's work, the computer was finding its way into the world's burgeoning telecommunications network so that it could extend its power beyond local, on-site use. This permitted computers to communicate with one another over great distances, and eventually, with the deployment of space satellites, to remain instantaneously in touch around the world. While the computer was shrinking physically to desk-top size, it was taking on a new, disembodied, electronic "size" that dwarfed all previous technology in the scope of its power. In our own day, these two developments—miniaturization and telecommunications outreach—have allowed even the most modest personal computer to link into information networks that span the planet, giving them, in the view of some enthusiasts, the dimensions of a global brain.

Achievements of this astonishing order were bound to shift our understanding of information away from people (as sources or re-

ceivers) toward the exciting new techniques of communication. This is because the main concern of those who use information theory is with apparatus, not content. For that matter, the theory does not even require a human source or receiver on either side of the apparatus. The source might just as well be a ballistic missile registering its trajectory on radar; the receiver might just as well be a computer programmed to trigger a retaliatory strike. Such a situation fulfills all the mathematical requirements of the theory.

Thanks to the high success of information theory, we live in a time when the technology of human communications has advanced at blinding speed; but what people have to say to one another by way of that technology shows no comparable development. Still, in the presence of so ingenious a technology, it is easy to conclude that because we have the ability to transmit more electronic bits more rapidly to more people than ever before, we are making real cultural progress—and that the essence of that progress is information technology.

THE BIOCOMPUTER
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Between them, Wiener and Shannon radically reconceptualized the meaning of information, lending the term a new mathematical precision without which the computer might never have developed much beyond the power of UNIVAC. But their professional work was too esoteric to find an audience outside the world of the logicians and technicians. For the general public, the intriguing image which Wiener had raised in *The Human Use of Human Beings*— that of information as the basis of life—found its most dramatic support from another, unexpected quarter: biology—or rather, the *new* biology, where the most highly publicized scientific revolution since Darwin was taking place.

In 1952, microbiologists James Watson and Francis Crick announced that they had solved the master problem of modern biology. They had broken the "genetic code" hidden deep within the molecular structure of DNA. The very use of the word *code* in this context was significant. For one thing, it immediately seemed to link the

discoveries of the biologists to those of the new information theorists, whose work had much to do with the "encoding" of information. The word also carried with it the thrill of an espionage story and, in fact, harked back to the original use made of the computer in England: to break the German secret code during World War II. No sooner had Watson and Crick published their breakthrough than the DNA molecule came to be universally seen as something like a tiny cybernetic apparatus that stored and processed microscopic bits of chemically encoded data. Supposedly, these coded messages controlled discrete physical processes in the replication of living things. Soon, the entire code of the double helix would be unscrambled and its message might be read off bit by bit like the memory store of a computer. As John Pfeiffer of MIT described the function of DNA in a 1960 television documentary on CBS, "The program's patterns of chemical bases may be compared to patterns of holes or magnetic spots on paper tapes fed into electronic computers."[9] The DNA "program" has not turned out to be quite that simple, but in the first flush of discovery, it seemed that Wiener's proposition had been confirmed: cybernetics and biology had found a common ground.

Since its inception, the new biology has been so tightly entwined with the language and imagery of information science that it is almost impossible to imagine the field developing at all without the aid of the computer paradigm. One biologist identifies "the theoretical tool" that unlocked the chemistry of life as

the new sciences associated with the development of computers. Theories of "control," "feedback," and "information transfer" were collated in 1948 by the American engineer and mathematician Norbert Wiener under the name of "cybernetics." . . . Biochemists seized on these new concepts in order to probe the ways in which the cell controlled and regulated its own metabolism.

The job of the cyberneticist, he explains,

is the study of *information transfer:* the converting of information from one form to another—the human voice into radio waves and back into sound once more, or a complex

mathematical equation into a set of punched holes on a tape, to be fed into a computer and then into a set of traces on reels of magnetic tape in the computer's "memory store." . . . To him, protein synthesis is just such another case. The mechanism for ensuring the exact replication of a protein chain by a new cell is that of transferring the *information* about the protein structure from the parent to the daughter cell.[10]

One is left to wonder: could the revolution in biology have occurred if the model of the computer had not been conveniently at hand waiting to be adopted? This would not be the first time a technological metaphor served to launch a scientific breakthrough. In the seventeenth century, at the very beginning of modern science, astronomers and physicists appropriated the model of the clock to explain the mechanics of the solar system and soon taught their society to see the entire universe as a clockwork instrument.

However much the new biology may have borrowed from the preexisting cybernetic model, it repaid the debt manyfold by lending information a mystique it could not have acquired in any other way. In effect, it became the secret of life. From a data-computing mechanism as tiny as the DNA molecule, all the subtle complexity of life on earth had evolved. As John Pfeiffer confidently put it, "This is automation at the molecular level." Here was an astonishing demonstration of how much could be pieced together out of mere particles of data. It was as if God Himself, formerly the great watchmaker in the sky, had been updated into the cosmic computer programmer. Within another decade, by the early 1960s, it became commonplace for people to speak not only of their genes but of their minds and private psyches as being "programmed." If it was not yet the case, as Wiener had predicted, that cybernetic machines would become more like people, certainly people were coming to see themselves more and more as a kind of machine: a biocomputer.

Ironically, as the new biology has grown a bit older, it has changed in ways that no longer make the simple cybernetic model seem quite so persuasive. In the early days, the genetic code looked as if it would be a lot easier to crack than has turned out to be the case. Initially, it was assumed that the message of the genes might be read off as so many fixed, linear sequences of nucleotide bases, much like the digital bit-string in a computer. More recently, as problems

of developmental regulation have gained prominence in the field, genes have become a lot trickier to interpret. The mysterious process of "transposition" has begun to draw attention. The work of Barbara McClintock, among others, suggests that genes may actually pick themselves up and move about in the genome, almost purposefully changing their meaning as they alter their position in response to some larger context.[11] So far the biologists have no model to use for that context, but neither computers nor cybernated systems would seem to serve. Maybe the context is something like an "idea" about the whole organism and its relationship to the environment. If this is so, then the cybernetic model that did so much to launch the new biology might be totally misleading. For there are no computer programs that behave this way. If they did, it would amount to saying that they had a mind of their own—and that way lies science fiction, not serviceable technology. Yet, for lack of a better choice, the data processing image lingers on, rendering biology in the late twentieth century more mechanistic than physics.

Every historical period has its godword. There was an Age of Faith, an Age of Reason, an Age of Discovery. Our time has been nominated to be the Age of Information. If the name takes, the fortuitous connection between cybernation and the new biology will have to be credited with lending information much of the vogue it has come to enjoy. Perhaps there is another reason for the increasing popularity and generality of the word, one that tells us something important about an era that is willing to accept such a seemingly characterless designation. Unlike "faith" or "reason" or "discovery," information is touched with a comfortably secure, noncommittal connotation. There is neither drama nor high purpose to it. It is bland to the core and, for that very reason, nicely invulnerable. Information smacks of safe neutrality; it is the simple, helpful heaping up of unassailable facts. In that innocent guise, it is the perfect starting point for a technocratic political agenda that wants as little exposure for its objectives as possible. After all, what can anyone say against information?

But in contemporary America, even a godword does not enter the popular consciousness in a decisive way until it can somehow be bought and sold in the marketplace. Only then can it be coveted as a possession, paid for, taken home, and owned. More importantly, only then does it qualify to receive the attention of the advertisers

who have the power to turn it from an interest into a want, from a want into a need. In the course of the 1950s, information had come to be identified with the secret of life. By the 1970s, it had achieved an even more exalted status. It had become a commodity—and indeed, as we have seen, "the most valuable commodity in business. *Any* business."

THE DATA MERCHANTS

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HIGH TECH AND THE CONSERVATIVE OPPORTUNISTS

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The mass merchandising of information is one of the later chapters in the big economic story of our time. For the better part of the past generation, the American economy has been steadily shifting its center of gravity both financially and demographically. The movement is out of the old urban centers of the Northeast/Midwest and into the Sunbelt, out of the smokestack industries and into that complex of sophisticated new electronic/aerospace technologies called high tech. This historic transition has been visibly under way at least since the mid-1960s, say, since the building of the Cape Canaveral launch site in Florida and the Johnson Space Center in Houston. But it was not thrust significantly upon the public awareness until the early 1980s, when two best-selling books—*Megatrends* by John Naisbitt and *The Third Wave* by Alvin Toffler—packaged it for popular consumption and labeled it as the rise of the "information economy," the advent of the Information Age.[1]

Books like these belong to that immensely popular category of contemporary literature called futurology, an ungainly hybrid of potted social science, Sunday supplement journalism, and soothsaying. They feature breezy scenarios of Things To Come pitched at about the intellectual level of advertising copy. Sensational snippets

and zany catchphrases fill every page with breathtaking amazements; glittering predictions whiz by on all sides. Reading Naisbitt and Toffler is like a fast jog down a World's Fair midway. We might almost believe, from their simplistic formulation of the information economy, that we will soon be living on a diet of floppy disks and walking streets paved with microchips. Seemingly, there are no longer any fields to till, any ores to mine, any heavy industrial goods to manufacture; at most these continuing necessities of life are mentioned in passing and then lost in the sizzle of pure electronic energy somehow meeting all human needs painlessly and instantaneously.

Thus, Naisbitt, charting the "megatrend" from "industrial society to information society," describes the new economic order as one in which

> we now mass-produce information the way we used to mass-produce cars. In the information society, we have systematized the production of knowledge and amplified our brainpower. To use an industrial metaphor, we now mass-produce knowledge and this knowledge is the driving force of our economy.

In the space of three sentences, one notes that "information" has become synonymous with "knowledge," as if there were no significant distinction between the two, and we finish with the idea that *knowledge* is being "mass-produced." But since knowledge (like "brainpower," if this means something like intelligence) is the creation of individual minds and has a great deal to do with the quality of thought, what relationship—even of a metaphorical kind—does this bear to the assembly-line construction of a car from interchangeable parts? Depth, originality, excellence, which have always been factors in the evaluation of knowledge, have somewhere been lost in the fast, futurological shuffle. As we will see, this is a liability that dogs every effort to inflate the cultural value of information.

Naisbitt, however, is not one to loiter over fine distinctions. Rather, he hastens forward to call for "a knowledge theory of value to replace Marx's obsolete labor theory of value" because "in an information society, value is increased by knowledge." This leads him to the conclusion that knowledge (or is it information?) is destined to be the principal product (or is it service?) of our economic life in the near future. With approval he quotes an expert who ob-

serves, "We are working ourselves out of the manufacturing business into the thinking business."

It is difficult to see that writing like this (and the passage is typical) has any meaning at all, so deep are the confusions that underlie it. An industrial economy is fundamentally a manufacturing economy; high tech itself requires manufacturing. The technology is constituted of machines; the machines exist to produce hard goods, ultimately the food, clothing, shelter, and transport our flesh and blood demands. A high tech economy remains a manufacturing economy if the factories have been automated and the number of service occupations multiplies. Even when industrial capital is exported to foreign places (Taiwan, Hong Kong, South Korea), manufacturing has still not been eliminated from the economy, but only internationalized under the same ownership. It may then be interesting to ask why such relocation is happening and who decided to make it happen. We might then discover that the movement is taking place at the hands of multinational firms in search of a cheap, nonorganized work force and subsidies from needy, cooperative governments. It may also be important to ask with respect to such developments what their effect is upon our own economy. Is there, for example, the need to maintain some healthy balance between the production of goods and services, and can market forces alone be trusted to strike that balance?

These are not issues that much concern the futurologists. Answering them would take the discussion into many tangled and unpleasant areas of controversy regarding investment choices, the costs and conditions of labor at home and abroad, the social control of capital. They prefer frothier subjects: life styles, new commodities, consumer fashions. Mainly, they dwell upon the goods, services, careers, and amusements that will be available in the Information Age to affluent professionals and upper-middle-class families. They write to showcase the good times to come for those who can afford the benefits.

But if Naisbitt, Toffler, and company are meager of substance, they nevertheless brim with the sort of noncontroversial trendiness that easily catches on among business types and public officials in search of attractively packaged convenience food for thought. Thus, the Office of Technology Assessment has been quick to pick up the theme, somberly announcing in a major declaration that "the United States has become an information society dependent on the creative

use and communication of information for its economic and social well-being." The National Committee on Excellence in Education agrees in another key public document, hastening to recommend that all students be put through at least a half year of study in computer science.[2] For obvious reasons, AT&T endorses Naisbitt-Toffler economics in its advertising, extravagantly announcing that "Like it or not, information has finally surpassed material goods as our basic resource." It is, indeed, "a new form of capital, one that is arguably more critical to the future of the American economy than money capital."

More significantly, a growing contingent of politicians, who are always in the market for buzz words and quick fixes, has homed in upon the glowing prognostications of the futurologists. In the 1984 presidential primaries, Gary Hart sought to energize his "New Ideas" candidacy by vaguely associating high tech with the solution to America's economic troubles. In doing so, he was angling his campaign at a constituency that the Democratic party old guard had overlooked: the voters in the prospering Sunbelt cities and the young, highly educated professionals across the country. The gambit failed to gain him his party's nomination, but it did manage to strike a telling contrast with Walter Mondale's seemingly retrograde loyalty to America's decaying industrial cities and their stodgy trade union leaders, still mired in such drab problems as job security and a living wage. (Unkindly, the Mondale wing of the party has been called "reactionary liberal," mainly due to its position on high tech.)

Mondale took the nomination, turned aside from Hart's trendy rhetoric . . . and lost by a landslide. This fateful decision by the Democratic party leadership to gamble the election on the support of its traditional blue collar and ethnic constituency has opened a remarkable possibility in American politics. The high tech frontier may now be staked out by the radical right wing rather than the liberal center. Crusading Sunbelt conservatives like Georgia Congressman Newt Gingrich have been surprisingly quick to appropriate the glamour of the Information Age for their own purposes. Their goal has been to design a flashy, updated style of conservatism that borrows heavily upon the futurologists to create a sense of forward-looking confidence. "The most powerful force changing our society is the information revolution," Gingrich announces in a book (*Window of Opportunity*) which bears the endorsements of President Reagan, Congressman Jack Kemp, and Alvin Toffler. "It is as powerful as the

word 'revolution' suggests."[3] Gingrich's text offers a rapid tour of the high tech frontier: computers, aerospace, telecommunications. Even the words of Carl Sagan are pressed into service to validate the importance of "man's leap beyond the planet," which Gingrich, chairman of the Congressional Space Caucus, sees as a prime business opportunity. Indeed, once the space shuttle has been fitted out to accommodate tourists, we will have "populism in space."

Along with Jack Kemp and other congressional right wingers, Gingrich has organized the Conservative Opportunity Society as a major political voice of the Information Age.[4] COS defines itself as "high tech, futurist, populist, and conservative." It is "anti-tax, anti-welfare state, and anti-communist." Its intention is to retire the cautious, often dour image that has for so long characterized conservatism. Instead, the Conservative Opportunists mean to provide a sharp, upbeat contrast to what Gingrich sees as the "gloom and despair" of the liberals, with their concern for the environmental limits of growth. COS opts for a "bright optimistic future" that is briskly in step with technological progress. In the troubled 1960s, Gingrich observes, "our hippies overshadowed our astronauts and the anti-technological bias of the Left overshadowed the possibilities of the computer age." There was "an epidemic of technological abhorrence" abroad in the land, which led to "the negative mindset of the welfare state bureaucrats." It also produced widespread immorality, sexual license, and a general decline of patriotic and traditional values: "a life without God." COS means to reverse all that. It hopes that by way of massive supply-side tax concessions, it can offer the high tech entrepreneurs the incentives necessary for a new era of growth. Growth, the Conservative Opportunists insist, is the panacea for all the nation's economic ills: unemployment, inflation, trade imbalances. There are even some daring members of the movement who are prepared to cast the old fiscal conservatism to the winds as a drab remnant of the past. The economist Paul C. Roberts, once an aide to Jack Kemp, insists that even the sort of unprecedented deficits accumulated under the Reagan administration must be seen as "transitional or temporary" and should be cheerfully met by all the borrowing the Treasury Department needs to do.[5] In the sunny heavens of high tech, deficits are only passing clouds. Sooner or later, the information economy will outgrow its debts, no matter how large.

If COS makes good in its aggressive bid to take over the Repub-

lican party, the result will be a strange brew of old-time religion, social Darwinist ethics, anticommunist chauvinism, and Flash Gordon technology. Such a potent right wing alliance of the Sunbelt and the space age was shrewdly foreseen by the conservative analyst Kevin Phillips as far back as 1968. He called it "the emerging Republican majority" and recognized Ronald Reagan as one of its most promising leaders.[6] Several years later, in 1982, the equally conservative futurologist Herman Kahn would be boosting that majority as the secret of "the coming boom" of the Reagan presidency.[7] He depicted it as a coalition of social, economic, and defense conservatives grounded in the money and ethos of the Sunbelt. All that alliance needed, so Kahn argued, if it was to become the right wing equivalent to the Roosevelt New Deal, was "an ideology of progress" to offset the no-growth economic philosophy that became a popular talking point during the 1970s. And this he felt it had discovered in the futuristic dynamism of the information economy, the way forward to "a world of opportunities, glamour, options."

SUNBELT POLITICS AND
THE WARFARE STATE
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As the futurologists and their conservative disciples present it, the rise of the information economy in America is a matter of manifest industrial destiny, a change so vast and inevitable that it might almost be a natural process beyond human control. It is hardly that. The conversion to high tech is the result of deliberate choices on the part of our political and corporate leadership. It is intimately linked to the steady militarization of our economic life since the beginning of World War II, without which very little of our aerospace and electronic technology would exist at all. In their research and development, the high tech industries remain significantly tied to the Pentagon budget. That has long been obvious with respect to NASA and nuclear power, but the nation's two most important computer development investments are also funded and controlled from military sources. Most importantly, these include the Defense Department's Information Processing Techniques Office and the recently formed

twelve-company consortium, the Microelectronics and Computer Technology Corporation at Austin, Texas, which was launched under the chairmanship of a member of the National Security Council and CIA.[8] In 1985, fully $40 billion was spent on electronics by the Pentagon. This tie with the military establishment will become even more binding if the United States ever embarks upon the crushingly extravagant Strategic Defense Initiative (the "Star Wars" missile defense system), which began to acquire determined political and corporate support during the Reagan administration.

It is revealing that members of COS like Gingrich and Kemp are careful to make a special appeal for vastly expanded military spending as part of their program, regardless of the deficits that may result. However strongly the Conservative Opportunists may insist upon crash dieting the federal government to reduce its bulk and cost, the Pentagon is always exempted from the prescription. This is especially understandable on the part of Sunbelt conservatives; the come-lately prosperity of states like Gingrich's Georgia is vastly dependent on the largesse of the military. In 1985, Sunbelt states received 60 percent of the Defense Department's $260 billion in contracts; that is more than twice the share they were awarded in the mid-1950s. California alone—and mainly southern California, where far right conservatives like Barry Goldwater and Ronald Reagan have always found their most stalwart support—comes in for more than two and a half times as much defense spending as any other state, a full quarter of the 1985 Pentagon budget. Meanwhile, over the last thirty years, the Midwestern "rust bowl" has seen its share of military contracts dwindle from a third to a mere tenth; the only way many firms in that part of the country can enjoy a portion of the defense budget is by subcontracting for Sunbelt companies.[9] The more conservative mood of America during the 1970s and 1980s surely has much to do with the increased wealth and voting power of the Sunbelt, the traditional stronghold of retirement communities, evangelical churches, and generally nativist values. But, in turn, this rightward political tilt results in large measure from the steady Western and Southern diversion of military money over the past generation. The information economy would seem to arrive not only with a military bias but with built-in conservative demographics.

It is thanks to the financial leverage provided by this firm commitment to the warfare state that the corporate community has been able to engineer the wrenching break with America's industrial past

we now find ourselves in. In large part, the advent of the information economy means that our major corporations are rapidly retiring two generations of old capital or moving it abroad. As they do so, with the rich support of military contracts, they are liberating themselves from the nation's most highly unionized labor so that investment may be transferred into more profitable fields. High tech is not only glamorous; it pays off handsomely, especially if those who are collecting the profits are excused from paying the social costs that result from running down old industrial centers and disemploying their work force in favor of relocating in the mainly "right to work" (nonunion) Sunbelt states. Such costs of the transition are most often "externalized" by the high tech firms, meaning they are swept out of sight and ignored. But they remain a liability of the total economy that must be paid for eventually. For example, some two thirds of the "new jobs" created in our economy in the late 1970s and 1980s and so loudly trumpeted by the Carter and Reagan administrations are low-skilled, part-time service employment. When once highly trained factory workers are squeezed into work of this kind—say, as janitors, security guards, or fast-food servers—they have taken an economic drubbing. With them, whole sectors of the economy decline to a lower standard of living and diminished expectations. The labor movement sees this erosion of middle-class industrial jobs as the beginning of a permanent "two-tier society," with fewer and fewer high-paying jobs in the highly skilled nonunionized upper tier.[10]

For that matter, even those who find work in high tech may be hired on at drab, poorly paid, nonunionized positions. It is becoming notorious that the new microchip plants, as dazzling as their work may sound to the world beyond the factory walls, come close to being sweatshop operations for the low skilled, mainly female work force they employ. High tech is, in fact, already an example of the two-tier society, with practically no mobility across the great divide. At the top are the entrepreneurs, inventors, and engineers, who live and move in the industry's fast lane. At the bottom are the production workers, for whom, in the words of Everett Rogers and Judith Larsen, "Silicon valley means low-wage, deadend jobs, unskilled, tedious work, and exposure to some of the most dangerous occupational health hazards in all of American industry. It is a dark side to the sparkling laboratories that neither barbecues, balloons, nor paid sabbaticals can hide."[11]

For those who own the information economy, some of the most valued information in the business is the know-how of professional union busters, who have found one of their best markets in high tech. The industry remains almost wholly without labor organization in the United States. Even so, in the constant drive to cut costs, assembly-line high tech has proven to be highly exportable; it is easily relocated to Asia or Latin America, where the work force is usually younger and more female, meaning cheaper and more docile.[12] Further adding to the insecurity of those who work in the information economy is the prominence of risky and speculative investments within the high tech industries, where, since the beginning of the 1980s, we have seen whole markets—like that for video games, home computers, cellular telephones—rapidly cycle through from boom to bust.

What those who celebrate the information economy have overlooked is the fact that high tech, if it is to be an authentic long-term contribution to the wealth of the nation as a whole, must be gracefully grafted upon the existing industrial system, using its skills, labor, resources, and manufacturing centers. It cannot abruptly supersede that system and hope to stand alone. Yet that is what futurologists like Naisbitt suggest when they describe "the information economy" as something that stands in stark contrast to "the industrial economy" and must now replace it—not only with a new technology, but with a murky new "knowledge theory of value." Such a historical scheme is nonsensical. Information technology is an outgrowth of the existing industrial system, which has always been dependent on the "knowledge" that undergirds invention, management, and marketing. Like the electrical, automotive, or chemical technologies that came before it, high tech arises as another stage in the ongoing industrial process. These technologies do not displace one another; they overlap, compound, and must be coordinated. In high tech America, even computer enthusiasts remain more dependent for their survival on the fieldworkers who pick the crops and the construction workers who build the buildings than they do on computer programmers or investment counselors working with spreadsheets.

High tech is embedded in the texture of industrial history; it needs to be planned into existence. Otherwise—left to the whims and impulses of the marketplace as the Conservative Opportunists would prefer—it will become the same sort of jolting, humanly

wasteful leap from one economic stage to another that produced the worst hardships of the first industrial revolution. No humane society would choose a second industrial revolution that repeated the same mistakes.

But inevitably, as the nation's economic resources are catapulted into high tech, the output of that investment has to be sold. Some of these products—the missiles, space shuttles, laser weapons—will always be restricted mainly to military buyers. The computer industry, on the other hand, while heavily dependent on military contracting, has also had access to a good-sized civilian market, at least for its more expensive equipment, in business and public administration. The question arises: can the latest generation of micro- and mini-computers be merchandised on a larger scale as mass consumption items? Can the general public be persuaded to see information as a necessity of modern life in the same way it has come to see the refrigerator, the automobile, the television as necessities? The computer makers are wagering billions that it can. Their gamble has paid handsomely and lost disastrously with each turn of the business cycle. Yet, it is primarily from their advertising and merchandising efforts that information has come to acquire a cultlike following in our society.

MEGAHYPE
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Through the early 1980s, I found myself working on a science fiction novel dealing with computers and computer scientists.[13] As part of the exercise, I consulted several experts in the field with a view to sizing up the state of the art and its probable near future. Since information technology is fast moving, I felt I needed a baseline for the novel so that I might have some fairly reliable idea of what computers might (and might not) be able to do when the book got into print and for the next four or five years thereafter—the better to know where fact left off and fantasy began.

After talking to several experts and enthusiasts—some academic, some in industry—I realized I had a problem. When it came to the power of computers, nearly everybody I met was prone to vastly optimistic exaggeration. Machine translation . . . conversation in or-

dinary language . . . total mastery of chess . . . face and voice recognition . . . creative writing . . . legal decision making—there was nothing these machines could not do, or would not soon be able to do. How "soon," I would ask. The answer was never too clear. Possibly by next year, almost certainly in another two or three, for absolute sure by the end of the decade. In any case *sooner* than you might think. At one discussion I attended, one of the world's foremost authorities in artificial intelligence asserted his firm conviction that a computer capable of surpassing human intelligence in all fields was certain to be built . . . within the next five to five hundred years. For, *in principle* (this phrase comes to be repeated on all sides like a liturgical response), nothing is impossible.

It soon became clear to me what the source of this optimism was and why I was having such trouble pinning down realistic predictions about the future of computers. All these people—the academicians as well as the industrial experts—were part of the information economy. They worked in firms tied to that economy, or consulted for them, or were linked to academic programs financed in some degree by those firms or by their military customers. From the viewpoint of these funding sources, it was important to be upbeat and bullish about computers, for this was their merchandise. The experts easily adopted that viewpoint, because the health of the computer industry was the life's blood of their profession. Not only that, but the media, which frequently come by for interviews, are always in the market for amazing predictions; the journalists want authoritative reports that corroborate the futurologists. In turn, reports of that kind feed back into industry projections of future growth, helping to sell stock and attract venture capital.

In short, the experts were *selling*. They were in the habit of extrapolating astonishing "megatrends" for the press, the public, the funding agencies. It was only when I applied persistent skeptical pressure—say, with respect to machine translation, or the ability of computers to "read" and "summarize" a book, a story, a lecture— that I might finally evince an honest admission of how deucedly difficult such problems really were and how far off a solution might be.

But in the marketplace such pressure is absent, and so optimism is free to soar until it reaches the sky-blue zenith—at which altitude it is indistinguishable from conventional advertising hype. If one were to believe the public relations copy of the computer industry,

electronic data processing has become the heartbeat of the economy. Without it, our lives would come to a standstill. That may very nearly be true over a wide range of the business world. When the computers are down, the banks do not function, investments cannot be made, the planes do not leave the ground nor can their tickets be sold, the newspapers cannot be printed, inventories cannot be checked, bills cannot be sent or paid, more and more assembly lines must stand idle. Very likely the nation could not be defended from instant annihilation by its enemies.

Is it wise to commit the society so massively to a technology that is so vulnerable to widespread breakdown, error, sabotage, and criminal tampering? The computer makers and computer scientists have no doubt that it is. And having won the commanding heights of the economy, they are moving rapidly to find other frontiers for investment. The current effort is to graft the microcomputer on to as many aspects of daily life as possible, so that our homes, workplaces, and schools will soon be no less dependent on the flow of electronic information. Without a steady supply, the children will not be able to learn, checkbooks will go unbalanced, appointments will not be scheduled, taxes will not be paid . . . possibly dinner will not reach the table.

The office work force is currently one of the major targets of the data merchants. As word processor and electronic file case, the computer has an obvious place in the white collar world. With that much initial leverage among the paperwork occupations, the computer industry has raised the prospect of the fully automated office where paper itself will become obsolete. On the video surface of the "intelligent desk," we are told, there will soon be floating simulations of memos and reports. All company records will be on-line, data bases for every purpose will be instantly accessible through vastly integrated, all-in-one organizing-accounting-managing programs. Word-processed documents will be distributed far and wide from terminal to terminal and simultaneously filed with abundant cross-indexing. Electronic mail will be the rule. Speech recognition equipment will take over dictation; everything will function by voice command; even the computer keyboard will be obsolete. When it is necessary to hold a meeting, it will be done by teleconferencing among colleagues and contacts at all points in the building or around the world.

The fully computerized office will do for white collar work what

the automated assembly line has done in the factories: it will "save" labor by eliminating it, starting with the file clerks and secretaries, but soon reaching to the junior executives and the sales force. Possibly these casualties of progress will find work at Burger King down the street, where the cash registers come equipped with pictures, not numbers, or as the janitors who clean up whatever there is left to clean up at the end of the day—at least until these jobs are turned over to robots. There may soon be no one left in the high-rise ziggurats of our cities but a small elite of top-level decision makers surrounded by electronic apparatus. They will be in touch around the globe with others of their kind, the only decently paid work force left in the information economy, manipulating spreadsheets, crafting takeover bids, transferring funds from bank to bank at the speed of light, arranging "power lunches." As time goes by, there will be less and less for them to do, for even decision making can be programmed. As one team of management scientists has observed,

> There is no reason why we cannot program computers actually to take decisions and, by means of generating the appropriate piece of paper or other output, to implement their decisions by initiating action. There is no intrinsic difference between a business decision and the decisions which are involved in a production process control system—an area regarded as perfectly legitimate for computerization.[14]

At that point, even the corporate leadership will not have to report to the office. Most of what needs to be done by way of human intervention will be done out of the home. One forms an eerie vision of the high industrial future: a vista of glass towers standing empty in depopulated business districts where only machines are on the job networking with other machines.

As for the home, the futurologists have a computerized scenario for it as well. It will become an "information center" organized around a computer that is linked by its busy modem to a worldwide array of data bases. The new electronic family will read its mail and the news of the hour off a video screen; it will bank, shop, invest, learn, and play at its interactive terminal. Nobody need ever leave the house, which will become school and workplace by virtue of the earth-girdling information networks that serve it. The Japanese are already aggressively selling automated computer-designed houses. A

number of integrated home automation systems have also appeared at the more affluent fringes of the American marketplace. They have catchy names: Homeminder, Tomorrowhouse, Smart House. If one has the proper wiring to accommodate the master panel, the house can be set on automatic to heat, cool, and ventilate itself without human intervention; no need to finger the thermostat or open the window. The home will be continuously monitored by all necessary security and emergency services. As one walks from room to room at night, one will not even have to flip the light switches on or off; the energy-efficient computer will sense and respond to every move. Speaking appliances will intone advice and warnings about their own proper use. Alvin Toffler looks forward to a house of the future so electronically responsive that, should it detect a leaking toilet, it will automatically consult with all the other home computers on the street to find the name of a good plumber—and schedule the repair. He calls this living in an "intelligent environment." [15]

Even friendship and personal warmth will be electronically mediated: the home terminal will be linked with numerous computer bulletin boards that will supply conversation, advice, gossip, humor, dating services—all the social commerce for which people once had to go in search of human beings in clubs, cafés, pubs, parks, and bars. Toffler predicts the coming of "electronic expanded families," a sort of computerized commune that might span the continents. Another enthusiast, Myron Krueger, expects to see the computer mature into an "intimate technology" that can be programmed for "electronic sex." For example:

> A sequence of ministrations ordinarily requiring two hands could be carried out automatically, allowing the lover to lavish attention elsewhere, just as one can set up rhythms on an electronic organ. Indeed, it is just possible that sexual concerts may arouse the masses of the future. . . . It is possible to postulate circumstances that would lead to such a development and lead many people to accept it. [16]

An article in the magazine *The Futurist* takes these possibilities several speculative steps forward to what one would hope was intended as the ultimate absurdity. But the prediction is not offered in that spirit; it is dead serious.

> The ultimate house may be a structure whose computer brain, equipped with sensors and linked through telecommunications networks to computer data banks and the brains of other houses, has developed an awareness of its own existence, and an intimate knowledge of its inhabitants. . . . This development will greatly add to our ability to "believe in" the computer as a conscious entity. Once your house can talk to you, you may never feel alone again. [17]

As far-fetched, and perhaps as unsettling, as this image of conscious and attentive microprocessors may seem, Steven Jobs of Apple Computer expects something like this well before the end of the century. He speaks of it as a shift from the computer as servant to the computer as "guide or agent."

> It's going to do more in terms of anticipating what we want and doing it for us, noticing connections and patterns in what we do, asking us if this is some sort of generic thing we'd like to do regularly, so that we're going to have . . . the concept of triggers. We're going to be able to ask our computers to monitor things for us, and when certain conditions happen, are triggered, the computers will take certain actions and inform us after the fact. [18]

. . . let us hope apologetically, when they make the inevitable big mistake.

At times, one cannot decide whether to weep or laugh at what the Information Age supposedly has in store for us. Pamela McCorduck hopes to see the home of the future equipped with a "geriatric robot" that will solve "the problems of aging."

> The geriatric robot is wonderful. It isn't hanging about in the hopes of inheriting your money—nor of course will it slip you a little something to speed the inevitable. . . . It's there because it's yours. It doesn't just bathe you and feed you and wheel you out into the sun when you crave fresh air and a change of scene, though of course it does all those things. The very best thing about the geriatric robot is that it *listens*. "Tell me again," it says, "about how wonderful/dreadful your children are to you. Tell me again that fascinating tale of the

coup of '63. . . ." And it means it. It never gets tired of hearing those stories, just as you never get tired of telling them. It knows your favorites, and those are its favorites, too.[19]

It might almost be a Samuel Beckett play . . .

HACKERS AND HUCKSTERS

■

As far-fetched as this futuristic brainstorming may be, it reveals what the data merchants think the public wants. If they are right, they leave us with a dismal picture of our cultural state. One shudders to believe there can really be an audience that takes fatuous and infantile applications of the computer like these seriously. How many people can there be who need to have their every least activity mediated—and presumably validated—by a machine? Ironically, the worst casualty of such megahype may be the computer itself. It is a remarkable invention that deserves our admiration over a wide range of uses. But at the hands of its enthusiasts, this ingenious machine is reduced to a trivial plaything, the carrier of silly, sybaritic values.

There is a point, however, at which the public relations hoopla surrounding the computer shades off into a twilight zone where potted metaphysics and science fiction freely mingle. Here, the hackers and the hucksters become convenient allies in the task of lending the cult of information a much more intimidating character. We begin to hear heady predictions by knowledgeable people of computers that will one day be smarter than people. How smart? One computer scientist at the University of California blithely tosses off the remark: "I think there'll be an all-knowing machine someday. That's what we're about."[20]

Behind this line of thought there lies a long, steady process of anthropomorphizing the computer as a surrogate human intelligence. As long as the computer was simply a number cruncher, it was rarely seen as much more than a super adding machine. It took its first important step toward mindlikeness soon after World War II, when the word *memory* was adopted for its storage capacity. No one had ever used that word in reference to the old Hollerith busi-

ness machines. Their means of holding and processing data was too obvious and cumbersome; they were clearly doing nothing more than fast-shuffling punchcards which had to be fed in and taken out by people.

But with the invention of stored program machines like UNIVAC and more sophisticated magnetic core systems, it became far less apparent to the public how computers retained data. Where was all the information being hidden away in these increasingly more compact machines? The engineers spoke of the computer has having a "memory," an attribute of mind. The machines "remembered" things, vastly more things than people did, and—mysteriously— were able to produce total recall at the push of a button. On the other hand, when it came to human brains, it seemed obvious that, as computer scientists like Robert Jastrow observed, "The amount of information and wiring that can be crammed into a cranium of fixed size is limited."[21]

Now, there is no evidence that human brains are anywhere near exhausting whatever limit they may have; nor do we have any reason to believe that cerebral volume has any relationship whatever to the function of thought, even to that of remembering. Is it possible that what we loosely refer to as "forgetting" in the human brain is exactly that form of storage and processing which makes information most usable for significant thinking? Might it be the case that the retention of too much data—more than a single mind can judiciously deal with—compromises the quality of thought? In print or in person, I have surely come across a great many people who lose their intellectual way in a forest of facts. "Data, data everywhere, but not a thought to think."[22] On the other hand, a rather decent amount of important culture has been created over the millennia by societies that, perhaps with good reason, placed little value on the collection of raw data. These are not views one would expect the data merchants to entertain. Instead, they fall back on the authority of the computer scientists, who make it possible for companies like Sony to advertise a computerized tape deck that is "so ingenious it actually compensates for the shortcomings of your memory."

Once the faculty of memory was metaphorically conceded to the machines, their mindlikeness was free to soar to superhuman heights. For if thinking is essentially data processing, as the cyberneticians insisted, then the mind that holds the most data is poten-

tially the superior mind, especially in the complex modern world, where there is far too much information reporting in for human brains to handle.

> The human mind [observes the Stanford University cognitive scientist Avron Barr] not only is limited in its storage and processing capacity, but it also has known bugs; it is easily misled, stubborn and even blind to the truth. . . . Intelligent systems, built for computer and communications technology, will someday know more than any individual human being about what is going on in complex enterprises involving millions of people.[23]

The futurologists have been quick to pick up on this theme: modern social complexity leads to computer supremacy. "An information bomb is exploding in our midst," Alvin Toffler announces. "People and organizations continually crave more information and the entire system begins to pulsate with higher and higher flows of data." We have already reached the point where "no one can keep the many complexities in mind while trying to think through a solution to the problem." But salvation is at hand.

> Because it can remember and interrelate large numbers of causal forces, the computer can help us cope with such problems [i.e., crime, housing, urban decay] at a deeper than customary level. It can sift vast masses of data to find subtle patterns. . . . It can even suggest imaginative solutions to certain problems by identifying novel or hitherto unnoticed relationships among people and resources.[24]

In a passage like this, one notes how the computer has been personified into a mental agency apparently working on its own initiative. Its power to store data has mysteriously matured into the power to find "subtle patterns" in society and to suggest "imaginative solutions" to political dilemmas.

A remarkable machine indeed. Does it exist? Will it ever? The author does not say. Why should a pop sociologist hold himself responsible to a higher standard of credibility than the scientists and technicians who are in charge of the technology? Computer scientists I. G. Good and Christopher Evans have blithely predicted the inven-

tion of an ultra-intelligent machine (UIM) somewhere in the 1990s which will be far smarter than any human intelligence and quite capable of taking over all major political decisions, including matters of war and peace.[25] Good, writing in the early seventies, was even then looking forward to a time when the UIMs will go into business on their own and produce "an intelligence explosion."

> The UIM will enable us to solve any practically soluble problem and we shall perhaps achieve world peace, the elixir of life, the piecemeal conversion of people into UIPs (ultra-intelligent people), or the conversion of the world's population into a *single* UIP.

In a book titled *Machines Who Think,* Pamela McCorduck, who works in Stanford University's artificial intelligence program, goes that prospect one further. She predicts that the UIM will "convert the entire universe into an extended thinking entity."

In what spirit do computer enthusiasts offer up wild prognostications like these? It is hard to say. Sometimes, as in the case of Good's remarks, there is a marked pathos behind the exuberance. In such an ultimate extension of "user friendliness," the computer has been cast in the wishful role of a benign angelic protector that will relieve us of adult responsibilities that have become too burdensome. On the other hand, some computer scientists appear to relish the tough-minded bravado that comes of debunking what they take to be human delusions of grandeur. Marvin Minsky of MIT is in that category. Over the years, he has cut a colorful public figure in the media by impishly sniping at whatever anyone nominates as a special, possibly rather complicated quality of the human mind: common sense, judgment, intuition, creativity. Or, for example, emotions. Nothing very remarkable there, Minsky tells us: "I think we'll be able to program emotions into a machine once we can do thoughts. . . . I'm sure that once . . . we've decided which emotions we want in a machine, that it won't be hard to do."[26] Working from such a minimal conception of human personality, Minsky has no difficulty concluding: "I think what we have learned is that we are probably computers." Such facile remarks are not without their influence. Sherry Turkle, who has made a study of children in highly computerized schools (including one much influenced by the work of Minsky's MIT artificial intelligence laboratory), found students

who readily characterized themselves as "feeling computers, emotional machines."[27]

Whatever the intention behind these speculations, we see reflected in them a well-developed motif in Western technological history. The machines we have invented might be said to fall into two major categories: *strong machines* and *smart machines*. Strong machines (the steam engine, dynamo, airplane) have had their share of public appreciation; but smart machines have elicited a very different response, a sense of self-effacing awe that has more than a touch of the pathological about it. The original smart machines were various kinds of clocks, governors, and player piano–type animations. We may no longer be that much impressed by the quaint old counting and timekeeping instruments we see in museums, but for some centuries of our past, clocks and clockwork devices exerted a strange charm over Western thought. The clock was, after all, a machine that seemed to be able to enumerate and regulate; it appeared to possess a sense of intelligent, mathematically precise order that had long been regarded as a peculiarly human gift. The clock's connection with mathematics—even if it was nothing more than regular counting—was especially fascinating to the scientists since it echoed their own taste for exact, objective measurement. Clockwork mechanisms, like music boxes and various wind-up toys, could be "programmed" (as we would say today) to mimic intelligent activities: even to play musical instruments, to write with pen on paper, to play games.

In contrast to strong machines, whose status has always been that of beasts of burden (hence we measure their strength as "horsepower"), smart machines have normally been treated with far more respect. They have a seductive appeal to the scientific imagination, which has freely borrowed them as models of the universe at large, often reshaping our experience of the world to make it fit that model. And in this there can be the real danger that we fall prey to a technological idolatry, allowing an invention of our own hands to become the image that dominates our understanding of ourselves and all nature around us.

The computer is the latest episode in this scientific infatuation with mechanistic metaphors borrowed from smart machines. Once again, as in the age of Newton, the scientists need to be reminded that the organisms (human beings) which came before mechanisms

are far more remarkable pieces of work than the tools they may occasionally invent when they are not spending their time singing songs, making jokes, telling tales, or worshiping God.

SILICON AND NATURAL SELECTION
■

In the early 1920s, Karl Capek wrote a play called *R.U.R.* in which the concept (and the word) *robot* first appeared. The robot was a sentient clockwork mechanism, a machine with a human face. More than an abstract model of intelligence, it could be imagined as having a life of its own. For example, in Capek's play, the robots turn into restless metallic Marxists; they rebel against their human exploiters and take over. This image of the humanoid machine has given rise to a line of thought that is now well represented among the computer enthusiasts as the ultimate expression of mechanistic supremacy. The computer has received an evolutionary interpretation which marks it out for a spectacular destiny. It may survive its maker and become the dominant species of "life" on earth.

This is a fresh note in the Western world's technological history. The theme has emerged in any number of science fiction tales; but as of the early 1960s, there were computer scientists who had begun to take some of their own metaphors seriously and literally. If the computer is a "brain" possessing "intelligence," might it not be likened to a biological "species"? And if that species is passing through "generations" in its development, then might it not be said to be "evolving"?

Of course, many machines—refrigerators, automobiles, vacuum cleaners—also undergo progressive improvement as they pass from model to model. We do not ordinarily speak of this as evolution. But when we come to the computer, its status as a smart machine places it in a special category. It is not simply accumulating improvements; it is becoming more sentient, more mentally competent, more autonomous.

John Pfeiffer of MIT was among the first to entertain the proposition that the computer's development deserved to be thought of as evolution in the strict, literal sense of the word. In his book *The*

Thinking Machine (1962) he argued that the computer was, uniquely, a technology whose limits could not be specified. This gave it a certain unpredictability, almost a willful freedom over against its human maker. "From this standpoint, the machine is always ahead of him, and will be ahead of him for an indefinite future." Especially under pressure of "the information explosion which already threatens to overwhelm us," human beings will have to allow the computer's unrestrained development to continue. This will make "the evolution of computers . . . a significant part of human evolution."[28]

Thinking along similar lines a decade later (1972), John Kemeny of Dartmouth, inventor of the BASIC programming language, was prepared to forecast a "symbiotic evolution" on the part of the human and computer "species."[29] With the human race facing the threat of extinction on many fronts, he saw such a "significant evolutionary change" as our best hope for making appropriate use of the "information-rich world" we had created around us.

These were benign predictions that still imagined a humanly beneficial coevolution on the part of human beings and computers. But some artificial intelligence experts are not at all convinced that the computer's evolution need be synchronized with that of the obviously deficient human brain. "The amount of intelligence we humans have is arbitrary," Marvin Minsky observes. "It's just the amount we have at this point in evolution. There are people who think that evolution has stopped and that there can never be anything smarter than us." Minsky disagrees; that would be like saying "that a person can't build a house any higher than he can reach."[30]

These evolutionary speculations tie in neatly with the idea that social complexity necessitates computer dominance. In effect, the conditions of modern life become a selective force that favors a new species, one better adapted to the scale and pace of the industrial future. Dr. Gordon Pask has called the new entity "micro man":

> The rapid proliferation of computation, communication, and control devices is coming to form what we call the "information environment." We believe, however, that the change is not merely quantitative. Underlying it are much deeper qualitative changes in the relationship between machines and human beings. These changes . . . are leading to the evolution of a new species, a species we have dubbed "micro man."[31]

Is micro man human or mechanical? Pask believes the question is beside the point. "The distinction between human thought and machine thought is becoming untenable. We envisage a revolutionary expansion of mind, be it individual, social, or wrought in material-other-than-brain-stuff."

It is important to underscore the assumptions that inspire these visions of human obsolescence. If thinking is simply a matter of information processing, then indeed there is no significant distinction to be made between the way human beings think and machines think, except to recognize that machines are better at the task. And if processing information is the commanding need of the time, then the machines obviously have to be granted a selective advantage. But what sort of "selection" are we discussing here? Not natural, but cultural selection surely. The "information environment" is, after all, a thing of our own making. It should, therefore, be within our power to change it to serve our own values. It is a grim vision of life that assumes we must timidly become the victims of the culture we have created.

How far can that fatalistic scenario be pushed? Robert Jastrow foresees the computer as the advent of an "intelligence beyond man's." It is "the child of man's brain rather than his loins" and "will become his salvation in a world of crushing complexity." But that alliance of human and machine will be unstable. The computer will continue its runaway evolution. Whereas

> human evolution is a nearly finished chapter in the history of life . . . We can expect that a new species will arise out of man, surpassing his achievements as he has surpassed those of his predecessor, *Homo erectus*. . . . The new kind of intelligent life is more likely to be made of silicon.[32]

At this high level of speculative fever, we are no longer discussing the mere cleverness of machines; the moral resolve and biological fitness of our own species are being weighed in the scales of evolutionary survival . . . and found wanting.

There is a fascinatingly convoluted interplay of ideas at work here. At first, the biologists borrowed from cybernetics to explain genetics as an information transfer mechanism. Here, we see the computer scientists borrowing from biology to suggest the evolution-

ary nature of data processing technology. Culture is like that; it often grows by metaphorical elaboration, one field of thought borrowing from another for suggestive images. But at a certain point, metaphorical elaboration becomes plain bad thinking. That point is where the metaphors stop being suggestive and are taken literally.

Nevertheless, slipshod thinking like this, voiced by experts in the field, has become mixed into the folklore of computers. It permeates the technology with a haunting sense of human inadequacy and existential failure. On the surface, the futurologists and the data merchants offer effervescent promises of convenience, affluence, fun and games; but their breezy optimism is laid over dark speculations about human obsolescence. That despairing motif comes with the machines and cannot help but shape our response to the new technology, even in its most trivial applications. Have we created something like a mind, one that is better suited to the alienating conditions of modern society, better able to cope with the pressure, the anxiety, the moral tension? If that were so, it might be taken as a damning judgment upon the inhumanity of the social order we have created for ourselves. But some computer scientists clearly regard it, instead, as an indictment of human nature itself; we possess a mind which is not fit to survive. That conclusion might be left floating at a high speculative level awaiting the outcome of the next thousand or million years of evolutionary selection. But in the meantime it can be given significant political substance. It can lead to the self-serving argument that more power should be entrusted to the machines the computer scientists have invented and control.

TECHNOPHILIA
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To some degree, the ideas we have reviewed here, zany and extravagant as they may be, are part of a tradition that is as old as industrial society. They may be seen as extreme expressions of technophilia, our love affair with the machines in our lives. This is not the first time people have projected their hope for happiness and their image of perfection upon the latest magic gadget to come along. The steam engine, the electric dynamo, the automobile, the airplane—each in its time held a similar position as the reigning emblem of progress.

Such technological infatuations come and go as each new wave of invention and investment makes a place for itself in our dynamic industrial economy. A century and a half ago, a Victorian futurologist filed this bit of doggerel with the *Illustrated London News:*

> Lay down your rails, ye nations near and far—
> Yoke your full trains to Steam's triumphal car.
> Link town to town; unite in iron bands
> The long-estranged and oft-embattled lands.
> Peace, mild-eyed seraph—Knowledge, light divine,
> Shall send their messengers by every line. . . .
> Blessings on Science, and her handmaid Steam!
> They make Utopia only half a dream.

What was the object of his utopian aspirations? The railway. With the benefit of hindsight, it is easy to see how naive and overwrought such expectations can be. Still, for the most part, we might be willing to bear with the salvational longings that entwine themselves around new technology. I think, however, the current fascination with the computer and its principal product, information, deserves a more critical response. This is because the computer does so ingeniously mimic human intelligence that it may significantly shake our confidence in the uses of the mind. And it is the mind that must think about all things, including the computer.

In our popular culture today, the discussion of computers and information is awash with commercially motivated exaggerations and the opportunistic mystifications of the computer science establishment. The hucksters and the hackers have polluted our understanding of information technology with loose metaphors, facile comparisons, and a good deal of out-and-out obfuscation. There are billions of dollars in profit and a windfall of social power to account for why they should wish to do this. Already there may be a large public that believes it not only cannot make judgments about computers, but has no *right* to do so because computers are superior to its own intelligence—a position of absolute deference which human beings have never assumed with respect to any technology of the past.

As it penetrates more deeply into the fabric of our daily life, enjoying at every step along the way the exuberant celebration of its

enthusiasts and promoters, the computer holds the possibility of shaping our thought, or rather our very conception of thought itself, in far-reaching ways. This is all the more likely to happen within the near future because of the massive scale on which the computer is entering the schools at all levels and there forming an entire generation of students.

THE HIDDEN CURRICULUM

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THE CHIMERA OF COMPUTER LITERACY

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In an effort to prime the pump for future sales of its product, the computer industry is currently making its wares massively available to universities and entire school systems at cut rate or free of charge. In California, which might be expected to set the national standard for high tech education and where (as of the mid-1980s) 80 percent of the schools had computers, Apple Computer has placed one of its machines as a free gift in every school in the state. This amounts to some 10,000 computers valued (as a tax write-off for Apple) at $20 million. Atari, IBM, and Hewlett-Packard have been quick to make similar offers, spurring Apple to propose placing a free computer in every school in the United States—something approaching 100,000 machines. The U.S. Congress has, however, refused to grant Apple's requested tax credit of $64 million for the donation.[1]

As the market for home computers sharply tapers off, the effort to place microcomputers in the schoolrooms of the nation has become more intense. But even without the benefit of such corporate favors, the number of computers in the country's public schools in 1983 stood at about 350,000, more than twice what it had been the year before. In 1984, the number doubled again to 630,000, which averages out to better than six machines for every public school and about one machine for every seventy-two pupils. Supposedly, the

increase in school computers will double annually through the 1980s, reaching a pupil–computer ratio of one to fourteen by 1990; some educators predict a one-for-one ratio will be attained by the mid-1990s: a computer on every desk. America is not alone in this effort; with strong government backing, the British, French, and Japanese are also pressing to computerize their classrooms. In Japan 70 percent of the high schools are scheduled by the Ministry of Education to have computers before the end of the decade; the French have launched an official campaign under the banner "100,000 Computers in Our Schools" targeted on 1995. The British, with the benefit of generous government subsidies, lead the pack with over 98 percent of the schools microcomputerized.[2]

In the United States, the machines are by no means evenly distributed. As one would expect, they tend to accumulate in the richer school districts. Seeking to offset such imbalances, a majority of the California legislature has called for the spending of some $30 million per year through the late 1980s to make certain that every student in the state, rich or poor, spends at least one hour each week in front of a video display terminal. Congress has debated (and tabled) several bills aimed at closing the computer "equity gap" between school districts; one proposal has called for budgeting up to $700 million a year to do the job of spreading computer literacy evenly across the nation.[3] The National Committee on Industrial Innovation—a citizens' group organized by former California Governor Jerry Brown —has taken a slightly different tack. It calls for the establishment of one demonstration school in each state devoted to fully computerized instruction, a recommendation which would cost some half a billion dollars.[4]

These are ambitious and costly plans. By way of keeping matters in perspective, some, like Governor Brown, have observed that none of the programs under discussion would cost as much as a single Trident submarine. True enough; but it is also the case that these educational millions are being budgeted for machinery at a time when the average teacher in American has a starting salary of $13,000—barely above the official poverty level. Against that background, what all the proposals highlight, with their belated call for rational planning, is that the computer has made a wastefully ragged and disruptive entry into the school systems of the nation. For the most part, the schools (or mainly trend-conscious administrators and anxious parents, less so teachers) have responded with the prompt-

ness and the gullibility of well-trained consumers to the commercial pressure of the computer industry. The instant folklore which has been scripted by the data merchants holds that children have a "natural affinity" for computers which "can be a powerful tool for teaching the information skills needed for life in an information society."[5] Indeed, so great is the instinctive love and skill that children bring to the computer that their troglodytic parents and teachers, like a species on the brink of extinction, may be in no position even to understand the passion that stirs in their offspring, let alone offer instruction. "Today's moms and dads must feel much like European parents felt in the nineteenth century when their children were emigrating to the New World," writes educator Barbara Deane. "Here we stand, not only waving our children off into a brave new world that we can scarcely imagine, but expected somehow to provide them with guidance in the use of computers—giving them maps, so to speak, of a land we do not know." Similarly the creator of a British computer literacy program tells us that "in the future, our children will be thinking in ways that we can't even envision at the moment. The computer is providing them with an intellectual tool that they can drive and control to achieve mental feats which we would probably consider absurd—if we knew what they were likely to be!"[6]

In the 1960s there was much talk of a generation gap; but that was understood to be a moral and political discrepancy. In the Information Age, the gap is purely technological, a matter of programming talents and keyboard virtuosity. "Kids and computers click," possibly in a way that leaves their parents no option but to stand aside and watch with amazement—but only after they have gone shopping and bought the equipment.

Undeniably, some kids click with computers. The emphasis, however, belongs on *some*—as in the phrase, *some* kids click with violins, or *some* kids click with paintbrushes. But there are no millions being spent to bring violins or paintbrushes into the schools. Initially, there was a simple justification for favoring computers over violins in the budgetary priorities of the schools. It was embodied in the catchphrase *computer literacy*—a seemingly undeniable necessity in the Information Age. Lacking that skill, children would grow up to be unemployable. In Britain, Apple has been crusading to computerize the schools with the slogan "Our kids can't wait."

But what is computer literacy? The original meaning of the phrase had to do with teaching programming—mainly in BASIC, the

simplest and most widely used of the high-level computer languages. But by the late 1970s, doubts had arisen. For one thing, many computer scientists had come to regard BASIC as a limited and retrograde choice among the many languages available. But more importantly, why teach programming at all when there is so much preprogrammed software coming on the market? For most purposes, the software does the job better than a rough, amateur program. There seemed to be no general need for the skill, outside of preparation for a career specifically in programming, which requires much more training than schools can provide. True, it somewhat demystifies computers to learn a little basic programming—if it is taught correctly. (The same can be said of learning how to take apart a car, or a stereo, or a refrigerator—all skills that help one penetrate the secrets of modern technology.) But is it worthwhile to give children any hands-on training at all in the use of a machine that changes so much from year to year? Does it pay to learn word processing by way of WordStar when superior programs, like WordStar 2000, or better still Macwrite, are on the way? The fact is, each new generation of computers requires fewer special skills, requiring less "literacy" of users, in much the same way that advances in automotive engineering have made driving a car easier.

As programming slipped out of the curriculum, computer literacy became more and more of an educational chimera. Teachers were often left with no better employment for their computers than to use them as electronic flashcards or for low-grade drill and practice at basic subjects—no great advance upon the less than enthralling computer-aided instruction materials and teaching machines of the 1960s. Some states (California, New York, Virginia, Minnesota) have spent generously to train their teachers in various computer skills, but that does no good when there is no clear idea as to whether the schools are to teach *about* computers, or *through* computers, or *by way of* computers.

Another problem: generally, teachers have found very little in the way of programmed instruction that integrates with existing curricula and their own experienced teaching methods. Should they, therefore, retool to fit the demands of the machine? Would that be "cost effective"? Even if they are willing to do so, which software are they to choose? There is a strong consensus among educators that most of what the market has to offer is poor, usually no better

than crudely adapted video games with some immediate visual appeal but little intellectual substance. One major professional survey by the Minnesota Educational Computing Corporation estimates that, as of 1984, only some 200 of the 10,000 educational software programs on sale were of any value.[7] Here the federal government has moved to help clear a path for the computers to enter the classroom. The Department of Education has awarded Harvard University a $7.7 million grant to establish an Educational Technology Center, whose purpose is to test and develop superior software. One dilemma with which the center is apt to confront the schools: good software is expensive to use. Students may quickly exhaust the benefits of low-grade software; a few minutes apiece at the machine, and they may have finished the drill or solved the problem posed by a trivial game. On the other hand, software which is challenging, absorbing, and highly interactive—and there is at least a smattering of that around—is machine-time intensive. Each student has to be given a decent chance to work out the problems. At best, the materials can be used in small groups. In any case, there have to be more machines. It might almost be expected that the computer industry would have a vested interest in high-quality software, if only as a means of selling more of its hardware.

A SOLUTION IN SEARCH OF PROBLEMS
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Joseph Weizenbaum of MIT once described the computer as "a solution in search of problems." There could be no better example of this than the way elementary and high schools are dealing with the machine. As things now stand, there is an atmosphere of urgent concern nationally and locally about *somehow* putting this magnificent solution to work in the schools—if only the right problem could be identified. The concern is understood to be something we owe our children but which also relates to national prestige and power. There is much talk about "catching up" or "staying ahead," about training the prospectively jobless and selecting the gifted for rapid advancement. But when it comes down to actual classroom assignments, is the computer to be a *subject* or a *vehicle* of instruction? If

it is a vehicle, what materials is it to carry? How much of the curriculum should it be allowed to take over? Is the curriculum to adapt to the computer, or the computer to the curriculum?

Obviously, these questions should be answered before purchases and retraining programs are budgeted. But once the computers arrive, either paid for or free of charge, it is difficult not to do *something* with them. So the teachers scramble to improvise educationally defensible uses. Perhaps sometimes they succeed.

Hovering over the cloudy concept of computer literacy there is the standard futurological assumption that the machine will someday connect the students with a wealth of data and make them citizens in good standing of the Information Age. As a matter of fact, few if any schools are teaching students how to access and search data bases. Wisely so; teaching that complex skill would surely be premature (and highly expensive) at any point before college. Meanwhile, the only information the children are receiving from the computer is that contained in software designed to teach, or help teach, the existing curriculum. In this respect, the machine has less information to offer than a textbook or workbook. Its data processing is necessarily being limited to the job of supplementing the text or other classroom materials: illustrating, animating, testing, and drilling. Some computer enthusiasts regard this as a low-grade use of the computer; "a waste of time, energy, and money," comments Robert Scarola. Such software "reinforces the idea of computers as routinizing machines."[8]

Those who believe the computer does these supplementary things well argue that it offers the student attractively animated displays and simulations to work with, plus self-paced, individualized instruction. Above all, it is instantaneously interactive. This means that instead of having to wait for a paper or workbook to be graded, and so losing momentum, students see their responses evaluated and corrected before their very eyes as soon as they give them. Often the machine gives them some cute electronic strokes for good work. It pipes a cheery little tune, beeps, flashes, shows a smiley face, or conjures up a little froggy figure to perform a victory dance.

As a matter of personal taste, I must say that I find the pictorial animations and most of the graphics that computers bring into the classroom to be aesthetically degraded, even ugly. The pictures may move, but they are nonetheless an eyesore. Computer art at the level of the most expensive animated and three-dimensional graphics soft-

ware can be authentically creative. But nothing remotely like this is apt to make an appearance in the schools. For one thing, the equipment is fabulously expensive, since it takes a great deal of heavy-duty mathematical processing to compose a fine-grain color picture. (The computer graphics generator marketed by Lucasfilm's Industrial Light and Magic division costs over $125,000.) For another, only trained professionals can use these machines properly. The animations that one finds in most affordable educational software may be clever by ordinary machine standards; it probably takes thousands of lines of code to program all the choppy, pixel-blockish gyrations. Hackers take satisfaction in that, but theirs is hardly a reliable artistic standard. Much of what they praise is just wretched to look at; it does not even come up to a mediocre Walt Disney level of cartooning. Have computer enthusiasts ever honestly pondered what long-term visual exposure to such junk art does to children's taste? Even worse, some teachers try to make use of the computer's low-grade graphic abilities to teach "art," lowering the subject to the level of the machine. One exception here may be the remarkably flexible Apple Macpaint program, which does a striking job of simulating the capacities of pencil and brush. But even so, why is this preferable to training the hand in the use of a real pencil and brush directly on paper?

In any case, animation (such as it is) and interactiveness are unquestionably the computer's most worthwhile educational features. Where drill and problem solving are concerned, it is always best to have a quick comeback. But this could, of course, be provided by the teacher—if there were enough teachers. The computer makers are banking on the assumption that there will never be. Their hope is that, given the choice between hiring people and buying machines, the public will not prove willing to pay the price of humanly individualized instruction and humanly interactive classrooms. Indeed, they are helping things turn out that way by spreading the word that: (1) teachers hate drill and exercise and would prefer to be freed for other, more creative purposes; and (2) teachers are very bad at drill because they become impatient and bossy, whereas (3) the computer is "the most patient of teachers."

If, on the other hand, you ask unemployed teachers if they are unwilling to be hired to handle drill and exercise, you are apt to get another viewpoint. They may even tell you they believe they can do the job with care, flexibility, and imagination out of their profes-

sional concern for children. What computers may be freeing most teachers for is joblessness. And that is a pity. Because even at the low-level task of drill, it helps to have a human intelligence at work, offering an encouraging smile here, a jibe there, a wink and a nod, perhaps catching the blush or stammer that reveals the nature of a student's problem. Isn't all this utterly obvious? Why, then, does it drop out of sight as soon as computers are under discussion? I had teachers who were quite adept at handling classroom exercises with patience and sensitive watchfulness; I could not have been alone in that experience. In any case, what does it do to the students' morale to be told that the drill they need in order to learn is a great bore, or possibly an obstacle to the teacher's "productivity"?

Currently, the hottest item on the computer industry's educational agenda is the "intelligent machine tutor," under development by IBM, Xerox, and Apple, among others. Hewlett-Packard has donated some $50 million to various universities to work up some combination of artificial intelligence and laser disk video graphics that might function as a "computer tutor" capable of teaching abstract concepts and engaging in spoken conversation. For computer scientists, it is no doubt exciting to ask: "Can we invent a machine that does what a teacher does?" But there is another question one might ask: "Why should we want to invent a machine to do that in the first place?" There was never any difficulty in answering that question where the machine was intended to take over work that was dirty, dangerous, or back-breaking. Teaching is hardly any of these. Indeed, it would seem to be one of those "human uses of human beings" to which people might expect to turn when the robots have "saved" their labor on the assembly lines.

There is no way around the fact that the computer makers have a vested interest in the technological unemployment of willing and available teachers. They are selling a labor-saving machine in an economy where that labor is abundant and could be had for a decent wage. Whenever the little stick-figure froggy does its dance, there is a would-be teacher somewhere who does without a paycheck.

Other than functioning as a mechanical teacher's aid—or teacher's replacement—does the computer offer anything distinctive as an educational device, something all its own that a teacher could not do as well? There are educators who believe it does. (In the next chapter, we will review one of the most impressive proposals of this kind: the Logo program of Seymour Papert.) Here, we will note that the

best interactive, problem solving software—games like the much-praised *Rocky's Boots* (created by Warren Robinnet and available from The Learning Company)—can bring unique features into the classroom. These are mostly playful, animated exercises in symbolic logic. The animations are as dreadful as any, but the concept behind the games is sophisticated and could not be executed with the same challenging quality except on an interactive computer. Software of this caliber is special; it is also potentially very expensive to use since it is machine-time intensive for each child. The better the software, the more hardware a school may have to buy to give all the students a chance.

Is the teaching of symbolic logic justified? Well, why not? It is intellectually substantial as a subject in its own right. Some would argue that it has a more general benefit: it can help train the mind to think clearly. That is a somewhat antiquated and dubious assumption. It is grounded in the creaky old idea of faculty psychology, which holds that there are certain mental muscles, like logicality, which should be developed for their general utility in life. For centuries Latin was doggedly taught in the schools on the same mistaken premise that it contributed to orderly habits of thought. Like the Latin masters of old, computer scientists understandably feel the same way about their favorite subjects: mathematics and logic.

Probably symbolic logic teaches nothing more than symbolic logic; but some students are good at it, enjoy it, and deserve to have the experience along with whatever else they are offered in the classroom. It can do no harm; whether it justifies the cost of the technology is another matter. But of one thing educators can be certain, and on this point they owe their students absolute candor. Clever educational software like *Rocky's Boots* will make no greater contribution to the students' employability than will rudimentary courses in outmoded forms of programming. In the job market students will face when they leave school, the choice high tech careers will require many years of more professional and specialized education. Even so, those careers will be for the high-achieving few. For the many, the five most available jobs in the information economy will be employment as janitors, nurse's aides, sales clerks, cashiers, and waiters.[9]

One might almost conclude from this fact that what the young most need to defend their interests in life is an education which will equip them to ask hard, critical questions about that uninviting prospect. Why is the world like that? Who made it that way? How else

might it be? There are subjects that, when properly taught, help people answer those questions. They are called social science, history, philosophy. And all of these are grounded in the sort of plain, old-fashioned *literacy* that gives inquiring minds access to books, to ideas, to ethical insights, and social vision.

THE COMPUTERIZED CAMPUS
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The computer has entered the world of higher education a great deal more smoothly and decisively than it has made its way into the elementary and secondary schools. Universities, after all, have more internal control over their choices than do bureaucratically congested school systems. This is also the province of learned men and women, scholars and experts who are supposedly prepared to make discriminating judgments that rise above the whims of the marketplace. Yet the campuses have also been targeted for a massive merchandising campaign by the computer makers, and the effort seems to be sweeping all before it.

Many leading universities purchased their first computer in the mid- to late 1960s, one of the IBM hulking giants. It became *the* campus computer, a proud and expensive possession that was frequently displayed as a sign of status. It was usually parked in an air-conditioned computer center and used mainly for administrative data processing. In short order, school records became computer printouts; grades and scheduling were done with punchcards. The better endowed schools, especially those with strong science departments, quickly moved to acquire a few more of these big mainframes for their technicians; these were used as widely as possible on time-sharing arrangements that were often the arena of intense competition and bickering on the part of the faculty.

By the early 1970s, the universities began to set up multiterminal computer labs, where students as well as faculty might be permitted to lay their hands on the technology. Once again, prestigious departments would push to have their own, autonomous labs for their majors as a sign of status. About this time, optional courses in computer programming began to appear, mainly for students in the sciences, engineering, and business. The society was by then becoming

highly computerized in all its major sectors; but there were few educators who thought computer literacy, in any interpretation of the term, had an urgent place in higher education. Significantly, things changed in the universities when the market changed. In the 1980s, with the advent of the microcomputer, a readily salable item, the computer industry went after academia with one of the most intense mass marketing efforts in business history. The goal has been nothing less than to place computers in the hands of every teacher and student. With the help of grants, donations, and stupendous discounts ranging up to 80 percent, the companies have succeeded in striking a number of what they hope will be bellwether deals with schools large and small. The campuses have not displayed much sales resistance to these blandishments.

The universities are a rich market. As a whole, they spent some $1.3 billion on computers in 1984. They are projected to spend $8 billion by the end of the decade. Smaller schools like Carnegie-Mellon (5,500 students) may spend as much as $10 to $15 million a year on the new technology; a big school like the three-campus University of Michigan (45,000 students) budgets up to $50 million a year.[10] A study by the National Science Foundation in 1981 estimated that it would cost some $30 million to fully equip a 5,000-student campus with computers; that is roughly the cost of putting up a new building. A large university must spend anywhere from $100 million to $200 million. These are not one-time expenditures. They bring with them maintenance and operating costs, plus the inevitable need to update equipment that often becomes obsolete by the time it is ready to use.[11] More promising still, the schools control an immense student market populated with prospectively high-earning professionals and white collar types, the ideal computer consumers. It will be a bonanza for the industry if the educators can be persuaded to impose a computer literacy requirement. Schools as influential as Harvard, Yale, and the University of California at Berkeley have seriously considered doing so but have not yet taken the step, perhaps because they have no better idea than the high schools what the phrase means. (But at least one small college—Dallas Baptist, where every entering student must buy a Radio Shack Model 100—has gone so far as to insist that at least three assignments per term in each freshman course should require the use of a computer.)[12]

Even more welcome to the data merchants than a computer literacy requirement is the required purchase of the machine itself as a

condition of admission. This is happening already. At Dartmouth, freshmen must now own a Macintosh; at Clarkson College in New York, Zeniths are required. Carnegie-Mellon, Drexel, Stevens Institute, and Drew are among the nearly dozen schools that now add the (usually well-discounted) price of a computer into their students' tuition. There is no saying how far this fashion in admissions policy will spread, but it is surely a bold innovation. Has there ever been another instance of the universities making the ownership of a piece of equipment mandatory for the pursuit of learning?

With the number of faculty and student microcomputers growing rapidly on the campuses, new problems and possibilities arise. Above all, there is the challenge of coordination: making sure all the machines are compatible with one another. A new figure of considerable power has appeared on the campus to handle the job: the "computer czar"—often bearing a title like Provost for Information Technology. The main project most czars have in view is networking: connecting all the campus computers in a graceful system. This may begin with a number of "clusters" or work stations, small collections of computers possibly located in the library or the dorms. But from any small beginning, greater networks can spread. This is a consequential decision that requires strenuous planning, possibly with capital outlays for extensive rewiring. The school that chooses to network has put down deep roots in the technology. The computers are there to stay and will grow in number. For this reason, the computer makers are eager to help the universities move to that plateau of computer permanence. At Carnegie-Mellon, IBM is assisting in building a network of 7,500 work stations. When it is completed, CMU will be the first school to have more computers than students. At the University of Houston (44,000 students on four campuses) Digital Equipment Corporation has struck a $70 million deal to lay in a 4,500-terminal network, for which it will pay half the cost.[13]

There is another tempting proposition that helps ease the universities toward full computerization. The schools and the manufacturers might go into business together. Several schools have contracted to undertake "joint research and development" projects with major firms. The faculty—having been richly endowed with discounted computers (or receiving them free, as in the case of some 150 humanities professors at Stanford, who were given IBM-PCs to take home) —agree to brainstorm new software or "courseware," which the

company will then merchandise on some mutually advantageous basis. Perhaps it would be too cynical to predict that much of this software, once it has served its purpose as bait, will languish in the firm's already overstocked inventory. But it will be interesting to see how much of what the professors design does see the commercial light of day. No doubt in some cases, the joint development deal makes perfect sense. MIT, for example, is the cradle of American computer technology; its faculty surely has much to offer and may already have been doing so by way of consulting or through the school's existing research programs. At MIT, both IBM and DEC are cooperating to contribute $50 million in equipment, staff, and maintenance as part of a joint effort called Project Athena. In addition, IBM has a $50 million project at Brown and a $10 million contract at the University of California, Berkeley. DEC has another $24 million spread among fifteen schools. IBM has given Princeton a more modest grant of only $6 million in equipment, but the award, which will bring 1,000 microcomputers to the campus in a fifty-cluster network, has the interesting twist of seeking to develop computer literacy programs that will draw in the humanities beginning with the Religion Department. The Religion Department has responded eagerly.[14]

The most ambitious, and so far the most fruitful of these arrangements, has been the Apple Consortium, which allied the company with twenty-four schools (all the Ivy League universities, Michigan and Stanford among them) in the development of the Macintosh. The schools gave at least $2 million each to the Apple Education Foundation; in return, during 1984, they were supplied with 50,000 Macs at discounts generous enough to undercut and anger many Apple retailers.[15]

If all works out as the computer makers would have it, there may one day be fully networked campuses where all the students and all the teachers do indeed have micros, and then perhaps they will rarely have to meet at all. They will simply exchange assignments and grades electronically. Networks may even outgrow the campuses that created them—as at the University of Houston, where teachers and students can link up from their own homes. Then, professors can not only grade their students electronically, but network with them at all hours of the day and night, and perhaps watch on line while assignments are processed across the video screen, making helpful suggestions along the way. (Of course, this sort of round-the-

clock, unpredictably intrusive fraternization would be possible now by way of telephone. Which is why, in my experience, professors go to great lengths to keep their phone numbers private. I am not certain why the computer terminal, always on and demanding attention, is supposed to make unrestricted teacher-student interaction more enticing.) The ultimate goal of networking on the grandest scale is to become a "wired city" that expands into the surrounding community. Together with Bell Telephone and Warner Communications, which holds the local cable television franchise, Carnegie-Mellon University is planning to do just that in the Pittsburgh area.

One would be hard-pressed to find another time when a single industry was able to intrude its interests so aggressively upon the schools of the nation—and to find such enthusiastic receptivity (or timid surrender) on the part of educators. This is all the more remarkable when one considers that probably no two teachers or computer scientists could come up with the same definition of "computer literacy"—the goal that launched the campaign. As for the general intellectual benefits of that skill, of these there is no evidence to be found beyond the claims of the computer industry's self-promotional literature, filled with vague futuristic allusions to life in the Information Age. Yet if the computer makers succeed in their hard sell, we may soon be graduating students who believe (with their teachers' encouragement) that thinking is indeed a matter of information processing, and therefore without a computer no thinking can be done at all.

"The great university of the future will be that with a great computer system," Richard Cyert, president of Carnegie-Mellon, has announced.[16] A dramatic statement of conviction. Doubtless many educators wish their schools had the resources his university has been able to muster in laying claim to such greatness, even though it remains obscure how quantities of computational power translate into quality of learning. There is no question but that computers have a valuable role to play as computing devices in the technical fields, as electronic record keeping systems, or as word processors. Taken together, this is a sizable contribution for any single invention to make in the daily lives of students and teachers. But the computer enthusiasts have promised that the new technology will do more than merely replace the slide rule, the typewriter, and the filing cabinet. Its benefits supposedly reach to intellectual values at the highest level, nothing less than the radical transformation of educational

methods and goals. The computer, after all, is the bountiful bringer of information, which is widely understood by educators themselves to be the substance of thought. Even Dr. Ernest Boyer, president of the Carnegie Foundation for the Advancement of Teaching, who has raised many keen criticisms on the waste and misuse of computers in the schools, agrees that "in the long run, electronic teachers may provide exchanges of information, ideas, and experiences more effectively (certainly differently) than the traditional classroom or the teacher. The promise of the new technology is to enrich the study of literature, science, mathematics, and the arts through words, pictures, and auditory messages."[17]

How disappointing it is, then, to see so much of this glowing promise come down to mere promotional gimmickry. There is, for example, the image of the fully networked campus which currently stands as the ultimate goal of computerization in the universities. Without leaving their dorms, students will be able to access the library card catalog; they will be able to log on to a student bulletin board to exchange advice, gossip, make dates, find a ride, buy used books. They will be able to submit assignments electronically to their instructors.

Yes, these things and a dozen more *can* be computerized. But why *should* they be? They all get done now by the most obvious and economical means: students walk to the library, the student union, the bookstore, to a nearby coffeehouse or cafe, where they meet other human beings. They talk, they listen, they make arrangements. Outside of disabled students (for whom computers can be a boon), who ever found these ordinary perambulatory activities so burdensome as to be worth the cost of an expensive technology to eliminate them? Indeed, it has always been my thought that an intellectually vital campus is one designed in its architecture, grounds, and general spirit to make such daily human intercourse graceful and attractively frequent—rather than one that spends millions to spare its students the exercise of leaving their dorms.

When enthusiasts come up with artificial uses like these for the computer, they are really doing nothing more than teaching another lesson in technological dependence, a vice already ingrained in our culture. For obvious commercial reasons, they are intruding a machine into places where it was never needed. Similarly, the prospect of having students submit assignments by some form of electronic mail is simply endorsing the sort of pseudo problem (like "static

cling" or "wax buildup") that exists only because the hucksters invented it in the first place to sell a product. I have come across computer advertising that seems determined to make me forget that the red pencil—underscoring, circling, working along the margins and between the lines of the page (things no computer can do)—is one of the most practical teaching tools ever invented. Every experienced teacher knows this; but the ads are out to embarrass me into agreeing that, as a full-fledged member of the Information Age, I should be dealing exclusively with floppy disks, light pens, and video screens.

I will admit that, to a degree, one's criteria of educational greatness may involve matters of personal taste. Some people relish the image of schools where ranks of solitary students in private cubicles sit in motionless attendance upon computer terminals, their repertory of activities scaled down to a fixed stare and the repetitive stroking of a keyboard. I find this picture barely acceptable even where it may be justified episodically for a computer-specific exercise: some drill, computation, or graphics work. The image becomes no more appealing when I am told that working with computers is a marvelous occasion for socializing: the students cluster around the machines, taking their cues from its directives, debating the fine points of this or that response to its queries. As an educational ethos, both these situations strike me as simply another form of technological desiccation in our lives, appearing in the one place we might most want to save from its blight.

My own taste runs to another image: that of teachers and students in one another's face-to-face company, perhaps pondering a book, a work of art, even a crude scrawl on the blackboard. At the very least, that image reminds us of how marvelously simple, even primitive, education is. It is the unmediated encounter of two minds, one needing to learn, the other wanting to teach. The biological spontaneity of that encounter is a given fact of life; ideally, it should be kept close to the flesh and blood, as uncluttered and supple as possible. Too much apparatus, like too much bureaucracy, only inhibits the natural flow. Free human dialogue, wandering wherever the agility of the mind allows, lies at the heart of education. If teachers do not have the time, the incentive, or the wit to provide that, if students are too demoralized, bored, or distracted to muster the attention their teachers need of them, then *that* is the educational

problem which has to be solved—and solved from inside the experience of the teachers and the students. Defaulting to the computer is not a solution; it is surrender.

But there are other issues that transcend taste, questions of educational theory, social policy, and professional ethics. It is simply wrong for any priorities about our schools to be set by those with commercial interests at stake. That vice has plagued public schools in the past; it may be more advanced now than ever, as the schools invest in glamorous machines without any clear idea of their use. They are doing so because they have absorbed mindless clichés about "information," its intellectual value and vocational urgency, that are little better than advertising copy. This has led them to overlook the degree to which educational problems are political and philosophical issues that will not yield to a technological fix.

To mention only the most obvious of the issues on which the ethics of the teaching profession require candor:

- Disruptive or alienated students in the schools may reflect an anxiety, even a desperation that stems from their disadvantaged social condition or from the compulsory nature of the school system itself; no matter how equitably the computers are spread through the classrooms, these students are not apt to find the will to learn.
- Students who are being sold on computer literacy as an easy response to their job hunger are simply being deceived; what they are learning in a few computer lab experiences will not make them one iota more employable.
- Teachers who are falling back on flashy software as a convenient classroom entertainment are wasting their students' time and demeaning their own profession.

One senses how distorted the discussion of education has become in the Information Age when educators begin to draw not only upon the products but upon the language and imagery of the industrial marketplace. "Productivity" is the word Dr. Arthur S. Melmed of the Department of Education uses to define "the central problem of education. The key to productivity improvement in every other economic sector has been through technological innovation. Applications of modern information and communication technologies

that are properly developed and appropriately used may soon offer education policy makers . . . a unique opportunity for productivity management."

Along the same lines, Richard Cyert of Carnegie-Mellon predicts that his school's computer network "will have the same role in student learning that the development of the assembly line in the 1920s had for the production of automobiles. The assembly line enabled large-scale manufacturing to develop. Likewise, the network personal computer system will enable students to increase significantly the amount of learning they do in the university." [18]

Computers, as the experts continually remind us, are nothing more than their programs make them. But as the sentiments above should make clear, the programs may have a program hidden within them, an agenda of values that counts for more than all the interactive virtues and graphic tricks of the technology. The essence of the machine is its software, but the essence of the software is its philosophy.

POWER AND DEPENDENCY
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Anyone who has watched children almost hypnotically absorbed by the dazzling display of a video game cannot help but recognize the computer's peculiar power to spellbind its users. Fortunately, the most excessive form of this electronic enchantment seems to have lost its hold on the adolescent imagination; the video arcades are fast declining in popularity. But what we have seen there at its extreme is a capacity to fascinate that has been connected with the computer since the earliest stored-program machines arrived in the universities. It reaches back to the first generation of young hackers at a few select computer labs, like that at MIT. Hackers have always been a freakish minority, highly gifted minds for whom the intricacies of the computer can become an obsession, if not an addiction; yet they play a crucial role in the history of the technology. They were the first to give themselves fully to the strange interplay between the human mind and its clever mechanical counterfeit. That interplay deserves the careful attention of educators because it carries within it a hidden curriculum that arrives in the classroom with the computer.

Among the hackers, one of the main attractions of the machine was the enthralling sense of power it gave its user, or rather its master. For one did not simply use a computer, one had to take intellectual control of it. This was a complex machine, an "embodiment of mind," as Warren McCulloch once described it, and it could easily elude effective application. Yet, even when it did so, its misbehavior arose from some rigorously consistent extension of its programming that demanded understanding. It was not like an automobile, which would malfunction simply because a part wore out; its problems were not merely physical. They could only be corrected by tracking the bug through the dense logic of the machine's program. But if the hacker mastered that logic, he could bend the computer to his will. ("His" is historically correct here; notably, nearly all the early hackers, like most hackers since, were male, many of them living in "bachelor mode.") As one computer genius reported to Steven Levy, who has written the best history of the early hackers, there was a day when he came to the "sudden realization" that "the computer wasn't so smart at all. It was just some dumb beast, following orders, doing what you told it to in exactly the order you determined. You could control it. You could be God." [19]

But the satisfaction of becoming the machine's God, of lowering it to the status of a "dumb beast," is not available to everyone; only to those who can outsmart the smart machine. First it has to be respected as an uncanny sort of mind, one that can perform many mental tricks better than its user. The relationship of the human being to the machine is, thus, an ambivalent one, a complex mixture of sensed inferiority and the need to dominate, of dependence and mastery. "Like Aladdin's lamp, you could get it to do your bidding." That is how Levy describes a certain exhilarating moment of truth in the early hackers' encounter with the computer. But like Aladdin's lamp, the machine holds a genie more powerful than the human being who temporarily commands its obedience.

The word *power* is freely sprinkled through the literature of computers. The computer is a "powerful tool"; it is fueled by "powerful theories" and "powerful ideas." "Computers are not good or bad," Sherry Turkle concludes in her study of the psychology of young computer users. "They are powerful." [20] As we have seen, computer scientists have been willing to exaggerate that power to superhuman, even godlike dimensions. Perhaps it will soon be "an

intelligence beyond man's." These heady speculations on the part of respected authorities are not simply whimsical diversions; they are images and aspirations that weave themselves into the folklore of the computer and become embedded in the priorities that guide its development. They are intimately involved in the sense of power that surrounds the machine, even as it is playfully presented to children at the basic level of computer literacy.

This can be a deeply illuminating educational moment for children—if it comes to them in the right way. It is their introduction to the form of power that most distinguishes their species: the power of the mind. At some point, they must learn that the phantom cunning and resourcefulness of the mind provides a greater biological advantage than size and strength, that intelligence counts for more than the brute force of muscle or of engines that replace muscle. In ancient Greece, children learned the value of cunning from the exploits of Odysseus, the man "of many devices." American Indian children learned cleverness from the mythic figure of Coyote the Trickster. All folklore features these masters of guile, who teach that a good trick may outdo the strongest sinews in the risky adventures of life.

In the modern West, the survival power of the mind has come to be concentrated in the "many devices" of our technology, and now most importantly in a smart machine which is the culmination of that technology. Whatever simple, gamelike computer exercises children may learn, they are also learning that the computer possesses what adults regard as the highest kind of power, a power that is similar to what human beings do when they lay plans, store up information, solve problems: something mindlike.

Because of this mindlikeness, the little box with the video screen on top, which doesn't look anything like a person, has come to be surrounded by all sorts of personifications. One "talks" to the computer. It "understands"—or doesn't understand. It "asks" and "answers" questions. It "remembers" things. It says "please" and "thank you." Above all, it "teaches" and "corrects" because it "knows" things and knows them better. If computer literacy takes hold in our schools, students may not be learning these mindlike qualities from another human being, but most often from a machine. Even if they are also learning from a teacher, the teacher will not be a "powerful" device. No one—certainly no computer scientist—has ever described a teacher's mind as "a powerful tool." Why not?

Because teachers cannot know as much as the box. The box can hold lots more information. Even if the little computer in the classroom is limited in its capacity, the children know there are other, bigger computers that are running the world they live in. They can be seen in the bank, the store, the doctor's office. And when all the computers are put together, they have a power no teacher can have. They never make mistakes. That is the power which adults respect and would have children aspire to: the power of always being right, quickly and absolutely. But this is a power that can only come through the machine. As one children's book puts it: "Computers never make mistakes. If there is a mistake, it is made by the people who are using the computer or because the computer is broken."[21] The mixture of loose, anthropomorphic metaphors, interactive software, and commercial imagery that accompany the computer into the classroom brings with it a clear, if subliminal, lesson. It is the lesson the computer's inventors and dominant users have ingrained in the technology: a conception of thinking, of order, of intellectual priorities. It goes something like this:

Here is a form of power. It is a power of the mind. It is the greatest power of the mind—the power to process limitless information with absolute correctness. We live in an Information Age that needs that power. Getting a job, being successful, means acquiring that power. The machine has it; you don't. As time goes on, the machine will have more and more of it. It will deserve that power because it fits better with the world than human brains. The only human brains that can be trusted are those that use the machine to help them think.

This lesson can be transmitted in an unthreatening, even inviting way. That is the style of all computer instruction. Start simple. Make it fun. Build confidence. Ideally, the machine should be "user friendly"—a curiously condescending phrase which suggests that the machine is being kind enough to simplify and slow down for less talented users who need to be babied along. Most encouraging of all, the machine will share its power with its users. It can be domesticated and brought into one's home as a mental servant. All one needs to do is adjust to the machine's way of thinking. Becoming computer literate, comments Paul Kalaghan, dean of computer science at Northeastern University, "is a chance to spend your life working with devices smarter than you are, and yet have control over them. It's like carrying a six-gun on the old frontier."[22]

A PRIVATE UNIVERSE
■

To those who gain access to its power, the computer offers a tempting reward. As one hacker puts it: "You can create your own universe, and you can do whatever you want within that. You don't have to deal with people."[23] Once again, this is an attraction that can be seen at its extreme in video game addicts. But it is there even in the current fascination of financiers and business people with spreadsheet manipulations. On the computer, one can create a self-contained fantasy world of exact logic, predictable parameters, selected data points. At some point, where one's talent to work the machine has developed sufficiently, that world laps over into one of the computer's most impressive technical capacities: simulation. For engineers and scientists (possibly even behavioral scientists) this can be an invaluable resource. It offers the chance to investigate imaginary scenarios, running through one "what if" after another. But the graphic precision and commanding clarity with which a simulation unfolds on the video screen may lead to a serious confusion, especially for children. The model—a neat, predictable private universe—may begin to look like a better "reality."

Simulation, one must remember, applies *only* to models. The computer, on cue, manipulates a set of hypothetical assumptions about reality, not reality itself. It may do this to study the long-range or extreme implications of those assumptions, or perhaps to play off assumptions against one another. In all that it does in this mode, the computer can never be "wrong." Its simulations will always be coherent and logically consistent. Of course, what it is doing may have no relationship whatever to the world outside its program. Yet, because it offers a manageable little "reality" of its own, it may tempt its user's attention away from the messy, frustrating angularities of imperfect daily life. This is especially apt to be the case where hypothetical "facts" take the place of data for the sake of the simulation.

Here, for example, is "a system for teaching research design through computer simulation" as one of the major educational software companies presents it in its instructional material. The system is called Exper Sim (for experimental simulation), a program available as part of Control Data Corporation's much publicized PLATO courseware. Exper Sim is a way of teaching "scientific method" by

simulations that overcome the "time limitations" of the classroom. As Control Data explains the program, it enables "students to run experiments on a computer which has been programmed to generate appropriate data. The computer serves as a replacement for actual data collection, saving time and obviating the need for costly lab space, equipment, and supervision."

One notes at once how, in the name of economy and efficiency, the student's experience is being restricted to the computer, which, supposedly, contains all the data needed. In the experiment, the student receives a list of variables from the instructor, formulates a hypothesis, and "considers what data he would like to collect to test that hypothesis." The experiment is then fed into the computer, which provides him with "raw" information of the sort he would have collected had he actually performed the experiment. After analyzing these data, the student plans another experiment aimed at refining his research strategy and expanding his conclusions.

What one sees here is the very real possibility that the student and the computer will become a closed system which reaches "conclusions" based on nothing but simulations. The machine has become a "replacement for actual data collection." But how is this possible? Computers process information; they do not "collect" or "generate" it.

This confusion shows up more dramatically in the use of computers to redo classic experiments for educational purposes. One such example is Mendel's famous breeding experiments, which underlie the laws of genetic inheritance.[24] A simulation can be run which rapidly displays the predicted outcome of the theory over many generations. Obviously, this saves a great deal of time. But it also goes a long way toward falsifying real science. Because this is *not* an experiment; it is the *simulation* of an experiment, and thus a severe reduction of reality. The experiment, after all, already edits reality for purposes of focus and control; the simulation now edits the experiment by eliminating the real scientific work involved: the careful arrangement of apparatus, the manipulation of materials, the false starts and pitfalls, the watchful, often boring waiting, the painstaking discriminations among results. But even worse, it neatly eliminates the risk, which is the whole point of experimentation. True experiments must stand the chance of failing to prove their hypothesis. In the simulation, however, everything always comes out right, because Mendel's theory and all his judgments have been pro-

grammed in. Yet, scientists who have troubled to repeat Mendel's work have always had to struggle with the fact that real, living sweet peas (or fruit flies) never fall obediently into discrete categories. They present blurred, fuzzy, intermediate, and borderline cases, which require difficult judgments on which different observers disagree. Perhaps, as some scientists suspect, even Mendel allowed his theory to shape his data: an important aspect of science for students to learn. How truly scientific are simulations that make reality more "theoretically" neat than it ever proves to be?[25]

Simulations are a step away from the disorderly reality around us into the tidy fictions of the computer. Where the computer's often dramatic graphic powers and magisterial calculations are combined with its highly touted mastery of information, this can create the impression that students are in touch with a superior, self-sufficient reality inside the machine, a reality which they have the power to control. They need go no further. Were it not for the inordinate praise and soaring hype that surround the computer, this might not be a serious danger. Children, and the public generally, would recognize that the "universe" which we can create on a computer screen is a small, highly edited simulation of reality. Moreover, it is a universe created by a small, highly edited simulation of *ourselves*. Only one narrow band of our experience is represented in the computer: logical reason. Sensual contact, intuition, inarticulated common-sense judgments, aesthetic taste have been largely, if not wholly, left out. We do not bring the full resources of the self to the computer.

We live in a world where electronic images and simulations are already crowding the larger, more intractable facts of life out of people's awareness. In our pursuit of order in an unruly world, we resort to spreadsheet projections, war games, economic forecasting, global modeling, electoral polling—the many computer abstractions that are supposed to help us manage a chaotic reality. From the time children begin playfully to pick their way through its make-believe logical landscape, the computer promises the power to understand, control, and always be right. But that power weakens toward illusion whenever we forget that what it commands is a figment of logical structures, hypothetical assumptions, and selected data—all of our own making and choosing. That illusion deepens toward pathos whenever we forget how limited a part of our own human nature went into the creation of that figment.

Of course, teachers can correct all along the line for these confu-

sions on the part of students. But will there still be teachers in the electronic classroom? Will there be enough of them with sufficient authority in the eyes of their students? Will they, themselves products of the Information Age, still know any other reality than the computer's reality? Above all, will they believe they have the right to correct a machine which, they have been told, is rapidly evolving toward "an intelligence beyond man's"?

FOUR

THE PROGRAM WITHIN THE PROGRAM

■

THE CASE OF LOGO

The computer has entered the schools on a wave of commercial opportunism. As one might expect, this has led to a great deal of often wasteful trial and error on the part of educators. The computer industry, promising the moon, has been willing to endorse any use of its product, no matter how frivolous or misconceived. Teachers have been left to pick their way through the claims as best they can. Some may hit upon beneficial applications, but there has been no overarching pedagogical philosophy to guide their improvisations.

In the midst of the confusion, there has been one notable exception. Seymour Papert, cofounder of artificial intelligence studies at MIT, is among the few computer scientists who has sought to develop a consistent educational philosophy for the use of the computer. That philosophy is deeply grounded in the complex learning theories of the Swiss psychologist Jean Piaget, with whom Papert studied for several years. The result of this merger between Piagetan psychology and artificial intelligence is the programming language Logo, which Papert has sought to elaborate into a comprehensive curriculum. More than a few clever pieces of software or a single course of study, Logo is offered as part of a radically new vision of

education, the most systematic effort thus far to think through the role of the computer in the schools. At least in the view of Marvin Minsky, Papert's partner at the MIT artificial intelligence laboratory, this ranks him as "the greatest of all living educationalists."

Papert has been at work on Logo and its applications since the mid-1960s. Along the way, he has spun off the widely used educational program called Turtle Graphics and written the book *Mindstorms* (1980). He was also briefly drawn into an instructive adventure in computer politics. In the early 1980s, the French government was inspired by politician and journalist Jean-Jacques Servan-Schreiber to set up a major computer research facility, the Centre Mondial Informatique et Ressources Humaines in Paris. Servan-Schreiber's special interest was in helping Third World countries to "jump into the new information society." At his invitation, Papert wrote the key paper formulating the center's program. Along with Nicholas Negroponte of MIT, he became its codirector. Papert's vision for the center was an idealistic plan for the use of Logo as part of an international computer literacy campaign. The center was generously funded, but then quickly passed from an academic to an economic orientation, whose main goals became that of merchandising French computer equipment in the former French colonies in Africa. In less than a year, Papert, along with Negroponte, had departed from the center. A self-styled "educational utopian," he had no taste for such neoimperialist commercialization.[1]

In seeking to give the computer a significant educational identity, Papert works from a candid awareness of how often the machine is misused in the schools. He is no facile optimist. But the many abuses have not dissuaded him from believing that the computer can dramatically transform the world of education, sparking a revolution "of ideas, not of technology." For Papert, the computer can be "an instrument for teaching everything."[2]

Logo is designed to enter the child's life at a very early stage—conceivably in kindergarten—as an ingeniously accessible programming language. Papert has been at pains to point out that Logo is not just for children; it is intended as a general-purpose language equally applicable at sophisticated levels. But its distinctive feature is its availability to youngsters, and that is where it has found its main audience and market. Very little general-use software has been produced in Logo. In its educational applications, Logo is fully interac-

tive; students can see the immediate result of the commands they give on the video screen. Usually, they start with simple geometrical graphics, using key-stroke commands to move a marker called a turtle. (Originally, there was an actual mechanical turtle connected to the computer which moved across the floor as directed. Most schools now use Logo without the toy, but the little arrow on the screen continues to be called a turtle.) The geometrical figures selected by the students are shaped by trial and error into little programs for drawing squares, circles, pentagons, etc. The language for executing the program is simple: the word *to* (as in "to circle," "to square") marks a command. Students choose their own names for these programs, which can, in turn, become subroutines within larger, more complicated programs.

Because the computer responds at once to every Logo command, students can study and correct their programs as they go along. This correct-as-you-go process is at the heart of Logo's instructional approach. Children see their mistakes; these become "bugs" that must be "debugged" by thinking back through the program and finding strategies to clear the inconsistencies. Papert emphasizes the educative importance of "the powerful idea" of debugging. It is an alternative to the tyranny of right answers which so often burdens the computer. He says,

> The question to ask about the program is not whether it is right or wrong, but if it is fixable. If this way of looking at intellectual products were generalized to how the larger culture thinks about knowledge and its acquisition, we all might be less intimidated by our fears of "being wrong."

Papert regards this as a primary benefit of the computer as an "object to think with." Because it encourages the student to try things and see how they turn out, then to correct and adjust, Logo is called a "discovery-learning" approach.

In this process of self-correcting programming, students are being made to "think about thinking." They are becoming "psychologists and epistemologists." Papert observes, "This powerful image of child as epistemologist caught my imagination while I was working with Piaget. . . . I came away impressed by his way of looking at children as the active builders of their own intellectual structures." It then became Papert's goal to use the computer as a way of helping chil-

dren self-consciously build such structures. Piaget divided the child's mental development into "concrete" and "formal" stages, the latter (for example, mathematical thinking) requiring more maturity and so coming later in life. In Papert's view, the concrete, hands-on use of the computer can give the child a much earlier introduction to the formal stage of development.

There is a problem here in Papert's scheme. It is not at all clear that the students are "thinking about thinking" in a comprehensive way that might, for example, acquaint them with how an artist rather than a geometer thinks about spatial problems. Rather, they seem to be critically reflecting upon a certain kind of thinking, namely (as Papert calls it), "procedural thinking." Debugging, after all, involves finding the false step in a step-by-step logical sequence. Does debugging in this special sense apply to any other style of thought? Could one imagine a way to debug a fairy tale or a game of hide-and-seek? How would one debug a drawing of a dinosaur?

Papert likes to claim that Logo, because it is transparently interactive at every step, amounts to letting the child program the machine, rather than having the machine program the child, as in many computer exercises. He speaks of the child "teaching the machine." But it is unclear that in this respect Logo is any different from other programming languages. True, students write the program, but they must do so on the machine's terms. They must stay within the machine's language and logic—or the machine will tell them, "I don't know how to . . ." Students are free to call a square a box, and they can instruct the machine to turn the box so many degrees this way or that. But they cannot order the computer to put a Hobbit in the box, or to make the box grow wings and fly away to Middle Earth. Logo grants the children control over an experimental "microworld" in which to do their programming; but the microworld is not the full terrain of the human imagination. It is, at last, a two-dimensional computer screen which can only display the capacities of the program. Logo has a repertory of just so many colors, so many shapes (an airplane, a truck, a rocket, a ball, a box, etc). It is well suited to geometrical play but not to fantasy that oversteps those narrow boundaries. As I read Papert's words, I found myself haunted by the image of the prisoner who has been granted complete freedom to roam the "microworld" called jail: "Stay inside the wall, follow the rules, and you can do whatever you want."

Through Logo, Papert believes the child "acquires a sense of

mastery over a piece of the most modern and powerful technology." Like many computer enthusiasts, he is much concerned with power; the word *powerful* appears prominently throughout *Mindstorms*. In one of the most developed Logo workbooks (Daniel Watt's *Learning with Logo)*, the phrase *powerful idea*—taken from Papert—appears as a little flag that punctuates the presentation in each chapter. But as with all computer exercises, the mastery comes through adapting to the machine's way of doing things. The same ambiguous relationship between power and dependence remains in Logo as in other computer curricula; the same illusion of control hovers over Papert's microworlds.

Most Logo curricula start with turtle geometry and soon end off after a small but useful repertory of basic programs has been learned. This may be enough to give the child a substantial taste of programming. But Papert's vision of Logo in the classroom is far more ambitious. He believes it can be used throughout the curriculum. It is at this point that Logo, the most fully elaborated of all the computer educational programs, reveals the pitfalls that enthusiasts may overlook.

Consider, for example, how the Logo curriculum seeks to embrace art.* Children are told that they can draw "anything." Accordingly, the exercise begins with a free-hand sketch. Now such a sketch, if it were done with care and imagination, might qualify with most teachers as, in and of itself, an art lesson. But with Logo, this is only a preliminary stage. The child is next instructed to *simplify* the sketch by analyzing it into a number of component geometrical forms. A truck, for example, becomes a big box and a small box sitting atop two circles for wheels. The constructivist artist Piet Mondrian might have approved of such exercises in geometrical abstraction, but even this is still preliminary. Logo actually takes hold with the next step, which is to write a program that will direct the computer to draw these boxes and circles on the video screen with everything in its correct place. This is tricky and is sure to involve lots of trial and error. Finally, when all the components are programmed,

* Throughout the remainder of this chapter, I will be following the lesson plans developed in Daniel Watt's *Learning with Logo* (New York: McGraw-Hill, 1983). Watt has worked extensively with Papert and the MIT Logo Group and has taken his lessons into schools for testing and revision. The material cited here on art and poetry comes from chapters 6 and 13.

the whole combination can be tucked away in a single command, TO TRUCK. When it is given, the cursor quickly draws a truck. If all goes well, it will look like this:
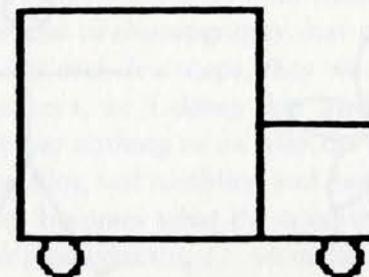
And here is the program that drew the truck, with all its subprograms, each of which was worked out as a separate exercise and then incorporated in the total program:

```
TO TRUCK
BIGBOX
    SUBPROGRAM: REPEAT 4 [FORWARD 60 RIGHT 90]
             END
MOVEOVER
    SUBPROGRAM: RIGHT 90 FORWARD 60 LEFT 90
             END
SMALLBOX
    SUBPROGRAM: REPEAT 4 [FORWARD 30 RIGHT 90]
             END
MOVEBACK
    SUBPROGRAM: LEFT 90 FORWARD 60 RIGHT 90
             END
WHEELS
    SUBPROGRAM: RIGHT 90
             RCIRCLE 5
             FORWARD 90
             RCIRCLE 5
             BACK 90
             LEFT 90
             END
```

Similarly, a Logo drawing of a flower becomes a series of curves programmed to be repeated through 360 degrees, and a Logo drawing of a person is a stick figure.
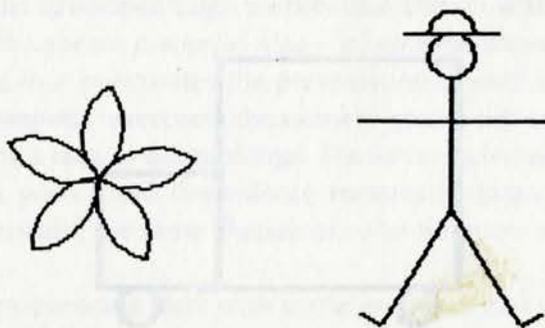
Unquestionably, the children who learn to produce programs for these designs have thought their way through a demanding exercise. They may be on their way to becoming first class computer programmers. What they haven't done is to learn anything about art; rather, they have been deliberately diverted from the skill of manipulating an artistic medium (crayon, pencil, brush) and the enjoyment of freely creating a picture. If their interest has been sustained through the exercise, it cannot be by the aesthetic pleasure of the task or the result, both of which are rigidly minimal. It can only be by the challenge of the programming, at which some students may be very good.

So then: can Logo teach art? Only if art is defined as what Logo can do in the way of art, which is not much. Logo does not allow the artistic imagination to romp; the child who would like to draw a horse, or a space monster, or a clown that does not look like a collection of boxes and circles is going to be out of luck. Nor does Logo allow the hand to use a pencil to sweep and shade and dance across the page. Art, like everything else Logo teaches, comes down to fingers stroking a keyboard, a mind working out a program. In a perverse sense, this may be an excellent lesson in computer science, especially in the artificial intelligence research that underlies Logo; the children learn the grand reductive principle: If the computer cannot rise to the level of the subject, then lower the subject to the level of the computer. Possibly, in the Information Age, children will find themselves living in a society where that principle has become the rule in all fields touched by the computer. Logo might then be seen as a useful preparation for "real life."

Logo gains its comprehensiveness in the classroom by finding similar ways to intrude something, *anything* the computer can do into whatever interest the child may have. Suppose the children want to dance. What does a computer have to do with that? In one videotaped Logo class I observed, students were encouraged to turn their dancing into an exercise in choreography, but not in their heads or muscles. Instead, after each few steps, they would run to the computer to stroke the keys, as if doing that made dancing real and serious. This clearly has nothing to do with the free kinesthetic play of the body, with twirling and tumbling and expressing. In the Logo classroom, the dance becomes what the computer can handle: geometrical patterns, angles, counting . . . so many steps this way, half-turn, so many steps that way. The exercise lacks the full plasticity of the body, the quality of the music, the emotional tone. But it does yield a program, and for that the children are praised. The lesson is a success.

Or take poetry. Here the student is directed to make up vocabulary lists for each part of speech: article, noun, verb, etc. Each list is then subjected to a randomizing process as part of a program for stringing words together in some specified order. Listing procedures like this are one of the special characteristics of the AI programming language called LISP, to which Logo is closely related.

At first, the result of working with randomized lists is apt to be nonsense: "A computer swims," "A refrigerator flies." So the students are told to try grouping words that "go together." This instruction is tossed off casually enough, but it is actually a mind-boggling demand if one takes it seriously. What words always "go together"? The lesson plan suggests grouping sports words, animal words, nature words. Nature words, for example, turn out to be "snakes," "drifts," "is hidden," "sleeps," "creeps," "murmurs."

The teacher is not encouraged at this point to make some cautionary remarks about the limitations of computer procedures like this. But unless that happens, something about the elusive, essentially protean nature of language will be obscured. For what the Logo lesson now demands is a linguistic absurdity. Language, by virtue of its metaphorically playful origins, simply does not fall into such categories. To which group—sport, animal, or nature—do the words "bat" and "fly" belong? It is precisely this problem of connecting words to well-defined contexts that govern their meaning which has made machine translation so nearly impossible. Behind

the problem lies the interesting speculation that language, with whose fluidity and unruliness programmers have such difficulties, arises from the poetic endowment of the mind and continues to bear the stamp of its origin. That possibility may be much to the point for the benefit of budding young poets. If the sort of groupings the Logo lesson now requires were a real part of language (rather than a temporary classroom fiction) the art of metaphor and simile would not be possible. When, after all, do words for "tiger" and "fire" go together? Maybe only in the line "Tiger! Tiger! burning bright . . ."

In any case, the *Learning with Logo* workbook suggests that by following this instruction, the students may finally get results on the computer that approach some kind of coherence: "Loudly the swirling misty swirling sea sleeps." Or sometimes, the result may be intriguingly haiku-like:

> Each limpid pond
> One bird faces over the frosty fir
> Wild blue moon

This leads to the speculation, "because the words go well together, it almost seems like poetry. And if we chose our sentence pattern carefully, maybe it will *be* 'poetry.' "

Now, at some point, more inquisitive children may wonder how an electrical box can be expected to write anything that deserves to be thought of as a poem, no matter how accidentally coherent. Aren't poems *about* something? Don't they have a *meaning* that comes out of somebody's life? When the children make up poems, their own minds would not seem to be doing anything at all like the poem-program. They mean to *say* something, and that something preexists the words as a whole thought. They are not simply shuffling parts of speech through arbitrary patterns.

The Logo curriculum anticipates this question. And this is where the real lesson gets taught. In his manual *Learning with Logo*, Daniel Watt explains it this way:

> When I see a computer can produce a poem, it makes me stop and think just a little. . . . You and I know that the computer was just following a procedure. The procedure tells it to select certain types of words according to a fixed pattern. It selects the words from several long lists of different types of words:

> nouns, verbs, adjectives, etc. . . . But wasn't I doing the same thing when I wrote my poem? I was following a procedure, too. The only difference was that I had a much larger choice of patterns and a bigger list of words in my head from which to choose. . . . How is that different from what the computer was doing?

At this point, the child may raise a question about the poetic importance of feelings and meanings, asking if a computer can craft a real poem from nothing more than raw linguistic materials. "Can it?" asks the Logo teacher: "I do believe that a very clever programmer could make a computer program complicated enough to write poems that would seem so 'human' that a poetry expert might have difficulty telling the difference."

The lesson goes on to give examples of more poetry simulations, but there is no hint at any point of what might be involved in "choosing our sentence patterns carefully"—which is, indeed, the whole befuddling secret of speech itself. Instead, the implication is that "poetry procedures" are not all that difficult to work out; indeed, they are just around the corner.

> Some computer scientists with big computers are programming them to turn out poems, mystery stories, and other kinds of "literary works." Will there ever be a time when you won't be able to tell the difference between something written by a computer and something written by a person? Someday you may have a chance to try to answer that question for yourself.

The words are kept simple, but behind them there is a theory of mentality that emerges straight from the core of artificial intelligence doctrine. In this case, the children learn that creating literature is nothing but filtering vocabulary through linguistic formulas. Instead of dwelling awhile on the power and insight of a poet or two, the better to acquaint the children with another sensibility, the lesson hastens to teach the data processing model of thought. This leads inevitably to the conclusion that the human mind and the computer are functionally equivalent, with the computer—at least the "big computers" that belong to the scientists—well on its way toward catching up in actual performance. Thus, by allying oneself with the

machine and working on its terms at strange conceptions of art and poetry, one may be able to appropriate some of its power.

As with all research in artificial intelligence, it is difficult to be sure in what spirit this program within the program is put forward. Is it another tiresome display of disciplinary chauvinism on the part of the technicians and logicians, determined to demonstrate the supremacy of their methods in the world of intellect? Or is it a sincere misconception about the nature of human creativity? In either case, the children are being exposed to a conception of art which is at once ludicrous and false. They are gaining their computer literacy at the risk of becoming cultural cripples.

Papert himself has been careful to keep the connection between Logo and artificial intelligence doctrine somewhat more tenuous. He defends his curriculum as a protracted lesson in procedural thinking, but he emphasizes that learning "to think like a computer" is mainly intended to make students self-conscious about the way the mind works more generally.

> I have invented ways to take educational advantage of the opportunities to master the art of *deliberately* thinking like a computer, according, for example, to the stereotype of a computer program that proceeds in a step-by-step, literal, mechanical fashion. . . . By deliberately learning to imitate mechanical thinking, the learner becomes able to articulate what mechanical thinking is and what it is not. The exercise can lead to greater confidence about the ability to choose a cognitive style that suits the problem.

He continues,

> I have clearly been arguing that procedural thinking is a powerful intellectual tool and even suggested analogizing oneself to a computer as a strategy for doing it. . . . The advice "think like a computer" could be taken to mean *always* think about everything like a computer. This would be restrictive and narrowing. But the advice could be taken in a much different sense, not precluding anything, but making a powerful addition to a person's stock of mental tools. . . . True computer literacy is not just knowing how to make use of computers

and computational ideas. It is knowing when it is appropriate to do so.

That would seem reasonable enough. But the problem is, Logo wants to be a comprehensive educational tool that can be tied into everything. It can only do that by connecting everything the child learns with procedural thinking, even when that makes no sense. Moreover, if the other cognitive styles that Papert alludes to enter the classroom at all, they do so simply as ideas in someone's head. Procedural thinking arrives on board an expensive piece of equipment that has been aggressively merchandised to the schools as a panacea. The teachers who offer computer instruction have similarly been expensively trained. The financial investment alone guarantees computer literacy will be given plenty of emphasis over as much educational ground as possible. In addition, there is an air of urgency surrounding the machine; the public believes the computer is associated with a skill the children must be taught for their employability. Taken as a whole, these factors are bound to skew the curriculum toward heavy computer prominence.

If the Logo curriculum prevails under these circumstances, the schools may indeed be doing a great deal to help students to think like computers. In contrast, who will teach them to think any other way? Where, for example, will the cognitive style called art come in? Curricula in art are notoriously underdeveloped as it is. Will the schools now have more or less time and money to balance the computer model of thought? How will these countervailing intellectual influences make themselves felt? The danger is that they will also be sought in the computer, the better to get one's money's worth out of the machine. Art will become Logo art, which, after all, does exist in Papert's programming repertory. If that happens, it would be worse than teaching no art at all.

That danger may seem to computer enthusiasts to be somebody else's problem, not theirs. They may see their mission as limited to opening the schools to a magnificent educational device. But they may be misconceiving their own interests as mathematicians and logicians in an ironic way. As Papert argues, Logo is intended to teach procedural thinking. Now, there is no doubt that the mind can be rigorously trained to think this way, and that it is a handy skill for a range of projects—once the project has been envisioned intuitively as a whole and then chosen as a worthwhile activity. These

two tasks—envisioning things as meaningful wholes, deciding what is worthwhile—are what the mind primarily and naturally does. In time and importance, they take precedence over the mapping out of procedures: ends before means. Experts in artificial intelligence have somewhat come to understand this in their struggle to cope with the phenomena of purposeful activity and common sense in our lives. They have come to see these as meaningful wholes which somehow, intuitively, seem to divide themselves up into countless subsidiary activities. There might almost be something more musical than mathematical to the matter: an orchestration of parts that contributes to the thematic whole. Accordingly, AI researchers have sought to develop programming languages that allow for the "hierarchical self-nesting" of subroutines within larger patterns or frames of purposeful conduct. Even such commonplace projects as planning a meal or baking a cake are now understood to be enormously complex, integrated structures of routines within routines, loops within loops.[3] But none of the routines makes any sense except within the context of a chosen project. Planning things out step by step (programming) within that project is a strictly secondary activity—one that may not always be necessary. Art and poetry obviously have little to do with drafting formal, logical sequences. No skill that involves physical coordination is mastered in that way. This is why no one ever learned to ride a bicycle or play a piano by simply reading a book on the subject and memorizing the rules. If a cook, a carpenter, or the captain of a ship had to write out all the procedures that went into their day's work, they would die of old age before they got the job done.

For that matter, even mathematics—Logo's strong point—may not have much to do with procedural thinking, at least not at its highest levels, where the joy and the creativity of the field are to be found. Mathematicians I have met (as distinct from computer scientists) seem quite willing to admit that they work by strange fits and starts of inspiration, by hunches, guesses, insights, by the sudden formation of surprising gestalts. How else to explain the fact that they ever get stuck trying to solve a problem, since all the logic they need is presumably there in their heads? How to explain the more interesting fact that, after being stuck for weeks, months, years, they may at last break through to a solution: the "ah ha!" experience. I know mathematicians who claim to sleep on a problem and wake

up with the answer. What is that all about? Probably the question is better left to the psychologists than the logicians.

The computer model of thought may distort the fundamental nature of mathematics as much as it does art. As a mathematician of my acquaintance once remarked, "The computer people don't seem to realize that higher mathematics was created by a mystic named Pythagoras. It wasn't invented to measure things; it was meant to be a vision of God." It is not difficult to imagine what artists and poets might have to say about Logo in their fields; but how many mathematicians would agree that mathematics is the same as programming?

As Papert realizes, it is extremely difficult to think procedurally; students have to be lured into it cleverly and then work at it with great persistence. Has it ever occurred to Logo educators that there may be a reason for the seeming strain of the exercise? It may be because the mind does not always and spontaneously solve problems in that way, especially the young and growing mind. Children may be much more absorbed at feeling their way through the major contours of mental life. They may be preoccupied with learning about the nature of human projects and the way adults decide among them. Envisioning things as meaningful wholes, choosing among them: this may be the first order of intellectual business for children. Careful, logical plotting of procedures may be premature for them, and so a distraction. Which is not to say that some of them may not be made interested in the specific task of programming a few geometrical problems. These can be made entertaining puzzles in their own right —like solving riddles or playing board games.

Computers "think" procedurally because it is the best they can do. Therefore, the people who program them have to think that way. But this is a special skill that we may value only because we have a machine in our lives that requires it. If we bring that machine into the classroom, will children be learning anything of basic importance about the natural habits and talents of mind? Or will they, by programming computers, simply be learning how to think like computer programmers?

In spite of my reservations about Logo, I would not vote against its use as a means of teaching basic programming skills. There are children who will be good at programming and who will enjoy developing their talents. They should have the chance—provided the

schools can afford the costs without losing quality in other areas. In the case of Logo, those costs are apt to be high because it is perhaps the most machine-time intensive of all approaches to computer literacy. There have to be a lot of machines available for the students to get the full benefit.

But precisely because it stems from a comprehensive and ambitiously conceived pedagogical theory, Logo should serve to warn us of the danger posed by the computer in the classroom. That danger would seem to be obvious: once there, the computer may be used to teach what it is inherently incapable of teaching—except in the form of a bad caricature. Many in the computer science establishment may not recognize that such a danger exists. Their data processing model of the mind encourages them to bring the computer into all areas of the curriculum.

What can one do in the face of this formidable pressure but fall back on the one absolute principle in educational philosophy? *Never cheapen.* Any method, any device, any pedagogical philosophy that depreciates the subject taught should be viewed with suspicion and used with caution. A curriculum in computer literacy that aspires to the generality of Logo runs the real risk of cheapening whole areas of intellect. One would hope that teachers recognized that risk when it entered the classroom. And having recognized it, one would hope they retained enough professional authority against the data merchants and the computer enthusiasts to speak out and draw some defensive perimeters around the minds of the young.

F I V E

OF IDEAS AND DATA

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IDEAS COME FIRST
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In raising these questions about the place of the computer in our schools, it is not my purpose to question the value of information in and of itself. For better or worse, our technological civilization needs its data the way the Romans needed their roads and the Egyptians of the Old Kingdom needed the Nile flood. To a significant degree, I share that need. As a writer and teacher, I must be part of the 5 to 10 percent of our society which has a steady professional appetite for reliable, up-to-date information. I have long since learned to value the services of a good reference library equipped with a well-connected computer.

Nor do I want to deny that the computer is a superior means of storing and retrieving data. There is nothing sacred about the typed or printed page when it comes to keeping records; if there is a faster way to find facts and manipulate them, we are lucky to have it. Just as the computer displaced the slide rule as a calculating device, it has every right to oust the archive, the filing cabinet, the reference book, if it can prove itself cheaper and more efficient.

But I do want to insist that information, even when it moves at the speed of light, is no more than it has ever been: discrete little bundles of fact, sometimes useful, sometimes trivial, and never the substance of thought. I offer this modest, common-sense notion of information in deliberate contradiction to the computer enthusiasts

and information theorists who have suggested far more extravagant definitions. In the course of this chapter and the next, as this critique unfolds, it will be my purpose to challenge these ambitious efforts to extend the meaning of information to nearly global proportions. That project, I believe, can only end by distorting the natural order of intellectual priorities. And insofar as educators acquiesce in that distortion and agree to invest more of their limited resources in information technology, they may be undermining their students' ability to think significantly.

That is the great mischief done by the data merchants, the futurologists, and those in the schools who believe that computer literacy is the educational wave of the future: they lose sight of the paramount truth that *the mind thinks with ideas, not with information.* Information may helpfully illustrate or decorate an idea; it may, where it works under the guidance of a contrasting idea, help to call other ideas into question. But information does not create ideas; by itself, it does not validate or invalidate them. An idea can only be generated, revised, or unseated by another idea. A culture survives by the power, plasticity, and fertility of its ideas. Ideas come first, because ideas define, contain, and eventually produce information. The principal task of education, therefore, is to teach young minds how to deal with ideas: how to evaluate them, extend them, adapt them to new uses. This can be done with the use of very little information, perhaps none at all. It certainly does not require data processing machinery of any kind. An excess of information may actually crowd out ideas, leaving the mind (young minds especially) distracted by sterile, disconnected facts, lost among shapeless heaps of data.

It may help at this point to take some time for fundamentals.

The relationship of ideas to information is what we call a *generalization.* Generalizing might be seen as the basic action of intelligence; it takes two forms. *First,* when confronted with a vast shapeless welter of facts (whether in the form of personal perceptions or secondhand reports), the mind seeks for a sensible, connecting pattern. *Second,* when confronted with very few facts, the mind seeks to create a pattern by enlarging upon the little it has and pointing it in the direction of a conclusion. The result in either case is some general statement which is not in the particulars, but has been imposed upon them by the imagination. Perhaps, after more facts are gathered, the pattern falls apart or yields to another, more

convincing possibility. Learning to let go of an inadequate idea in favor of a better one is part of a good education in ideas.

Generalizations may take place at many levels. At the lowest level, they are formulated among many densely packed and obvious facts. These are cautious generalizations, perhaps even approaching the dull certainty of a truism. At another level, where the information grows thinner and more scattered, the facts less sharp and certain, we have riskier generalizations which take on the nature of a guess or hunch. In science, where hunches must be given formal rigor, this is where we find theories and hypotheses about the physical world, ideas that are on trial, awaiting more evidence to strengthen, modify, or subvert them. This is also the level at which we find the sort of hazardous generalizations we may regard as either brilliant insights or reckless prejudices, depending upon our critical response: sweeping statements perhaps asserted as unassailable truths, but based upon very few instances.

Generalizations exist, then, along a spectrum of information that stretches from abundance to near absence. As we pass along that spectrum, moving away from a secure surplus of facts, ideas tend to grow more unstable, therefore more daring, therefore more controversial. When I observe that women have been the homemakers and childminders in human society, I make a safe but uninteresting generalization that embraces a great many data about social systems past and present. But suppose I go on to say, "And whenever women leave the home and forsake their primary function as housewives, morals decline and society crumbles." Now I may be hard pressed to give more than a few questionable examples of the conclusion I offer. It is a risky generalization, a weak idea.

In Rorschach psychological testing, the subject is presented with a meaningless arrangement of blots or marks on a page. There may be many marks or there may be few, but in either case they suggest no sensible image. Then, after one has gazed at them for a while, the marks may suddenly take on a form which becomes absolutely clear. But where is this image? Not in the marks, obviously. The eye, searching for a sensible pattern, has projected it into the material; it has imposed a meaning upon the meaningless. Similarly in Gestalt psychology, one may be confronted with a specially contrived perceptual image: an ambiguous arrangement of marks which seems at first to be one thing but then shifts to become another. Which is the "true" image? The eye is free to choose between them, for they are

both truly there. In both cases—the Rorschach blots and the Gestalt figure—the pattern is in the eye of the beholder; the sensory material simply elicits it. The relationship of ideas to facts is much like this. The facts are the scattered, possibly ambiguous marks; the mind orders them one way or another by conforming them to a pattern of its own invention. *Ideas are integrating patterns* which satisfy the mind when it asks the question, What does this mean? What is this all about?

But, of course, an answer that satisfies me may not satisfy you. We may see different patterns in the same collection of facts. And then we disagree and seek to persuade one another that one or the other of these patterns is superior, meaning that it does more justice to the facts at hand. The argument may focus on this fact or that, so that we will seem to be disagreeing about particular facts—as to whether they really *are* facts, or as to their relative importance. But even then, we are probably disagreeing about ideas. For as I shall suggest further on, facts are themselves the creations of ideas.

Those who would grant information a high intellectual priority often like to assume that facts, all by themselves, can jar and unseat ideas. But that is rarely the case, except perhaps in certain turbulent periods when the general idea of "being skeptical" and "questioning authority" is in the air and attaches itself to any dissenting, new item that comes along. Otherwise, in the absence of a well-formulated, intellectually attractive, new idea, it is remarkable how much in the way of dissonance and contradiction a dominant idea can absorb. There are classic cases of this even in the sciences. The Ptolemaic cosmology that prevailed in ancient times and during the Middle Ages had been compromised by countless contradictory observations over many generations. Still, it was an internally coherent, intellectually pleasing idea; therefore, keen minds stood by the familiar old system. Where there seemed to be any conflict, they simply adjusted and elaborated the idea, or restructured the observations in order to make them fit. If observations could not be made to fit, they might be allowed to stand along the cultural sidelines as curiosities, exceptions, freaks of nature. It was not until a highly imaginative constellation of ideas about celestial and terrestrial dynamics, replete with new concepts of gravitation, inertia, momentum, and matter, was created that the old system was retired. Through the eighteenth and nineteenth centuries, similar strategies of adjustment were used to

save other inherited scientific ideas in the fields of chemistry, geology, and biology. None of these gave way until whole new paradigms were invented to replace them, sometimes with relatively few facts initially to support them. The minds that clung to the old concepts were not necessarily being stubborn or benighted; they simply needed a better idea to take hold of.

THE MASTER IDEAS

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If there is an art of thinking which we would teach the young, it has much to do with showing how the mind may move along the spectrum of information, discriminating solid generalizations from hunches, hypotheses from reckless prejudices. But for our purposes here, I want to move to the far end of the spectrum, to that extreme point where the facts, growing thinner and thinner, finally vanish altogether. What do we find once we step beyond that point into the zone where facts are wholly absent?

There we discover the riskiest ideas of all. Yet they may also be the richest and most fruitful. For there we find what might be called the *master ideas*—the great moral, religious, and metaphysical teachings which are the foundations of culture. Most of the ideas that occupy our thinking from moment to moment are not master ideas; they are more modest generalizations. But from this point forward I will be emphasizing master ideas because they are always there in some form at the foundation of the mind, molding our thoughts below the level of awareness. I want to focus upon them because they bear a peculiarly revealing relationship to information, which is our main subject of discussion. *Master ideas are based on no information whatever.* I will be using them, therefore, to emphasize the radical difference between ideas and data which the cult of information has done so much to obscure.

Let us take one of the master ideas of our society as an example: *All men are created equal.*

The power of this familiar idea will not be lost on any of us. From it, generations of legal and philosophical controversy have arisen, political movements and revolutions have taken their course.

It is an idea that has shaped our culture in ways that touch each of us intimately; it is part, perhaps the most important part, of our personal identity.

But where did this idea come from? Obviously not from some body of facts. Those who created the idea possessed no more information about the world than their ancestors, who would, doubtless, have been shocked by such a pronouncement. They possessed far less information about the world than we in the late twentieth century may feel is necessary to support such a sweeping, universal statement about human nature. Nevertheless, those who shed their blood over the generations to defend that assertion (or to oppose it) did not do so on the basis of any data presented to them. The idea has no relationship whatever to information. One would be hard pressed even to imagine a line of research that might prove or disprove it. Indeed, where such research has been attempted (for example by inveterate IQ theorists), the result, as their critics are always quick to point out, is a hopeless distraction from the real meaning of the idea, which has nothing to do with measurements or findings, facts or figures of any kind. The idea of human equality is a statement about the essential worth of people in the eyes of their fellows. At a certain juncture in history, this idea arose in the minds of a few morally impassioned thinkers as a defiantly compassionate response to conditions of gross injustice that could no longer be accepted as tolerable. It spread from the few to the many; finding the same insurgent response in the multitude, it soon became the battle cry of an era. So it is with all master ideas. They are born, not from data, but from absolute conviction that catches fire in the mind of one, of a few, then of many as the ideas spread to other lives where enough of the same experience can be found waiting to be ignited.

Here are some more ideas, some of them master ideas, each of which, though condensed in form, has been the theme of countless variations in the philosophy, religious belief, literature, and jurisprudence of human society:

Jesus died for our sins.

The Tao that can be named is not the true Tao.

Man is a rational animal.

Man is a fallen creature.

Man is the measure of all things.

The mind is a blank sheet of paper.

The mind is governed by unconscious instincts.

The mind is a collection of inherited archetypes.

God is love.

God is dead.

Life is a pilgrimage.

Life is a miracle.

Life is a meaningless absurdity.

At the heart of every culture we find a core of ideas like these, some old, some new, some rising to prominence, some declining into obsolescence. Because those I list here in terse formulations are verbal ideas, they might easily be mistaken for intended statements of fact. They have the same linguistic form as a point of information, like "George Washington was the first president of the United States." But of course they are not facts, any more than a painting by Rembrandt is a fact, or a sonata by Beethoven, or a dance by Martha Graham. For these too are ideas; they are integrating patterns meant to declare the meaning of things as human beings have discovered it by way of revelation, sudden insight, or the slow growth of wisdom over a lifetime. Where do these patterns come from? The imagination creates them from *experience*. Just as ideas order information, they also order the wild flux of experience as it streams through us in the course of life.

This is the point Fritz Machlup makes when he observes a striking difference between "information" and "knowledge." (He is using "knowledge" here in exactly the same way I am using "idea"—as an integrating pattern.) "Information" he tells us, "is acquired by being told, whereas knowledge can be acquired by thinking."

Any kind of experience—accidental impressions, observations, and even "inner experience" not induced by stimuli received from the environment—may initiate cognitive processes leading to changes in a person's knowledge. Thus, *new knowledge can be acquired without new information being*

received. (That this statement refers to subjective knowledge goes without saying; but there is no such thing as objective knowledge that was not previously somebody's subjective knowledge.)[1]

Ideas, then—and especially master ideas—give order to experience. They may do this in deep or shallow ways; they may do it nobly or savagely. Not all ideas are humane; some, which bid to become master ideas and may succeed, are dangerous, vile, destructive. Hitler's *Mein Kampf* is a book filled with toxic ideas that were born of vengefulness and resentment. Yet they became, for a brief interval, the master ideas of one troubled society. No one who ever read that book and hated it did so because they thought the author had gotten some of his facts wrong; no one who ever read it and loved it cared about the accuracy of its information. The appeal of the book, whether accepted or rejected, was pitched at a different level of the mind.

Here are some more ideas that, at least in my view, are just as toxic:

Society is the war of each against all.

Self-interest is the only reliable human motivation.

Let justice be done though the heavens fall.

The only good Indian is a dead Indian.

Nice guys finish last.

The end justifies the means.

My country right or wrong.

It is precisely because some ideas—many ideas—are brutal and deadly that we need to learn how to deal with them adroitly. An idea takes us into people's minds, ushers us through their experience. Understanding an idea means understanding the lives of those who created and championed it. It means knowing their peculiar sources of inspiration, their limits, their vulnerabilities and blind spots. What our schools must offer the young is an education that lets them make that journey through another mind in the light of other ideas, including some that they have fashioned for themselves from their own

experience. The mind that owns few ideas is apt to be crabbed and narrow, ungenerous and defensive in its judgments. "Nothing is more dangerous than an idea," Emil Chartier once said, "when it is the only one we have."

On the other hand, the mind that is gifted with many ideas is equipped to make its evaluations more gracefully. It is open and welcoming to its own experience, yet capable of comparing that experience discriminately with the lives of others, and so choosing its convictions with care and courtesy.

EXPERIENCE, MEMORY, INSIGHT

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One of the major liabilities of the data processing model of thought is the way in which it coarsens subtle distinctions in the anatomy of the mind. The model may do this legitimately in order to simplify for analytical purposes; all scientific models do that. But there is always the danger—and many computer scientists have run afoul of it—that the model will become reified and be taken seriously. When that happens on the part of experts who should know better, it can actually falsify what we know (or should know) about the way our own minds work.

Take, for example, the significant interplay between experience, memory, and ideas, which is the basis of all thought. I have been using the word *experience* here to refer to the stream of life as it molds the personality from moment to moment. I use the word as I believe most artists would use it; more specifically, it is experience as it would be reflected in the literary technique called stream of consciousness.

Experience in this sense is the raw material from which moral, metaphysical, and religious ideas are fashioned by the mind in search of meaning. This may seem like an imprecise definition, especially to those of an empiricist inclination. In the empiricist tradition "experience" has come to be the equivalent of information. It is the sensory data which we collect in neat, well-packaged portions to test propositions about the world in a strictly logical way. When the empiricist philosophers of the seventeenth and eighteenth centuries defined experience in this way, they were in search of a form of

knowledge that would serve as an alternative to statements that were meant to be accepted on the basis of authority, hearsay, tradition, revelation, or pure introspective reasoning. Experience was intended to be that kind of knowledge which was firsthand and personally tested. It was also meant to be available for inspection by others through *their* experience. Hence, it was *public* knowledge and, as such, free of obfuscation or manipulation. This, so the empiricists argued, was really the only kind of knowledge worth having. Unless all the rest could be verified by experience, it probably did not deserve to be regarded as knowledge at all.

But experience of the kind the empiricists were after is actually of a very special, highly contrived variety. Modeled upon laboratory experimentation or well-documented, professional research, it exists almost nowhere except in the world of science—or possibly as evidence in a court of law. We do not normally collect much experience of this sort. Rather, we ordinarily take in the flow of events as life presents it—unplanned, unstructured, fragmentary, dissonant. The turbulent stream passes into memory where it settles out into things vividly remembered, half remembered, mixed, mingled, compounded. From this compost of remembered events, we somehow cultivate our private garden of certainties and convictions, our rough rules-of-thumb, our likes and dislikes, our tastes and intuitions and articles of faith.

Memory is the key factor here; it is the register of experience where the flux of daily life is shaped into the signposts and standards of conduct. Computers, we are told, also have "memories," in which they store information. But computer memory is no more like human memory than the teeth of a saw are like human teeth; these are loose metaphors that embrace more differences than similarities. It is not the least of its liabilities that the cult of information obscures this distinction, to the point of suggesting that computer memory is superior because it remembers so much more. This is precisely to misinterpret what experience is and how it generates ideas. Computers "remember" things in the form of discrete entries: the input of quantities, graphics, words, etc. Each item is separable, perhaps designated by a unique address or file name, and all of it subject to total recall. Unless the machine malfunctions, it can regurgitate everything it has stored exactly as it was entered, whether a single number or a lengthy document. That is what we expect of the machine.

Human memory, on the other hand, is the invisible psychic ad-

hesive that holds our identity together from moment to moment. This makes it a radically different phenomenon from computer memory. For one thing, it is fluid rather than granular, more like a wave than a particle. Like a wave, it spreads through the mind, puddling up here and there in odd personal associations that may be of the most inexplicable kind. It flows not only through the mind, but through the emotions, the senses, the body. We remember things as no computer can—in our muscles and reflexes: how to swim, play an instrument, use a tool. These stored experiences lodge below the level of awareness and articulation so that there is no way to tell someone how we drive a car or paint a picture. We don't actually "know" ourselves. In an old bit of folk wisdom, the daughter asks her mother how she bakes such a good apple pie. The mother, stymied, replies: "First I wash my hands. Then I put on a clean apron. Then I go into the kitchen and bake a good apple pie."

Moreover, where we deal with remembered experience, there is rarely total recall. Experiences may be there, deeply buried in our brain and organism, but they are mostly beyond recollection. Our memory is rigorously selective, always ready to focus on what matters to us. It edits and compacts experience, represses and forgets—and it does this in ways we may never fully understand. As we live through each present moment, something immediately before us may connect with experiences that call up vivid sensory associations, pains, pleasures; these in turn may make us laugh, they may leave us sad, they may bring us to the point of nausea or deep trauma. Some of what we have experienced and stored away in memory may derive from our speechless childhood; some may be phantoms of prenatal recollection. Much is drawn from private fantasies never reported to anyone, hardly admitted to ourselves.

We may say that we remember what "interests" us; but we may also perversely conceal or recompose things that are too threatening to face. The recollections we retain are mysteriously selected, enigmatically patterned in memory. There are hot bright spots filled with rich and potent associations; there are shadowed corners which may only emerge vividly in dreams or hallucinations; there are odd, quirky zones that delight to fill up with seemingly useless, chaotic remnants—things we remember without knowing why, even items (insistent song lyrics, irritating advertising jingles) we would just as soon erase if we could . . . but we can't. If we could draw a full anatomy of memory in all its elusive variety, we would have the

secret of human nature itself. The shape of memory is quite simply the shape of our lives; it is the self-portrait we paint from all we have experienced. It is not the computer scientist but a literary artist like Vladimir Nabokov who can tell us most about the strange dynamics of experience. He writes:

A passerby whistles a tune at the exact moment that you notice the reflection of a branch in a puddle which in its turn and simultaneously recalls a combination of damp leaves and excited birds in some old garden, and the old friend, long dead, suddenly steps out of the past, smiling and closing his dripping umbrella. The whole thing lasts one radiant second and the motion of impressions and images is so swift that you cannot check the exact laws which attend their recognition, formation, and fusion. . . . It is like a jigsaw puzzle that instantly comes together in your brain with the brain itself unable to observe how and why the pieces fit, and you experience a shuddering sensation of wild magic.[2]

Experience, as Nabokov describes it here, is more like a stew than a filing system. The ingredients of a lifetime mix and mingle to produce unanticipated flavors. Sometimes a single piquant component—a moment of joy, a great sorrow, a remembered triumph or defeat—overpowers all the rest. In time, this stew boils down to a rich residue of feelings, general impressions, habits, expectations. Then, in just the right circumstance—but who can say what this will be?—that residue bubbles up into a well-formed insight about life which we may speak or paint or dance or play out for the world to know. And this becomes, whether articulately or as an unspoken existential gesture, an *idea*. Certainly, this has much to do with the climate of opinion in which we find ourselves, the traditions we share, the autobiographical momentum of our lives. But how these will combine in any given mind at any given moment and what they will produce is wholly beyond prediction. The stew of personal experience is too thick, too filled with unidentifiable elements mixed in obscure proportions. What emerges from the concoction can be genuinely astonishing. Which is only to observe what all culture tells us about ourselves: that we are capable of true originality. History teems with such marvelous examples of invention and startling con-

version. Paul of Tarsus struck blind on the road to Damascus rises from the trauma to become the disciple of a savior he had never met and whose followers he had persecuted; Tolstoy, falling into an episode of suicidal depression, disowns his literary masterworks and strives to become an ascetic hermit; Gandhi, driven from the white-only compartment of a South African train, renounces his promising legal career to don a loincloth and become the crusading mahatma of his people. This is experience at work, mysteriously shaping new ideas about life in the depths of the soul.

So too all of us, as we bear witness to the emerging convictions of others, confront what they say and do with the full force of our experience. If there is a confirming resonance within us, it may be because our lives have overlapped those we encounter. But it may also be that the power of the encounter in itself—then and there in a single moment—shatters the convictions of a lifetime, and we have the sense of beginning anew, of being reborn. For there are such instances of people being unmade and remade by charismatic confrontation and the pressures of crisis. It may even be the case that these gifts of originality and sudden conversion play a crucial evolutionary role in the growth of culture. Perhaps this volatility of mind is what saves human society from the changeless rigidity of the other social animals, the ants, the bees, the beasts of the pack and the herd. We are gifted as a species with a crowning tangle of electrochemical cells which has become an idea-maker. So spontaneously does this brain of ours make ideas and play with ideas that we cannot say much more about them than that they are there, shaping our perceptions, opening up possibilities. From moment to moment, human beings find new things to think and do and be: ideas that erupt seemingly from out of nowhere. We are remarkably plastic and adaptable animals, and the range of our cultural creativity seems unlimited. It would be a great loss if, by cheapening our conception of experience, memory, and insight, the cult of information blunted these creative powers.

There are computer scientists who seem well on their way toward doing that, however. They believe they can simulate our originality on the computer by working out programs that include a randomizing element. (The Logo program for poetry which we reviewed in the previous chapter is an example of this.) Because this makes the output of the program unpredictable, it has been identified as "cre-

ative." But there is all the difference in the world between such contrived randomness and true originality. Again, the data processing model works to obscure the distinction. In the human mind, an original idea has a living meaning; it connects with experience and produces conviction. What the computer produces is "originality" at about the level of a muscular spasm; it is unpredictable, but hardly meaningful.

Of course, there are other forms of experience that come to us more neatly packaged and labeled: things learned by rote or memorized verbatim, precise instructions, procedures, names, addresses, facts, figures, directions. What such experiences leave behind is much like what fills computer memory: *information* in the proper sense of the term. Our psychological vocabulary does not clearly distinguish these different levels and textures of memory; we have simply the one word for the remembrance of things past. We *remember* a phone number; we *remember* an episode of traumatic suffering that changed our lives. To sweep these different orders of experience under the rubric *information* can only contribute to cheapening the quality of life.

"The heart has its reasons," Pascal tells us, "which reason cannot know." I would take this to mean that the minds of people are filled with ideas which well up from deep springs of mixed and muddled experience. Yet these ideas, hazy, ambiguous, contradictory as they may be, can be, for better or worse, the stuff of strong conviction. In a debate that involves such "reasons," information is rarely of much use. Instead, we must test and sample in the light of our own convictions, seeking the experience that underlies the idea. We must do what I dare say you are doing now as you read these words, which are convictions of mine presented for your consideration. You pause, you reflect, probing to discover what my moral and philosophical loyalties might be. As you try to get the *feel* of the ideas I offer, you cast about in your recollections to see if you can find there an echo of the experiences I draw upon. You may loiter more over nuances and shades of meaning than over matters of fact. Here and there you may detect distant implications or hidden assumptions that you may or may not care to endorse. Possibly you sense that some of your fondest values are challenged and you hasten to defend them.

There is no telling how this critical rumination will turn out, but one thing should be obvious: none of this is "data processing." It is the give and take of dialogue between two minds, each drawing upon

its own experience. It is the play of ideas, and all the information in all the data bases in the world will not decide the issues that may stand disputed between us.

THE EMPIRICIST GAMBIT

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Once they focus on the matter, many people will find the primacy of ideas so obvious that they may wonder why it has to be raised as a bone of contention at all. How have the computer scientists managed to subordinate ideas to data so persuasively? This is an intriguing historical question to which we might do well to give some attention.

Earlier in this chapter, I made reference to the empiricist school of philosophy and the way in which it has chosen to reinterpret the meaning of experience. Let us return for a moment to the impact of empiricism upon Western philosophy, for it plays a significant role in the cult of information.

Some four centuries ago, in that turbulent transitional zone that leads from the Renaissance to the modern period, the realm of knowledge in the Western world was a relatively small island of certainty surrounded by a sea of accepted mystery. At its far, unfathomable reaches, that sea merged with the mind of God, the contents of which might only be approached by an act of faith. On the island, the major bodies of thought were the scriptures, the works of the Church fathers, a handful of surviving Greek and Roman masters, and possibly a small select group of Jewish and Arab thinkers. Over several centuries of the medieval period, these sources had been worked up, often by way of brilliant elaborations, into an august repertory of knowledge that was held to answer all the questions the human mind could expect to have answered.

In such a culture, there is no such category as "information"; facts count for very little where whatever can be known is already known and has been assimilated to well-known truths. Instead of information there is confabulation: constant, sometimes inspired play with familiar ideas that are extended, combined, reshaped. By the latter part of the sixteenth century, this intellectual style was becoming more and more incompatible with the social and economic dynamism of Western society. For one thing—a dramatic thing—

new worlds were being discovered, whole continents and cultures that were unaccounted for by any existing authority. These were *discoveries*. And if there could be geographical discoveries, then why not new worlds of the mind as well? Francis Bacon used just that comparison to justify his restless quest for a "New Philosophy." He, Descartes, Galileo, Giordano Bruno were among the first to match their culture's expansive passion for physical discovery with a corresponding intellectual daring.

These seminal minds of the seventeenth century hit upon an exciting cultural project. Their proposition was this: Let us devise a kind of inquiry which will have the power to discover *new things* about the world—about its forces, and structures, and phenomena. This will be a way of thinking that will be the equivalent of the great voyages of discovery that have found new worlds across the seas. This style of inquiry, they decided, should involve rigorous, well-targeted interrogation of nature by close observation and experimentation. It should be undertaken in a spirit of total objectivity, avoiding all assumptions and presuppositions. It should simply try to see things as they really are. The result of this new method will be a growing body of solid, reliable facts, usually measurements, which have heretofore been overlooked. Then, if an observer sets about scrupulously collecting these facts, they will eventually speak for themselves, shaping themselves into great truths as vast in their scope as the size of the whole universe.

We can now recognize this method (the *novum organum*, as Bacon called it) as the distant beginning of the modern scientific world view. No one can fail to appreciate its historical contribution; but we also have enough historical perspective to know how very misconceived that method was. In its narrow focus on facts, it left out of account the crucial importance of theoretical imagination, hypothesis, speculation, and inspired guesswork—without which science would not have had its revolutionary impact. Looking back from our vantage point, we can clearly see theoretical imagination at work in the minds of Galileo, Newton, Kepler, Boyle, Hook, contours of thought which were there but which they were too close to notice. We have learned that great scientific breakthroughs are never assembled piecemeal from lint-picking research. At times, limited, fine-grained investigation may succeed in raising important doubts about a scientific theory; but it must at least have that theory before it as a target or a baseline. Without some master idea that

serves that function, one would not know where to begin looking for facts. Science is structured inquiry, and the structures that guide its progress are ideas.

There was, however, a good reason why the founding fathers of modern science should have erred in the direction of overvaluing facts at the expense of ideas. In Galileo's day, the dominant ideas about nature were derived from a few sacrosanct authorities—either Christian theology or Aristotle. In order to free themselves from this increasingly restrictive heritage of tired, old ideas, these daring minds were moved to call *ideas themselves* into question. So they recommended a new point of departure, one which seemed innocuously neutral and therefore strategically inoffensive to the cultural authorities of the day: they would concentrate their attention on the clear-cut indisputable facts of common experience—the weights and sizes and temperatures of things. Facts first, they insisted. Ideas later. And this proved to be a persuasive approach. It brought to light any number of terrestrial and astronomical novelties that could not be adequately explained by Aristotle, the Bible, the Church fathers—or perhaps had never been noticed by them at all. If the mission of the early empiricists is viewed in its historical context, it can be recognized as a clever philosophical gambit whose purpose was to break down ethnocentric barriers and ecclesiastical authority. In this, it finally succeeded. By encouraging a bold skepticism about all inherited ideas, it liberated the restricted intellectual energies of Western society. Its connection with the birth of modern science will always endow it with a special status.

The trouble is, the very success of the empiricists has helped to embed a certain fiercely reductionistic conception of knowledge in our culture, one that drastically undervalues the role of the imagination in the creation of ideas, and of ideas in the creation of knowledge, even in the sciences. In our time, minds loyal to the empiricist love of fact have seized upon the computer as a model of the mind at work storing up data, shuffling them about, producing knowledge, and potentially doing it better than its human original. Those who see the world more or less in this way represent one pole in an argument which had already been joined in the days of Plato, Aristotle, and Democritus. Which is more "real," things or the ideas we have of things? Does knowledge begin in the senses or in the mind?

It is hardly my intention to try to adjudicate that argument here. I only wish to emphasize that the data processing model of the mind

is not some purely objective "finding" of contemporary science. It grows from a definite philosophical commitment; it represents one side in an ancient debate, still with us and still unsettled. The empiricist side of that debate deserves to be respected for the rich contribution it has made to our philosophical heritage. We would not want to do without it. But I have found it interesting, whenever I am in the company of those who hold a rigorously empirical position, to remind them of a paradox: their viewpoint is itself an *idea*. It is an idea about ideas . . . and about knowledge, experience, and truth. As such, it is not based on fact or information, because it is this very idea which defines information in the first place. There is ultimately no way around ideas, then. They are what the mind thinks with, even when it is attacking the primacy of ideas.

For that matter, the computer is also an idea, just as all machines are. It is an idea about number, and classification, and relationship —all realized in the form of a physical invention. The proposition that the mind thinks like a computer is an idea about the mind, one that many philosophers have taken up and debated. And like every idea, this idea also can be *gotten outside of*, looked at from a distance, and called into question. The mind, unlike any computer anyone has even imagined building, is gifted with the power of irrepressible self-transcendence. It is the greatest of all escape artists, constantly eluding its own efforts at self-comprehension. It can form ideas about its own ideas, including its ideas about itself. But having done that, it has already occupied new ground; in its next effort to understand its own nature, it will have to reach out still further. This inability of the mind to capture its own nature is precisely what makes impossible to invent a machine that will be the mind's equal, let alone its successor. The computer can only be one more idea in the imagination of its creator. Our very capacity to make jokes about computers, to spoof and mock them, arises from our intellectual distance from them. If there is anything that frustrates the technician's talent, it is open-ended potentiality.

NO IDEAS, NO INFORMATION
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From the viewpoint of the strict, doctrinaire empiricism which lingers on in the cult of information, the facts speak for themselves. Accumulate enough of them, and they will conveniently take the shape of knowledge. But how do we recognize a fact when we see one? Presumably, a fact is not a mental figment or an illusion; it is some small, compact particle of truth. But to collect such particles in the first place, we have to know what to look for. There has to be the idea of a fact.

The empiricists were right to believe that facts and ideas are significantly connected, but they inverted the relationship. *Ideas create information*, not the other way around. Every fact grows from an idea; it is the answer to a question we could not ask in the first place if an idea had not been invented which isolated some portion of the world, made it important, focused our attention, and stimulated inquiry.

Sometimes an idea becomes so commonplace, so much a part of the cultural consensus, that it sinks out of awareness, becoming an invisible thread in the fabric of thought. Then we ask and answer questions, collecting information without reflecting upon the underlying idea that makes this possible. The idea becomes as subliminal as the grammar that governs our language each time we speak.

Take an example. The time of day, the date. These are among the simplest, least ambiguous facts. We may be right or wrong about them, but we know they are subject to a straightforward true or false decision. It is either 2:15 P.M. in our time zone, or it is not. It is either March 10, or it is not. This is information at its most irreducible level.

Yet behind these simple facts, there lies an immensely rich idea: the idea of time as a regular and cyclical rhythm of the cosmos. Somewhere in the distant past, a human mind invented this elegant concept, perhaps out of some rhapsodic or poetic contemplation of the bewilderingly congested universe. That mind decided the seemingly shapeless flow of time can be ordered in circles, the circles can be divided into equal intervals, the intervals can be counted. From this insight, imposed by the imagination on the flux of experience,

we derive the clock and the calendar, the minutes, days, months, seasons we can now deal with as simple facts.

Most of our master ideas about nature and human nature, logic and value eventually become so nearly subliminal that we rarely reflect upon them as human inventions, artifacts of the mind. We take them for granted as part of the cultural heritage. We live off the top of these ideas, harvesting facts from their surface. Similarly, historical facts exist as the outcroppings of buried interpretive or mythic insights which make sense of, give order to the jumbled folk memory of the past. We pick up a reference book or log on to a data base and ask for some simple information. When was the Declaration of Independence signed and who signed it? Facts. But behind those facts there lies a major cultural paradigm. We date the past (not all societies do) because we inherit a Judeo-Christian view of the world which tells us that the world was created in time and that it is getting somewhere in the process of history. We commemorate the names of people who "made history" because (along other lines) we inherit a dynamic, human-centered vision of life which convinces us that the efforts of people are important, and this leads us to believe that worthwhile things can be accomplished by human action.

When we ask for such simple points of historical information, all this stands behind the facts we get back as an answer. We ask and we answer the questions within encompassing ideas about history which have become as familiar to us as the air we breathe. But they are nonetheless human creations, each capable of being questioned, doubted, altered. The dramatic turning points in culture happen at just that point—where new idea rises up against old idea and judgment must be made.

What happens, then, when we blur the distinction between ideas and information and teach children that information processing is the basis of thought? Or when we set about building an "information economy" which spends more and more of its resources accumulating and processing facts? For one thing, we bury even deeper the substructures of ideas on which information stands, placing them further from critical reflection. For example, we begin to pay more attention to "economic indicators"—which are always convenient, simple-looking numbers—than to the assumptions about work, wealth, and well-being which underlie economic policy. Indeed, our orthodox economic science is awash in a flood of statistical figments

that serve mainly to obfuscate basic questions of value, purpose, and justice. What contribution has the computer made to this situation? It has raised the flood level, pouring out misleading and distracting information from every government agency and corporate boardroom. But even more ironically, the hard focus on information which the computer encourages must in time have the effect of crowding out new ideas, which are the intellectual source that generates facts.

In the long run, no ideas, no information.

S I X

COMPUTERS AND PURE REASON

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THE LIGHT IN PLATO'S CAVE

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Up to this point, we have been concentrating on the computer's capacity to store and retrieve seemingly limitless amounts of data. This is one of the machine's most impressive and useful powers; it is the feature that stands foremost in the minds of those who hail the advent of the Information Age. They are emphasizing the computer's ability to access data bases, of which there are already thousands in existence, and to channel this wealth of material into people's homes and workplaces.

But when we speak of the computer as a "data processor," it is easy to overlook the fact that these two words refer to two separate functions that have been united in the machine. The computer *stores* data, but it can also *process* these data—meaning it can manipulate them in various ways for purposes of comparison, contrast, classification, deduction. The data may be numbers which are being run through mathematical processes; but they may also be names, addresses, medical records, personnel files, technical instructions which are also being run through a program to be sorted, ordered, filtered, or placed in some designated sequence. Thus, when a computer is ordered to run a spreadsheet scenario for a business, it draws upon all the data it holds for that business (inventory, overhead, earnings, seasonal performance, etc.), but it also massages the data, shaping them as the program instructs. Even a simple mailing list may reor-

ganize the material in its data bank in response to a program designed, for example, to segregate names by zip code in order to upscale the subscription list of a magazine or to edit out names on the basis of credit rating, ethnicity, age, etc.

These two operations have become so integrated in the performance of most computers that they are rarely thought of any longer as separate functions. Yet they are, and each may be given a separate evaluation. *Storing* data connects the computer with the job of record keeping; it dates back to the ledgers and filing cabinets which electronic data banks are now replacing. In this capacity, the computer mimics the faculty of memory. *Processing* data, on the other hand, represents a different line of technological descent. Here the computer dates back to the adding machine, and in this capacity, it mimics the power of human reason. For many computer enthusiasts, this second line of development is the real significance of the machine. They value its ability to work through lengthy logical-mathematical procedures with blinding speed and absolute precision. For them, this is the computer's closest approximation to the human mind.

In Chapter 4, we touched upon Seymour Papert's Logo computer curriculum. Logo is an example of a computer application that has very little to do with data; the value Papert sees in it is its capacity to teach "procedural thinking," and so to discipline the rational faculties in a way that a mathematician would find important. He believes children should be taught to "think like a computer" because he believes computers have somewhat the capacity to think like human beings and so can help children learn that mental skill.

I have argued that those who celebrate the computer as an information keeper and provider tend to underrate, if not ignore the value of ideas, assuming, as many strict empiricists have, that information somehow compiles itself automatically into knowledge without the active intervention of theoretical imagination. Yet, ironically enough, the second line of technological descent that flows into the computer—that which has to do with procedural thinking—derives from a very different philosophical tradition, one which is intimately connected with the power of pure reason. Along this rationalist line of descent, the computer draws upon a class of ideas which has proved to be uniquely persuasive and long-lived, even though it has no connection whatever with data or with human experience of any kind. These are *mathematical ideas:* ideas discovered in the light of

unaided reason, fashioned from the logical structure of the mind itself.

In the history of philosophy, it is mathematics that has again and again been used as an example of a priori knowledge, knowledge which supposedly has no connection with sensory experience, with the data of observation and measurement. As Bertrand Russell observes:

> Mathematics is . . . the chief source of the belief in eternal and exact truth, as well as in a supersensible intelligible world. Geometry deals with exact circles, but no sensible object is *exactly* circular; however carefully we may use our compasses, there will be some imperfections and irregularities. This suggests the view that all exact reasoning applies to the ideal as opposed to sensible objects; it is natural to go further, and to argue that thought is nobler than sense, and the objects of thought more real than those of sense perception.[1]

The classic formulation of this idea about mathematical ideas is that of Plato, for whom geometry served as the model of all reliable knowledge. Plato assumed that geometrical ideas are born into the mind as our one sure foundation for thought. In the darkness and confusion of life, we have the certainty of mathematics to guide us. In his famous Allegory of the Cave, Plato portrays the human race as a population of wretched slaves confined by their physical mortality to a tenebrous dungeon where they can see nothing but a blurred show of animated shadows; they know nothing that is not impermanent and illusory. In their squalid prison, there is but one distant glimmer of illuminating sunlight. Only the true philosopher discerns it; it is the power of pure reason, which gives us, especially in the form of mathematics, a knowledge of eternal verities, the pure forms that transcend the flux of time and the frailty of the flesh.

Over the centuries, in a variety of ways, philosophers have taken issue with Plato's theory of knowledge and the mystique which it lends to mathematics. Still, for all the criticism, there remains a haunting quality to mathematical ideas, a trust in the clarity of numbers and of mathematical logic that lingers on in modern science and which survives in cybernetics and information theory. Plato's mysticism may have been banished from these new sciences, but the spell

of geometrical certainty remains. For, ironically enough, the machine that gives the cult of information its greatest strength is grounded in a body of ideas—mathematical ideas—which has nothing to do with information, and which might conceivably be seen as the best proof we have to offer of the primacy of ideas.

As computers have grown "smarter" (meaning faster, more capacious, more intricate in their programming) over the past two decades, computer scientists have often exhibited some uneasiness with the name of their machine. As most recent textbooks in computer science hasten to tell students in the first chapter, the computer is no longer merely a computing instrument; it has transcended its lowly origins to become a form of artificial intelligence in the broadest sense. Thus, Margaret Boden observes,

> It is essential to realize that a computer is not a mere "number cruncher," or supercalculating arithmetic machine, although this is how computers are commonly regarded by people having no familiarity with artificial intelligence. Computers do not crunch numbers; they manipulate symbols. . . . Digital computers originally developed with mathematical problems in mind, are in fact general purpose symbol manipulating machines. . . .
>
> The terms "computer" and "computation" are themselves unfortunate, in view of their misleading arithmetical connotations. The definition of artificial intelligence previously cited—"the study of intelligence as computation"— does not imply that intelligence is really counting. Intelligence may be defined as the ability creatively to manipulate symbols, or process information, given the requirements of the task in hand.[2]

It is certainly true that computers have evolved a long way from being super adding machines. But it is also true that, in large measure, the reputation which computer science and computerized forms of "intelligence" have acquired in our popular culture borrows heavily upon the age-old mystique of mathematics. Insofar as computer scientists believe that computers are "machines who think" and that may someday think better than people, it is because of the machine's historic connection with what the scientists and technicians have always taken to be the clearest, most productive kind of thinking:

mathematics. The promise that many enthusiasts see in the computer is precisely that it will, in time, produce a form of intelligence which will apply the exactitude of mathematics to every other field of culture. The computer's repertory of symbols may no longer be limited to numbers; nevertheless, the hope remains that its more sophisticated programs will be able to manipulate symbols with the logical rigor of mathematical reasoning. Fritz Machlup makes the point that the word *computation* has taken on a vastly extended usage, now covering whatever computers can do as symbol manipulators. This leads to a good deal of public confusion. When, for example, a cognitive scientist speaks of artificial intelligence programs, and people "read a sentence or clause to the effect that 'mental processes are computational processes,' they are most likely to think of processes of numerical computation—but would be wrong."[3]

It is, however, this very error which works to enhance the prestige of the computer by making it all too easy to believe that whatever runs through a computer thereby acquires the ironclad certainty of pure mathematics. Though they would blush to associate themselves with Plato's mysticism, many opportunistic figures in computer science and especially artificial intelligence have exploited that error for all it is worth in the confused public mind.

It is curious how, at times in the most unpredictable way, something of the old Platonic spirit surfaces in the world of computer science. Plato was convinced that it was the corruption of the flesh that separates us from the highest forms of knowledge. So he recommended the study of geometry as a sort of purgation of the senses that would elevate the mind above the body's mortality. We can see exactly this same alliance of the ascetic and the mathematical in the following passage from Robert Jastrow's study of "mind in the universe":

> When the brain sciences reach this point, a bold scientist will be able to tap the contents of his mind and transfer them into the metallic lattices of a computer. Because mind is the essence of being, it can be said that this scientist has entered the computer, and that he now dwells in it.
>
> At last the human brain, ensconced in a computer, has been liberated from the weakness of the mortal flesh. . . . It is in control of its own destiny. The machine is its body; it is the machine's mind. . . .

It seems to me that this must be the mature form of intelligent life in the Universe. Housed in indestructible lattices of silicon, and no longer constrained in the span of its years by the life and death cycle of a biological organism, such a kind of life could live forever.[4]

In this disembodied form, Jastrow imagines that the computer will transform us into "a race of immortals."

THE OLD MATHEMATICAL MAGIC
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The mathematical model of absolute certainty is one of the undying hopes of our species. As tough-minded as most scientists might be (or wish to appear to be) in their response to the old mathematical magic, that Platonic dream survives, and no place more vividly than in the cult of information. Data—the speed and quantity of their processing—may be what the cult most often emphasizes in its celebration of the computer. But quite as important as the data is the mathematical precision with which the computer's programs manipulate the information fed into them. This is what computer scientists mean by the term *effective procedure*. We are told that a computer can do anything for which an "effective procedure" is given. The phrase means "a set of rules (the program) unambiguously specifying certain processes, which processes can be carried out by a machine built in such a way as to accept those rules as instructions determining its operations."[5] The search for such a procedure would be pure whimsey were it not for the fact that there is one field of thought which offers us a model of just such strict logicality: mathematics, the field that produced the computer in the first place. When limited to the realm of what *can* be treated with such logical rigor, the computer functions at its full strength. But the further we stray from that realm, the more rapidly its powers fade.

Unfortunately, not all computer scientists are willing to concede that point. They forget—and help the public forget—that mathematical ideas are of a very special kind. They are *formal* ideas, meaning they are built from axioms by unambiguously specifiable rules. They can be analyzed into parts, and the parts are ultimately logical

principles and postulates that lend themselves to mechanical manipulation. The value of mathematical ideas lies precisely in this analytical clarity and nonambiguity. Within their field of proper application, they have the power to confer logical transparency; they strip away ambiguity to reveal the skeletal structure that connects parts, stages, and procedures. They can be programmed. This is because, by an astonishing exercise of the human imagination, mathematical systems have been developed outside the real world of daily experience, which is more often than not blurred, fuzzy, and infinitely complex.

Since there are areas of the real world that appear to approximate formal order, there are portions of mathematics that can be applied to that world in order to isolate its more measurable and rule-abiding elements. Where that happens, we have the realms of theoretical and applied science. And so here too computers can be highly useful in channeling large amounts of information through scientific and technical programs. But even here we should bear in mind that there are underlying ideas of a nonmathematical kind (we might call them insights or, perhaps, articles of faith) that govern all scientific thought. Take our basic conviction that there is a rational order to nature, a pattern which the mind can grasp. This is the most fundamental of scientific ideas. But what is it based upon? It is a hunch or a desperate hope worked up perhaps from fleeting perceptions of symmetries or regularities in nature, recurring rhythms and cycles—all of which are continually dissolving in the "buzzing, booming confusion" of daily life. But working with that idea as a kind of filter, we screen out the exceptions and distractions and find deeper regularities which begin to look like an *order* of things. But what kind of order? Our science has chosen to look for the order of numbers. We work from Galileo's potent idea that "the great book of nature is written in the language of mathematics." But we might have chosen another kind of order. There is the order of music (thus the astronomer Kepler spent most of his life searching for the harmony of the spheres); there is the order of architecture and of drama; there is the order of a story (a myth) told over and over; there is the order of a god's behavior, where we watch for reward and punishing, wrath and mercy. Which order is the most important? Making that choice is also an idea to be selected from all the possibilities.

Very nearly the whole of modern science has been generated out of a small collection of metaphysical, even aesthetic ideas such as:

The universe consists of matter in motion. (Descartes)

Nature is governed by universal laws. (Newton)

Knowledge is power. (Bacon)

None of these ideas is a conclusion arrived at by scientific research; none of them is the result of processing information. Rather, they are premises that make scientific research possible and lead to the discovery of confirming data. Once again, these are master ideas about the world, and like all master ideas, they transcend information. They arise from another dimension of the mind, from a capacity for insight that is perhaps akin to the power of artistic and religious inspiration.

There is no question but that in the area of mathematical and scientific ideas, the computer supplements the mind significantly. It can carry out calculations at blinding speed; it can make hypothetical projections; it can offer amazingly flexible graphic representations; it can produce complex simulations that stretch the imagination. This is quite a lot for a machine to offer. Yet it may be that even in the sciences, the computer's proficiency as an information processor has its liabilities. At least one leading scientist has raised a provocative warning about the use of computers in astronomy. Sir Bernard Lovell writes:

I fear that literal-minded, narrowly focused computerized research is proving antithetical to the free exercise of that happy faculty known as serendipity. . . . Would the existence of radio galaxies, quasars, pulsars and the microwave background ever have been revealed if their discovery had depended on the computerized radio observations of today? . . . The computers act as very narrow filters of information; they must be oriented to specific observations. In other words, they have to be programmed for the kinds of results that the observer expects. Does this mean, then, that computers are antiserendipitous? And if they are, should we not be troubled that they may be obscuring from our understanding further major features of the universe?[6]

THE SEDUCTIONS OF SOFTWARE
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There is a predictable response to the argument I have been making here. It would insist that computers can *also* be programmed with nonmathematical ideas. Indeed, this is done all the time. For this is what a "program" is: an algorithm, a set of instructions that organizes information for some purpose. The ideas that animate programs may be too obvious to merit comment, as in the case of a family budget program that operates from the assumption that bankruptcy is undesirable and should therefore be avoided. (The program may then even dramatize the warning with a sharp command or a blinking signal.) Or the idea may be as brutally simple as the goal of the video game which dictates that Ms. Pacman should eat without being eaten.

Many programs are a great deal more complex than that. There are integrated management packages that claim to do the jobs of an entire office staff and perhaps a vice president or two. There are computer games that are fiendishly complicated, to the point of requiring as much intuition as calculation—meaning the complexities of strategy outdistance logical analysis. The trouble is, in the world of computer science *both* the ideas that govern the program *and* the data that are put through the program have come to be included within the concept of "information." The cult of information has gained a great deal for its mystique by bringing the program as well as the data within its province. But this can be a disastrous confusion. For it is like saying that there is no difference between, on the one hand, the architectural design of a building (the blueprints) and, on the other, all the measurements of all the materials that will be used in constructing that building. The materials and their measurements comprise a vast mass of detailed information that might usefully be entered into a computer under various convenient and cross-referenced headings and then called up for review at the push of a button. Yet it is the design of the building that holds this shapeless chaos of quantities together and gives it meaning. This is what answers the question, What is all this information about? It is also the design, once it is before us, that allows us to ask even more important questions which the data in the computer's memory cannot

possibly answer. Do we really want to build this structure in the first place? Does it have a sensible relationship to its site, its neighborhood, its environment? Is it beautiful? Is it practical? Will it work? Will it make us proud? Will we feel at home in it? Does it have warmth, nobility, a human scale, a sense of its time and place that will make it welcome to those who must live with it and work within it?

We might discuss the design in all these respects without any measurements of any materials being given at all. (Even the true meaning of "human scale" may not always be a matter of size, but often of the character of the environment.) We are then talking about the *idea* of the building, as we had it in mind or perhaps as it might exist in a mere doodle on a scrap of paper. Nowadays the doodle might be done by the architect with an electronic stylus on a video screen, but the distinction holds: the idea comes first, the idea contains the data, the idea governs the data.

Once we reflect upon the matter, we cannot fail to see that the data and the program that processes the data stand on different levels, the one subordinate to the other. Why is it, then, that they have both come to be called "information"?

In part, this may have to do with the fact that whatever gets fed into a computer is at once translated into binary numbers. The numbers become bits, the letters of words become packages of bits called bytes. The binary code then comes to be seen as a comprehensive "language" that homogenizes all that it expresses. In some universities, the systems used to help make the translation (BASIC, PASCAL, LISP, etc.), metaphorically referred to as "programming languages," can now be substituted for the study of French, German, Russian . . . the faster to make the students computer literate. These are not, of course, languages at all; they are coding systems. But in the computer's electronic metabolism, the omnivorous bit devours everything—numbers, words, geometrical forms, graphics, music—into long strings of ones and zeros. Does this not, then, erase the distinction between data and idea? As I was once told by a computer expert, "information" is anything that can be entered into the machine as off/on, yes/no.

Now, if there were such a thing as a conscious transistor, this might be the odd way in which such an alien entity would see the world: as an infinite collection of undifferentiated "ones" and

"zeros." But the fact that a transistor could not tell the difference between the bits that are data and the bits that are ideas, does not mean that *we* are free to blur this vital distinction. For if we do, we risk surrendering our intelligent control over the programs that now govern more and more of our lives. Every piece of software has some repertory of basic assumptions, values, limitations embedded within it. In no sensible meaning of the word are these "information." Crude as they may often be, they are ideas about the world, and, like all ideas, they must be kept in clear, critical view.

In early 1985, a financial columnist ran an experiment that involved four of the most widely used computer financial planning programs. A hypothetical middle-class family was invented and its financial resources, needs, plans, preferences were run through the programs. The result was four strikingly different sets of recommendations, covering such options as investments, savings, liquidity, insurance, retirement.[7] Why? Because the advice of each plan was programmed with different assumptions, a fact which none of the services mentioned. For the user, it simply seemed to be a matter of entering personal financial information and getting a printout which had every appearance of absolute authority.

This illusion of mathematical certainty becomes especially pronounced in the current obsession with spreadsheets in the business community. Since the first spreadsheet software was published by David Bricklin of the Harvard Business School in the late 1970s, this form of computerized accounting has become what Steven Levy calls a "virtual cult" among the entrepreneurs.[8] A useful way of modeling and projecting financial decisions, the spreadsheet like all programs is built upon an underlying matrix of assumptions. Some of these are ideas about people, their tastes and motivations; some are value judgments that place priorities upon various courses of action. All require some form of numerical weighting and factoring, perhaps of a crude or foolish kind. Then, too, even in the business world there are imponderable matters of good will, morale, satisfaction with one's enterprise, moral conduct; all these demand attention, yet, because they resist quantification, may find no place in the spreadsheet program. The vice of the spreadsheet is that its neat, mathematical facade, its rigorous logic, its profusion of numbers, may blind its user to the unexamined ideas and omissions that govern the calculations. As Levy observes, "Because the spreadsheet looks so authoritative—*and it was done by a computer, wasn't it?*—the hy-

pothetical model gets accepted as gospel." It is, once more, an example of the mathematical mystique obscuring clear, critical evaluation of the underlying program.

We may not care to bear down on the matter, but even in the simplest video games our children play, there can be questionable ideas at work. The games are clearly dominated by ruthless competition and willful destruction. *Winning* is what matters, *killing* is what is valued. Many of the games are profoundly sexist, drawing on stereotypic macho images that appeal to adolescent boys—the main clientele for the video arcades. In contrast, one firm, which has published a series under the title "Computer Games for Girls," has imbued its software with conventional ideas of femininity, such as avoiding bloodshed, cooperating, taking time to clean up and pick flowers. Girls play the game as partners, not competitors; their games involve rather little hand-eye coordination.[9] It is commendable that the firm has tried to include girls in its market, but its games also deal in sexist stereotypes.

In a sensitive critique of video games, Ariel Dorfman concludes that the vast majority of them carry assumptions and goals that contribute to a form of "psychic numbing."

> Those who play videogames and leave their sensitivity and ethics aside when they deal with fictitious extinction on the blithe screen, when they militarize their free time, do so in the same society which contemplates mass murder as deterrence, corpses as statistics, forty million dead as victory, permanent escalation as peace.[10]

Perhaps most child's play throughout history has revolved around violent excitements, especially that of adolescent boys whose conception of manhood is still sadly underdimensioned. But surely the computer, with its hypnotic graphics and lightning fast responses (an enemy world spectacularly destroyed at the flick of a joystick), makes that wretched reflex of the pubescent glands more bedazzling and therefore more seductive.

It is only when we strike a clear distinction between ideas and information that we can recognize that these are radically different levels of discourse requiring different levels of evaluation. In most cases, we may be able to assess the data that flow through the program as either "right" or "wrong," a question of fact that yields to

standard research methods. But the ideas that govern the data are *not* information; nor are they sacrosanct matters of mathematical logic. They are philosophical commitments, the outgrowth of experience, insight, metaphysical conviction, which must be assessed as wise or foolish, childlike or mature, realistic or fantastic, moral or wicked. That critical project spans the full range of computer software, from the video game that places the fanciful annihilation of a galaxy beneath the power of a child's thumb to the computerized war machine that places the real choice of genocide before our presidents and generals. Weighing such matters up in the critical scales requires an education which standard computer literacy will never provide.

Since information technology has been with us, its discriminating users have recognized the principle of GIGO: garbage in—garbage out. The computer can do no better than the quality of the information selected by a human intelligence to be entered into it. But this principle needs to be extended to another level. The mathematical rigor of the computer may mislead some into interpreting GIGO as what Ashley Montague once construed it to mean: garbage in—gospel out. We need another principle that makes us aware of the fallibilities which may be embedded in the programs that lie waiting inside the machine to receive the information. Even when the data are well selected, they may be ambushed by intellectual "garbage" of another order hiding in the depths of the program.

AN ALIEN INTELLIGENCE

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> However much intelligence computers may attain now
> or in the future, theirs must always be an intelligence
> alien to genuine human problems and concerns.
> Joseph Weizenbaum[11]

The genius of computer science lies in its remarkable capacity to elaborate extremely complex programs out of extremely primitive building blocks. Not many computer users may realize that ultimately everything the machine does is derived from the rapid manipulation of a few basic logical relationships, like those expressed in the words *and, or, both, neither, implies.* There is very little any

computer program produces that cannot be traced back to a small collection of simple rules, such as:

This is the same as *that;* put *these* together.

This is not the same as *that;* put *this* someplace else.

If *this* is so, then *that* is so; move right along.

If *this* is so, then *that* is not so; *that* can be eliminated.

Either *this* or *that;* make a choice.

And so on.

These are the kinds of two-choice rules that translate neatly into the zero/one notation of binary numbers and move smoothly through the off/on channels of electrical transistors. Thus, we get a nice three-tiered synergistic sandwich: *effective procedures* (the idea of the program) based upon *binary arithmetic,* based upon the *physical stop-go traffic of electrons* through semiconductors. This is an intriguing interplay that connects humanly useful operations with an invisible substratum of nonhuman physical phenomena. When the programming rules that govern this interplay are densely packed into long sequences and run by at blinding speed, what the computer does no longer looks simple at all. Especially when probabilities, priorities, and weightings have been calculated into the program, it may look something like a cunning little intelligence at work, deliberating, choosing, deciding. Yet, it is an intelligence that its designers know is operating by strict mathematical rules and physical laws. Understandably, then, some computer scientists have wondered how much farther such procedures might be extended into the realm of intellect. How many faculties of the human mind—its intuition, creativity, judgment—might be simulated by running data through the sort of formal processes that characterize mathematical thinking?

The study called artificial intelligence (AI) represents such a quest: to find ways to program as many kinds of thoughts as possible so that a computer can simulate them. It is a challenging pursuit which has produced programs of much greater sophistication than its critics would have predicted ten or twenty years ago, when the field was first making its way into the universities. Among its highly touted achievements are the several "expert systems" that can serve

as valuable aids to physicians, geologists, chemists, and geneticists. Essentially, these systems are programs that represent a composite of how experts in certain fields would work their way through a problem. For example, a physician might enter a collection of symptoms into a computer which will then sort them through and suggest the diagnosis on which several specialists might agree. The logic of the matter is simple: where the specialists have seen *this*, and *this*, and *this* in their patients, they have usually come to the following conclusion. Of course, the specialists may also have picked up a few things intuitively from the patient's general look—slouching posture, glazed eyes, sallow cheeks—that are difficult to include in the program. Or, the specialists being specialists, they may have overlooked something vital outside their field of expertise. It is dubious that even such an ingenious system will ever be able to function except in an advisory capacity to flesh and blood physicians who must ultimately rely upon their own judgment—to the point of bearing the ultimate responsibility in a malpractice suit.

As impressive as such advances are, AI continues to fall short of what its enthusiasts have been promising since the study began in the early 1950s. As we have seen, AI has been peculiarly characterized by extravagant, often propagandistic claims in its own behalf, with the result that authorities in the field have contributed as much to the folklore of computers as the advertisers, promising machines that would translate languages, understand speech, process visual images, make legal, political, and financial decisions, and, in general, outstrip human intelligence in every application. Thus, in 1959, Herbert Simon and Allen Newell were predicting that "in the visible future" their research would produce computers with problem solving powers "coextensive with the range to which the human mind had been applied."[12] Marvin Minsky was prepared to hazard even more ambitious forecasts:

> In from three to eight years, we will have a machine with the general intelligence of an average human being. I mean a machine that will be able to read Shakespeare, grease a car, play office politics, tell a joke, have a fight. At that point, the machine will begin to educate itself with fantastic speed. In a few months, it will be at genius level, and a few months after that, its power will be incalculable.[13]

That prediction was made in 1970. Even Minsky's colleagues at the MIT artificial intelligence laboratory found it extravagant; more judiciously, they predicted such results would take another *fifteen years* at the outside. By then, they thought Minsky was probably right in believing that computers would be in a position to "decide to keep us as pets."

The reason for such conscienceless self-advertisement is not difficult to identify. There is a great deal of money at stake. Along with its more recently born companion discipline cognitive science, AI has been one of the most richly funded fields of academic research over the past two decades. Its public image and its fortunes have fluctuated greatly over that period, depending on the success of its efforts, but currently AI is back in the public eye and placed high on the military-industrial payroll. It has become the great hope of the computer industry as it seeks to produce a new generation of more sophisticated merchandise—the so-called fifth generation. AI is now being looked to for the great breakthroughs that will yield supersmart machines in every walk of life, from talking refrigerators to the automated battlefield. Some observers estimate that by the mid-1990s, AI will be at the center of a market worth $50 billion a year, *if* all the promised inventions materialize. As one commentator has put it (Michael Bywater writing in the London *Observer* in November 1985), "artificial intelligence is a two-word phrase which makes US Department of Defense officials salivate when they hear it."

AI and cognitive science have played along opportunistically with this new wave of speculative investment, associating their professional interests with the sky's-the-limit commercial hype that helps fund its research. Major corporations like IBM, Digital Equipment, and Data General, along with the Pentagon's Defense Applied Research Projects Agency (DARPA), have been making lucrative arrangements with leading universities to stimulate the necessary research. These developments have not gone uncriticized from within the computer science profession. Some worry that military-industrial money on the current scale will vastly distort the priorities of research; others are concerned (rather belatedly) about the ethical implications that arise from the alliance between information technology and the Pentagon. But more basically still, there are those who charge that AI has been oversold to a degree that flirts with outright fraud. The field may be nowhere near capable of producing

what it advertises. This challenge was raised at the 1984 meeting of the Association for Computing Machinery by Lewis M. Branscomb of IBM, who observed, with respect to AI, that "the extravagant statements of the past few years have become a source of concern to many of us who have seen excessive claims by researchers in other fields lead to unreasonable expectations in the public."

The charge was put even more pointedly by Herbert Grosch, formerly of IBM:

> The emperor—whether talking about the fifth generation or AI—is stark naked from the ankles up. From the ankles down, the emperor is wearing a well worn and heavily gilded pair of shoes called expert systems. They are useful, but we've had them for over thirty years. All that the fifth-generation boys have done is relabel them.[14]

The problems that AI has encountered in pursuing its inflated claims are illuminating, if for no other reason than that they reveal the limitations of the mathematical mind when it strays beyond the boundaries of pure reason—or rather seeks to extend those boundaries into the real world.

At the outset—as soon as the first postwar generation of computers began to move in on the universities—the computer scientists were elated by the rapid progress they had made in programming their machines to play games of strategy like tic-tac-toe, checkers, and chess. The strategy for tic-tac-toe was quickly mastered by the computers, as it has been by most ten year olds. The game of checkers also yielded its few secrets rapidly. Since the first chess program was developed in 1957, computerized chess strategies have been worked up to the "high expert" level of play.[15] These successes were highly encouraging. If the machine could do so well at such demanding tasks, then what could it not do?

But as it turns out, AI has run into its toughest problems at another, much humbler level of mental activity. While computers do impressively well with games of strategy, they continue to be stymied in the areas of life where "common sense" and "natural languages" are decisive. For example, suppose the task is to develop a program that will deal with the following pedestrian scenario:

You want to find out what's happening in the world. How can

this be done? Let us say by reading the morning newspaper. Where is the morning paper? Somewhere on the front lawn. Then, obviously, you should go out, pick it up, and bring it in the house. Correct. Unless it is raining. If it is raining, you don't wish to get wet. How can this be avoided? By putting on a raincoat, then going out and picking up the paper.

This is an actual research project that has been funded for study by the Alfred P. Sloan Foundation at the Computer Science Division of the University of California at Berkeley. It has involved developing an effective procedure that deals in some sensible sequence with determining if it is raining, how hard it is raining, putting on a raincoat, going outside, picking up the paper—all of this in a simulated form obviously; the computer does not leave the lab to go scrambling around the campus to find a real newspaper.[16]

Not much of a problem, it would seem. But for the computer, this tiny slice-of-life adventure must be scripted into an enormously long and detailed program, with many a bug and glitch along the way. And if the choice of using an umbrella is worked into the situation, or the need to decide *how* wet one might be willing to get before using either umbrella or raincoat, the program becomes a jungle of conflicting contingencies. Is this how the human mind deals with such a common-sense problem? Certainly not. Yet it is the only way a computer can do it—and not very well at that.

An ironic, but deeply significant truth emerges from research like this. The most valuable thing that AI and cognitive science may be proving is the severe limitation of mathematical logic over a vast range of problems in the real world. We simply do not seem to get through much of our life by way of effective procedures. We may have a computer that can come close to stalemating a grandmaster at chess, but the machine may still not be smart enough to come in out of the rain. This suggests that there is a radical discrepancy between the way a machine simulates thinking and the way people actually think. In fact, that discrepancy could even include those areas, like mathematics and chess, where computers produce their most impressive results. As we suggested in our discussion of Logo in Chapter 4, it may not be the case that people play chess or do mathematics the way machines do. In these activities, too, the human mind may often work in the same quirky, informal, fuzzy way it functions when it decides (without seeming to think about it) that

there is no point in fetching a sopping wet newspaper off the front lawn anyway, and so settles for turning on the radio to catch the news.

The sort of effective procedures that have been developed in mathematics and chess are the best AI has to offer us as an approach to the understanding of human thought. If they are as alien to real thinking as some critics believe, then that is all the more reason to be on one's guard about the way software manipulates data. For the mathematical rigor of the procedure may not even be the result of *real* mathematics, but of a crude mechanical caricature of the mathematical mind at work. In which case, the old mathematical magic which lies at the root of information technology may be misleading to the point of deception. A computer mimics a quality of mind, but inappropriately, claiming an authority it does not deserve.

The vice that always hovers over AI and cognitive science is to insist that what an effective procedure leaves out doesn't really matter or can be fed in later as part of some yet-to-be-developed program. Thus, with respect to computerized tasks that may need a certain emotional flavoring, Marvin Minsky assures us,

> We'll be able to program emotions into a machine once we can do thoughts. We could make something that just flew into a rage right now, but that would be a brainless rage. It wouldn't be very interesting. I'm sure that once we can get a certain amount of thought, and we've decided which emotions we want in a machine, that it won't be hard to do.[17]

Facile remarks like this are based upon the fact that every human activity can be reduced to *some* kind of formal description—if we eliminate all the unprogrammable ambiguities, subtleties, and imponderables. For example, a computer can be programmed with key words that trigger sets of rules that invoke a selection of "frames" representing "romantic love," "familial love," "Platonic love." If the romantic love frame is activated, the machine can print out "I love you," or better still, "I *really* love you," followed by "parenthesis-sigh-parenthesis." It can even be loaded with an anthology of great love poems which it then quotes.

For some AI experts, the brutal simplification involved in such an effective procedure may be seen as a first step in a lengthy search

for something more authentic. The danger is that, at some point, the search becomes frustrating and is given up, but the first step is not repealed. Because the first step is so logically rigorous, it comes to be seen as reliable: a true advance or maybe the goal itself. Which is like accepting a rough caricature as an adequate substitute for a studied protrait—or even for the real person behind the likeness.

THE FLIGHT FROM REALITY

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The examples given here of AI at work in highly contrived laboratory experiments may seem harmlessly academic, even a bit amusing, since the projects under study are so far removed from real life. We might conclude that if everyday common-sense activities cannot be successfully duplicated by AI, then the research will never get beyond the drawing board and may eventually join the ranks of such failed efforts as the search for perpetual motion or the universal solvent.

But that is not quite how the world works when powerful institutions are out to maximize their influence and their profits. AI is now penetrating our economic life in a variety of highly consequential ways as part of the massive economic conversion to high tech. It is common knowledge that a great and increasing amount of shopfloor automation has been introduced into the manufacturing sector with a view to robotizing the assembly lines. This effort to save labor costs by more and more mechanization is being steadily stepped up through the chain of industrial command, through the highly skilled and supervisorial levels. At every stage along the way automative technology is based on the same assumption that guides research in chess playing and common-sense problem solving in the AI laboratories: namely, that effective procedures can be developed for what skilled or semiskilled workers, and perhaps even for what foremen and managers do in the production process. The public at large now readily believes this can be done; after all, we have read glowing reports and seen impressive films of automated factories at work. The propaganda of industry and government keeps telling us it can be done and that the result will be more and cheaper productivity. Thanks to high tech, high-priced human labor will be automated out

of the wage market and American industry will once again become competitive in the world.

But there is at least a small body of dissenting literature on the subject of automation, especially with respect to the effort to replace highly skilled crafts by such major industrial programs as integrated computer assisted manufacturing (ICAM). The doubts all have to do with problems that arise when computer scientists seek to reduce a skilled machinist's work to a formal, numerically controlled process: in other words, to play chess with people's labor. It is being discovered that nothing about such work is as simple as it may seem at first sight from the distant and lofty viewpoint of the computer scientist. Skilled work requires far more adaptability, experienced judgment, intuition than anyone has yet been able to program. The hour-to-hour reality of the shop floor is simply not a chess board.

In a remarkable and detailed study, David Noble has collected an impressive body of evidence—including the nitty-gritty experience of industrial workers themselves—that highlights the many expensive but usually well-disguised failures that continue to plague the drive toward total automaticity.[18] But the effort to create workerless factories continues, with one level of corrective technology being heaped upon another in the search for "adaptive control." The pursuit is well funded by industry and by the military and represents a "sweet problem" for the computer scientists, especially for AI researchers, who remain ever ready to claim the power to do miracles. Noble observes,

Adaptive control is the attempt to make machines fully self-correcting, through the use of sophisticated sensors, delicate feedback mechanisms, and even "artificial intelligence." Such devices, it is hoped, will automatically compensate for all variations and changing conditions, and render machining a totally automatic, self-contained process, one amenable to remote management control.

The result of this costly and determined campaign to build "the factory of the future" is a workerless production process loaded with "sensors, monitors, counters, alarms, self-actuated repair devices" which is more and more prone to breakdown or malfunction. The factories become like those advanced military weapons systems—the

F-16 fighter, the AEGIS cruiser, the Maverick antitank missile—which have reached a level of complexity and delicacy that finally overwhelms the ability of those who must use them.[19] "The greater complexity required to adjust for unreliability," Noble comments, "merely adds to the unreliability." He calls the effort "a flight from reality"—the reality of how the human mind and organism actually work, which is nothing like the data processing model even in the supposedly dull mechanical routine of the production process.

When AI is described as "an alien intelligence" by critics like Joseph Weizenbaum, it may seem that this is a sentimental response to the cold logic of the computer. Certainly many AI defenders have tried to construe the criticism in that way and so to dismiss it as a mere "cry of the heart." But it may also be the case that an alien intelligence is one that simply cannot do most of the jobs it is supposed to do because it is not in touch with the reality we must all live within. So it seeks to create *another* reality, one that can meet the rarefied specifications of pure reason. Which is precisely what Plato did when he established the first academy and retired there to contemplate the design of his ideal republic. He was frank to admit that no society could achieve the geometrical perfection he sought without becoming an autocracy. His philosophical utopia never reached beyond the boundaries of the academy; there was not the wealth or power to build it.

The domineering exponents of pure reason are still with us today in the form of the computer scientists, wielding the age-old mystique of mathematics for all it is worth. And having invented a machine that embodies that mystique, they have found the social forces that have the power to make their utopia a serious political proposition.

THE FIFTH GENERATION . . . AND BEYOND

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Those who toil in the ranks of AI and cognitive science are nothing if not persistent. As often as their promises have fallen flat, they have renewed them with ever more bravado. They are a dogged lot. What Marvin Minsky promised in 1970 to achieve in "three to eight years" ("a machine with the general intelligence of an average human

being" and not long after of "genius level") is still on the AI agenda, now more actively touted than ever because there have been technological breakthroughs and conceptual innovations. Currently, one can find all these breakthroughs and innovations packaged together under the label "the fifth generation," the supersmart computers so long predicted and now—almost—at hand.

In a much publicized survey of these new technological horizons, two prominent computer scientists appear to have arrived at some of the same conclusions I have been presenting in these pages: namely, that computer-processed information and human ideas are "separate entities" that function at significantly different mental levels. But the scientists go on to develop this distinction in a remarkable and revealing way. In their study *The Fifth Generation,* Edward Feigenbaum and Pamela McCorduck agree that the raw information which computers can now process so abundantly may have little value after all; it can even overwhelm us.

So they argue that in order to have "intellectual leverage," information must be "well-engineered." By this they mean, it must be "constantly selected, interpreted, updated, and adapted as circumstances change." Now this is more or less what I have identified as the function of ideas: to winnow the data and organize them. Information that has been "engineered" in this way becomes what Feigenbaum and McCorduck define as "knowledge," and this, they tell us, is what our emerging economy of "knowledge workers" must have.

Within the cult of information, this would seem to be an important concession. It amounts to saying that information processing is not everything. This is rather as if a devout Calvinist (with whose single-minded rigor computer science sometimes shares a curious similarity) were caught flirting with the heresy that faith alone will not bring salvation but must be supplemented by good deeds. Yet—again in the style of Calvinist theologians hastening to preserve the sovereignty of God—Feigenbaum and McCorduck quickly devise a way to rescue the omnipotence of the computer. There lies before us, they announce, a *"new* computer revolution," which will lead us through "the transition from information processing to knowledge processing." That transition will be achieved by the next (the fifth) generation of computers. These remarkable machines will be nothing like the computers we have come to know; they will be KIPs—

knowledge information processors. KIPs will have the power to "subsume the confusion of details, data points, and ever-changing information under orderly, general, and plausible interpretations."

It is difficult to understand what "interpretation" means in this context. Ordinarily, an interpretation is what results when we apply some moral, aesthetic, or ideological judgment—an idea—to an intellectual problem. This is usually what people take issue with in one another's interpretations. For example, we might have a Marxist interpretation of *The Wealth of Nations,* or a Freudian interpretation of Hamlet, or an existentialist interpretation of Marx and Freud. The clash of such ideas among thoughtful people is pretty much what fills and enlivens our cultural life. We compare and contrast our differing views of things, using the ideas that our experience has given us to select, filter, and shape the facts at hand. The result is, at best, fruitful dialogue; at worst, bitter argument, perhaps violence.

What are we to make, then, of the prediction that KIPs will produce "orderly, general, and plausible interpretations" so that "the burden of producing the future knowledge of the world will be transferred from human heads to machine artifacts"?[20] In the fifth generation, may we expect to have Marxist and Freudian and existentialist computers, possibly arguing among themselves? Or will the new computers, lacking the living experience that leads to such commitments in life, work out their own peculiar nonhuman interpretations of things, perhaps based upon various chemical modifications of their silicon?

The prospect of machine interpretation is not only whimsical; it is absurd. Interpretation belongs solely to a living mind in exactly the same way that birth belongs solely to a living body. Disconnected from a mind, "interpretation" becomes what "birth" becomes when it does not refer to a body: a metaphor. But Feigenbaum and McCorduck are not speaking metaphorically. They are speaking literally, and they *think* they are saying something meaningful. If they were, what a nightmare that would be. Bad enough to have computer enthusiasts insisting that the information which gets processed through computers is unassailably correct. Imagine being confronted with machine interpretations that were held to be just as authoritative. We might then find ourselves reading *the* correct "interpretation" of the latest presidential press conference, hot off the

computer. Granted that in one sad respect this might make life easier for troubled minds that can no longer make sense of the world. But for whom besides the defeated and resigned is it a "burden" to produce the knowledge of the world? There are surely more than a few of us left who enjoy thinking.

Feigenbaum and McCorduck recognize—commendably—that the mind needs something more than raw information to think with. But their notion of knowledge is deeply perplexing. While they realize that knowledge has something to do with selecting, judging, interpreting, they fail to grasp the role ideas play in this process, which is no doubt why they believe that a new generation of computers can be transformed into knowledge-producing machines.

An idea (or the information that flows from an idea) becomes knowledge when it gathers to itself a certain broad consensus in the society. Knowledge is a status conferred upon an idea by that consensus. How does this consensus come about? It occurs when a sufficient number of people agree that an idea is true. And how do they arrive at that conclusion? By applying some shared idea about truth to the matter under discussion. For example, in medieval times, there was the widely shared idea that truth could be found at that point where the teaching of scripture, the authority of the Church fathers, and (possibly) the logic of Aristotle harmoniously intersected. Leading minds like the Schoolmen of the period argued various matters along these lines, seeking that intersection. If an idea—such as that of original sin, or the trinitarian nature of God, or the arrangement of the planets in the cosmos—passed through the filter of these authorities, it became "knowledge." Some three centuries later, when direct empirical verification became the prevailing idea of truth, this "knowledge"—once accepted by learned and honest minds—came to be regarded as questionable and at last faded out of the culture.

A society's criterion of truth is among its master ideas. Arguments about the criterion are, therefore, the most interesting and usually the most heated. Every society that is not wholly isolated or moribund is normally filled with many competing ideas about truth, each with its own loyal following. These days, we witness lively, often nasty exchanges between evangelical Christians and their "secular humanist" opponents where issues are hotly in dispute because the criteria of truth are hopelessly at odds between the camps. For the one, the Bible is the supreme, if not the sole measure of truth on

faith, morals, history, geology, biology. For the other, the Bible is simply an old book filled with many defunct ideas. These and other contending ideas of truth jostle and struggle and collide with one another all about us each day; or they mix and mingle and ally. The result is that ever-troubled and turbulent thing we call civilized life, where one person's information is another's nonsense, one person's knowledge is another's superstition. Usually there is a mainstream consensus that the priesthood, or the academies, or some other dominant institution reflects and enforces, and this is generally what gets labeled as "knowledge." But in a lively culture, that consensus is always under pressure and at hazard from dissenting elements.

If the Information Age continues into a fifth (or a tenth) generation to come, when the computers will have become microscopic in size and jammed full with millions of times the data they now hold, there is no chance whatever that we will mechanize the dilemmas of cultural debate and hard personal choice. Ideas produce knowledge, and human minds—quite mysteriously—create ideas. Who would want it any other way?

The fifth generation of AI-enriched computers is now beginning to work its way into practical applications. Rich contracts have gone out from the military and the corporations to tap the latest research. But even before the fruits of these investments have been harvested, there are rumors of a new generation of information technology under study. One might wonder how much further AI and cognitive science can be pushed, since they already promise to surpass the limits of human intelligence itself. Still, the Japanese are reported to be pioneering a more distant, barely imaginable frontier. The Japanese Science and Technology Agency has announced that it has formed a joint project with several Japanese high tech companies to open a "sixth generation" of computerized telecommunications research. Under the direction of Hiroo Yuhara of Uniden Corporation, the project is examining various forms of parapsychological and extrasensory perception to see whether these occult forces of the mind can be harnessed.[21]

Yuhara believes the human body possesses sensors that can act as electrical transmitters. These might be connected to computers by way of a magnetic link. The result would be "the ultimate modem": the extrasensory powers of the human psyche integrated in some ethereal way into the global telecommunications grid. As the Science

and Technology Agency puts it, computer ESP carries industrial research forward into "the study of man's spiritual activities."

Just as the Japanese initiative in fifth generation technology spurred the Americans and Europeans into action, surely this new effort will have the same inspiring result. Perhaps before long we will have a new discipline in the computer laboratories: artificial clairvoyance. And the military, having bought so much of the rest of the Star Wars scenario and wanting "the Force" to be with them, will no doubt rush forward to provide the research funds.

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SEVEN

THE COMPUTER AND THE COUNTERCULTURE

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BIG BLUE AND THE GUERRILLA HACKERS

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Until the mid-1970s, the prevailing public image of information technology was austere and exotic. It focused on a mysterious, highly expensive machinery that belonged in the exclusive care of trained technicians. Its operations had to be discussed in the esoteric language of information theory, with the aid of much mathematics. As an extension of the human mind, the computer was coming to be seen as a necessary adjunct of all advanced scientific thought and high-level decision making, a role that still further distanced it from public access. Its reputation as a rival to human intelligence may have had much to do with science fiction exaggerations (like the rebellious computer HAL in the film 2001), but there was already a lively discussion abroad about the way in which automation would soon revolutionize the assembly line and the white collar workplace by taking over an ever larger range of skilled employment. There was very little the public knew about computers that did not make the machines seem elite and intimidating.[1]

Perhaps most dramatically of all, by way of saturation television coverage, the nation had been many times treated to the sight of the

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Johnson Mission Control Center in Houston, where massed ranks of technicians seated before massed ranks of computers supervised the triumphs of the still glamorous space program. Oddly, the television presentations from the center always featured panoramic vistas of computer screens, as if the machines were the stars of the event. The technicians, turned away and faceless, seemed to be no better than anonymous, almost servile attendants taking their cues from the machines. As a result of this familiar national scene, it was becoming nearly impossible to imagine scientists and engineers out of the company of scintillating video terminals where arcane calculations raced by at a breathtaking pace. The computer, rapidly assimilated to the scientific mystique, was bidding to dominate it.

Quite as intimidating as such media imagery was the social fact that the province of information technology was still under tight corporate control. Indeed, it was dominated by the most elite and private of corporations: IBM, a high tech colossus that stood astride the world, suave, aloof, and imperial. Since the war years, "Big Blue," as IBM was known in the industry, had grown into the quintessential embodiment of the technocratic business style. As close to a world monopoly as any firm had ever come, its control of the industry was assumed to be efficient to the point of infallibility. By the mid-1960s, it owned two-thirds of the information technology business. What it did not own largely survived by its sufferance, salvaging the crumbs that IBM let fall from its plate. So large and domineering was IBM that it was not regarded as anybody's "competition"; rather, it was the "environment" within which everybody else did business. Other companies surrounded IBM like the vassals of the crown; their business was mainly to do what IBM chose not to do or to produce plug-in compatibles for IBM equipment.

True to its lordly stature, IBM had brought the postwar organization man ethos to its perfection. It was run like a taut ship whose disciplined crew was coolly ruthless in the marketplace, fanatically loyal to the firm, machine-tooled to fit the corporate chain of command. But at some point in the 1960s, infallible Big Blue made a miscalculation. The possibility was at hand for making small, low-priced computers. This could be done as simply as by detaching existing terminals from their mainframes and upgrading them into autonomous data processors. Such machines would have minimal memory and could only run reduced programs, but they would be more compact and cheaper than even the minicomputers then being

used in offices and laboratories. In effect, they could be household appliances. IBM nevertheless elected to keep its money and brains concentrated on the development of large-scale computers. This was, of course, where most of its thriving military and civilian market lay: with expensive mainframe machines and their accessories. Perhaps, in part, IBM's decision also sprang from the fact that the company saw the future of information technology in its own corporate image: rigidly hierarchical and centrally controlled. IBM had never conceived of selling computers to the general public. It preferred to sell big, often custom-tailored machines to big customers. Or better still, it would lease its products, keeping them under its own control. IBM's machines went out to the world as locked black boxes; their inner architecture was proprietary, meant to be accessible only to company engineers. Where Big Blue would not lead, other major computer firms were not prepared to tread; its decision to maintain its elitist style thus allowed a chink to open in the walls of the industry's citadel.

The chink was the microcomputer, a highly affordable, table-top machine suitable for home and personal use. IBM and the other major firms were not unaware of the technical feasibility of such a computer. Computers had been getting steadily smaller as they grew more powerful, and all the while becoming progressively cheaper. Engineers at IBM and other companies had hand-tooled in-house prototypes of computers small enough to be carried in a briefcase. But was there a significant market for such a device? Big Blue judged not. Others thought differently.

The most important of these "others" was the growing population of young computer enthusiasts who had been gathering along the fringes of computer research for the better part of a generation. In his study *Hackers: Heroes of the Computer Age,* Steven Levy traces their origins back to the MIT computer laboratory of the late 1950s, where gifted students were often allowed to congregate, sometimes staying on through the night to run the equipment. Most of these early computer addicts were cut from the Tom Swift mold: adolescent mechanical geniuses capable of improvising brilliantly out of scraps and patches for the sheer love of solving sweet problems. Among them were to be found the inventors of the first computer games and toy robots, novelties they did not even trouble to patent. By the late 1960s, some of these youthful talents had found their way into the lower echelons of the computer industry. There, a few

of them were already experimenting with primitive microcomputers, all of which would be shelved by the companies they worked for.

In the folklore of computer history, the early hackers are remembered as a special breed. Reportedly, many of them were socially gauche to the point of being unworldly. They are the archetypal "nerds" of the profession. As a group they possessed even less political consciousness than commercial savvy; they were purely technicians from first to last. But by the end of the 1960s, there was another species of hacker on the horizon, emerging mainly on the West Coast from the ranks of the antiwar movement. These were the radical or guerrilla hackers, who were destined to give the computer a dramatically new image and a political orientation it could never have gained from Big Blue or any of its vassals in the mainstream of the industry. At their hands, information technology would make its closest approach to becoming an instrument of democratic politics.

AN ELECTRONIC POPULISM
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In the spring of 1970, a small group of dropped-out computer scientists who had been involved in the war protest movement at the University of California at Berkeley came together in the midst of the Cambodia crisis to discuss the politics of information. They constituted one of the earliest gatherings of socially concerned hackers. They deplored the fact that the computer was being monopolized for profit and power by the same military-industrial complex that already controlled every other major technology. Yet they were also convinced that their profession held the key to a vital participatory democracy. That key was information. In the words of *People's Computer Company*, a radical hacker newspaper that began publication in late 1972: "Computers are mostly used against people instead of for people, used to control people instead of to *free* them. Time to change all that—we need a . . . people's computer company."[2]

What, then, was to be done? The solution for the Berkeley hackers was Resource One, "a community computer utility" quartered in

an artist's warehouse collective in the industrial sector of San Francisco. Its founders made the following argument:

> Both the quantity and content of available information is set by centralized institutions—the press, TV, radio, news services, think-tanks, government agencies, schools and universities—which are controlled by the same interests which control the rest of the economy. By keeping information flowing from the top down, they keep us isolated from each other. . . . Computer technology has thus far been used . . . mainly by the government and those it represents to store and quickly retrieve vast amounts of information about huge numbers of people. . . . It is this pattern that convinces us that control over the flow of information is so crucial.[3]

Several corporations and foundations contributed small grants to Resource One; most importantly, Transamerica Corporation gave the effort its centerpiece: an IBM XDS-940 time-share computer, an overaged behemoth of a machine that was well on its way toward obsolescence. Resource One refurbished the machine and advertised it as a true public utility, in the hope that political activists would make use of it and the skill of its operators to run voter surveys, collect social statistics, organize mailing lists. An "urban data base" became an early high priority; it would coordinate data from the census, election returns, land use, property valuations. Also on the agenda were a social services referral directory and an accounting service for nonprofit community groups.

Resource One hulked along for a few years sustained mainly by the sweat capital of its organizers, but it never found enough support or use to give it the prominence it sought. The problem, so some frustrated members speculated, was a technical one. The technology was too restricted; it needed to get out into the community, where people could gain hands-on experience with this exotic machine. Accordingly, a new project was spun off: Community Memory, which was envisioned as a network of small computer terminals distributed throughout the Bay Area. The terminals would be available free of charge and linked to the Resource One central data bank and processing unit. Some anticipated a much larger project: a nationwide alternative information system that would use the

AT&T long lines to link together cities and campuses across America. The objective was to create "a direct democracy of information."

Community Memory got its first operational terminal established in August 1973; it was located in a heavily trafficked record store near the University of California campus in Berkeley. The terminal proved popular as an electronic bulletin board; it also carried a lot of hearsay, therapeutic outpouring, gossip, and graffiti. The terminal shifted places a few times; a couple more were added along the way, one at a San Francisco branch library in a working-class community. But when Resource One went broke in 1975, Community Memory soon followed it into bankruptcy, though it was to resurface some ten years later with a network of three terminals, still operating at the bulletin board and graffiti level: amusing, marginally helpful, an improvement over the three-by-five card on a corkboard, but hardly an instrument for significant social change even in as politicized a locale as Berkeley.

As halting as these efforts were, they struck a new populist chord in the public perception of information. They identified the computer as, potentially, a "radical social artifact." In the words of Michael Rossman, one of the project's theoreticians:

> Community Memory . . . is *convivial* and *participatory* . . . A CM system is an actively open ("free") information system, enabling direct communications among its users, with no centralized editing of or control over the information exchanged. . . . Such a system represents a precise antithesis to the dominant uses both of electronic communications media, which broadcast centrally-determined messages to mass passive audiences; and of cybernetic technology, which involves centralized processing of and control over data drawn from or furnished to direct and indirect users. . . . The payoff is efficient, unmediated (or rather self-mediated) interaction, eliminating roles and problems that develop when one party has control over what information passes between two (or many) others. This freedom is complemented by the way the system democratizes information-power, for no group of its users has more access to its main information than the least user has.[4]

From the viewpoint of those who launched Resource One and Community Memory, information was much more than an indus-

trial necessity or a commercial commodity. It was the life's blood of democratic politics, and as such too precious to be conceded to corporate and government control. For political activists who had spent the Vietnam and Watergate years protesting the secrecy, the coverups, the news management of the government, the computer looked like the antidote to technocratic elitism—provided its power could be made universally accessible. But how was this to be done? Resource One had tried to bring the people to the computer—a single, esoteric, mainframe machine; Community Memory had tried to being the computer to the people in the form of smaller, user-friendly terminals. Neither approach had developed much social momentum. But meanwhile, the technology itself was changing in ways that suggested another strategy for the creation of an electronic populism. By the mid-1970s, the microcomputer, which IBM had written off as a poor investment, began to look more and more like an affordable tool that might attract a sizable population of users on the open market. Suppose, then, the technology were to be brought into the homes of America like radios, television sets, stereo record players. Would that not offer the distribution and the access necessary to break the corporate-government monopoly of information processing?

THE HEROIC AGE OF THE MICROCOMPUTER

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From its beginning, the microcomputer was surrounded by an aura of vulgarity and radicalism that contrasted sharply with the mandarin pretensions of the high tech mainstream. This is because so much of the new, smaller-scaled technology was left to be developed outside the corporate citadel by brash, young hackers—especially in California, where the socially divergent types had gathered along that strip of the San Francisco peninsula which was coming to be called Silicon Valley. By the mid-1970s, small groups of these hackers had begun to meet in informal rap sessions where computer lore was freely swapped like gossip over the cracker barrel in a country store. The feel of these meetings was deliberately down-home: a self-

conscious rejection of the stilted corporate style. The names told a good deal about the spirit of the times. One start-up company of the period called itself the Itty-Bitty Machine Company (an alternative IBM); another was Kentucky Fried Computers.

Here was an ambience where scruffy and unshaven types in jeans could freely congregate to discuss the machines they were developing in attics and garages. The Homebrew Computer Club in Menlo Park (near the Stanford University campus and industrial park) was the most colorful and productive of these funky town meetings. It has since taken on legendary proportions in memoirs of the period. It was at Homebrew that Stephen Wozniak unveiled his new micro-computer in 1977. The name he gave it—the Apple—brought a new, organic, slightly rustic quality with it that was meant to soften the hard edge of the technology, to make it plain-folks and friendly. The name also recalled the old Beatles' record company. (Still another anecdote derives the name from the fruitarian diet which Steven Jobs, Wozniak's partner, had brought back from his mystic sojourn in India.)

The breed of hacker that assembled at places like Homebrew had been huddling along the borders of the high tech world for several years. Many of them were university dropouts and veterans of recent countercultural politics in the Bay Area. In the words of one partici-pant-observer, the style "had its genetic coding in the sixties, in anti-establishment, anti-war, pro-freedom, anti-discipline attitudes."[5] The perception of computers and information the guerrilla hackers brought to their work was a weird amalgam of political insurgency, science fiction, do-it-yourself survivalism, and pure fun and games. If they had not actually read the works of E. F. Schumacher, their motto nonetheless might have been "small is beautiful"—if for no other reason than that "small" was all they could afford to build for themselves. Similarly, if they had not studied the theories of Ivan Illich, their search was for an Illich-style "convivial" technology that built a community of interest and need among users. Mixed with these more serious veins of thought, there was more than a touch of whimsey, a taste for childlike fantasy that saw the computer as a sort of magic box that might emerge from a sword and sorcery tale. Thus, the first microcomputer to circulate through the hacker underground —it appeared in 1975 as a mail order kit packaged by a couple of overworked computer freaks in Albuquerque—was named the Al-tair, after an alien planet in the "Star Trek" television series.

As primitive as the Altair kit was, it became what haughty IBM had never imagined that an economy-sized data processor could be: "an absolute, runaway, overnight, insane success."[6] It soon became a featured item in the *Whole Earth Catalog*, a further boost for its sales. The guerrilla hackers were prime examples of the *Catalog's* worldview, an ethic of rugged self-reliance and pioneer adventure. In its initial issue in 1968, the *Catalog* had announced itself to the world as "an outlaw information service," intended for a disaffi-liated readership of freaks and rebels. For the most part, the *Catalog* featured the wares of simple living and rustic ways: woodburning stoves, wigwams, buckskin clothing, techniques of midwifery and backyard horticulture. But from its inception, it had also been fasci-nated with certain forms of high tech: stereo systems, cameras, syn-thesizers, and, as early as its first issue, computers. The *Catalog* was, after all, inspired by the work of Buckminster Fuller, the maverick engineer who had patented the geodesic dome.

The dome might, in fact, be seen as the harbinger of the sort of populist technology that the microcomputer would one day become in the eyes of its inventors. Thanks to Fuller's special gift for gran-diloquent obfuscation, the dome had acquired a metaphysical aura that appealed to countercultural tastes. Not only did Fuller make it seem cheap and easy to build, daring to live in, and culturally diver-gent in style, but he insisted that its basic stuctural unit—the tetra-hedron—somehow resonated with the geometric logic of the cosmos. As a result, in the later 1960s, a cult grew up around the dome; Fuller's disciples, beginning with Stewart Brand, the editor of the *Whole Earth Catalog*, touted this piece of eccentric engineering as uniquely a *people's* technology, the emblem of a cause. Indeed, there were those who predicted that whole communities of domes might soon appear on the outskirts of major cities like barbarian encampments, harbingers of a new culture. Several years further along, the microcomputer, an invention of Fulleresque mavericks toiling away in back porch workshops, came to be seen in the same light—as a technology of liberation.

By a quirky coincidence that might only be imaginable in Cali-fornia, this insurgent vision of information technology was shared, or at least occasionally voiced, by the governor who happened to be in office at the time the talents of the Homebrew Computer Club were beginning to take on major industrial proportions. Jerry Brown was among the first American politicians to pick up on the promise

of high tech. As one might guess, the governor's interest, like that of California governors before and since, was solidly rooted in the sort of big military-industrial contracts that are the staple of the state's economy. But Brown had the knack of being able to associate himself, if only obliquely and ambiguously, with a range of offbeat values and countercultural types. He was an outspoken opponent of nuclear power and a strong environmental champion. He was known to keep company with Zen Buddhists, rock stars, and Schumacher-style economists; early on, he had enlisted Stewart Brand as a confidant and advisor. In Sacramento, he had created a State Office of Appropriate Technology, where ambitious schemes for solar and wind energy, urban homesteads, and organic farming were being brainstormed. And when it came to the computer, he could throw off such remarks as:

More people are spending more of their time on collecting, analyzing, and processing information, and that is an entirely different culture from what we've known. . . .

By pressing a button, you'll get more and more information on the decision-making going on. . . . Information is the equalizer and breaks down the hierarchy.[7]

There was an interval in the early 1980s—it did not last longer than a few intoxicating years—when, in California at least, the guerrilla hackers seemed on the brink of making over the Information Age on their own terms. Emerging from their musty garages and sweeping across the high tech landscape, they had succeeded in throwing the corporate giants of the industry off balance. Their achievement was more than a matter of marketing, though that was a large part of the story. The microcomputer makers had found a buying public the major companies had overlooked. But their profits stood on a base of solid technical innovation. From the first Apple machine onward, the microcomputer hackers had made a virtue of the limited data storage capacity at their disposal by developing an interactive connection between the keyboard and the videoscreen. The user could see at once what was going on in the machine. This enhanced the computer's game-playing ability; but far more importantly, it set up a new, almost conversational relationship between

user and machine in which many began to see inviting educational possibilities. When this capacity for instant interaction was combined with Stephen Wozniak's ingenious disk drive for the Apple II, the world of floppy disk software suddenly blossomed, soon to become an industry in its own right with an outreach far beyond hackers and professionals. Even Big Blue would have to come to terms with a technological breakthrough of this importance; it would have to revise its plans and enter the personal computing competition in earnest. But IBM was well behind in the race, and it lacked the guerrilla hackers' entrepreneurial daring and unbuttoned innovational style. Their invention, the microcomputer, was a runaway sensation that looked as if it might change the American way of life at every level—including the manners and morals of the marketplace.

The hackers even had a friend (of sorts) in the governor's office who could speak for their vision and command a national, mainstream audience. The heady exuberance of the period vibrated through the annual trade fairs of the new industry, starting with the first held in Marin County in 1977, where the astonishing Apple II was first unveiled. These events were becoming latter-day countercultural gatherings in the San Francisco Bay Area. Those who attended still speak of their experience of excited wonder as they walked among the exhibits surveying the technological power that seemed to be before them for the taking. All the while, throughout Silicon Valley, new firms, clever new products, bright new social possibilities were springing up too fast to be counted. And the money was pouring in. Apple Computer astounded its founders by doing $200,000 worth of business in 1976. The next year, it sold $7 million worth of Apples. Five years later, it had come within sight of the billion dollar mark. In the meantime, it had gone public on the stock market, instantaneously transforming its backers into multimillionaires.

At the zenith of his success, Stephen Wozniak, cofounder of Apple and now a countercultural Horatio Alger, decided it was time to put all the money to good use. Dropping out of the company, he decided to revive the flagging spirit of the dissenting 1960s. He set about producing a big outdoor rock festival—bigger than Woodstock and wholly dedicated to the unfolding promise of the Information Age. There were two of these events, one in 1982, the second

in 1983. Together they cost Wozniak $20 million of his own money. From all around the country, the rebels, the dropouts, the surviving hippies, the rock stars came to mingle with the new wealth of Silicon Valley and to create . . . who could say what revolutionary possibilities?

They were called the US Festivals.

REVERSIONARIES AND TECHNOPHILES
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Utopian visions of the future have generally been divided between two philosophical camps. The first—it might be called the *reversionary* scenario—has begun by wishing the industrial world away. The nineteenth century socialist leader and artist William Morris typifies this viewpoint. Anguished by the moral horrors of Victorian factory life and the aesthetic horrors of mass production, Morris (in his *News from Nowhere*) envisaged a postindustrial future that recreated the preindustrial past, a society of villages, family farms, and tribal settlements. His ideal economy was based on the handicrafts; government was an informal communal arrangement among virtuous bucolics.

In contrast, other utopians—the *technophiles*—have enthusiastically embraced the urban-industrial system, hoping to see it mature into a wholly new order of life in which science and technology have permanently mastered the forces of nature and have undertaken to redesign the planet. This is the future predicted by Francis Bacon in his *New Atlantis* and by H. G. Wells in his *Shape of Things To Come*.

The future which the guerrilla hackers envisioned is unique in its determination to synthesize these two seemingly contradictory images. They wanted to have it both ways. Committed by their tastes and talents to the expansion of high tech, they had no hesitation in seeking to play through the full repertory of computer electronics and global telecommunications. But the new technology would be contained within an organic and communitarian political context. Somehow the folksy, funky ways of the Homebrew Computer Club and Community Memory would be preserved. Things would be kept decentralized and humanly scaled; indeed, the computer would

make that very result possible. It would undergird a new Jeffersonian democracy based, not upon the equal distribution of land, but upon equal access to information. The destiny of the microcomputer was to create a global culture of electronic villages cradled in a healthy natural environment—the sort of world one found scattered through the pages of the *Whole Earth Catalog*. In this charming and idealistic scenario, one pictures the computer terminal as a sort of hearth or campfire around which, by way of their modems and satellite transmitters, the clans gather to exchange gossip and graffiti with their counterparts half a world away. So rustic was some of the imagery of this worldview that one might almost believe the computer was a new kind of plow. There was, for example, the poem which Richard Brautigan wrote in the later 1960s. Its title, "All Watched Over by Machines of Loving Grace," was later appropriated by Loving Grace Cybernetics, the company that set up the Berkeley Community Memory experiment in 1973.

I like to think (and
the sooner the better!)
of a cybernetic meadow
where mammals and computers
live together in mutually
programming harmony
like pure water
touching clear sky

I like to think
(right now, please!)
of a cybernetic forest
filled with pines and electronics
where deer stroll peacefully
past computers
as if they were flowers
with spinning blossoms

I like to think
(it has to be!)
of a cybernetic ecology
where we are free of our labors

and joined back to nature,
returned to our mammal
brothers and sisters,
and all watched over
by machines of loving grace[8]

The computer was not the first or the only piece of advanced technology to be assimilated to this hybrid reversionary-technophiliac vision. Earlier on, as we have seen, there was a similar fascination with Buckminster Fuller's geodesic dome, which became for many of those in the counterculture of the 1960s and 1970s a sort of futuristic wigwam. The one major effort of the period at building a village of domes—it was called Drop City, located on the outskirts of Trinidad, Colorado—was described by its founders as a "weed-patch commune." Its domes were assembled out of junked cars from the nearest dump. While it lasted from 1965 to about 1975, Drop City sought to be an easy amalgamation of sophisticated engineering and tribal simplicity.[9] Along these same lines, there was the zany media metaphysics of Marshall McLuhan, who saw television and the computer as the electronic building blocks of a "global village" that would be cozy and participative, yet technologically sophisticated. There was the architect Paolo Soleri, who believed that the solution to the ecological crisis of the times would be found in his megastructural "arcologies"—ant-heap cities in which the urban billions could be neatly compacted. There was Gerard O'Neill, who barnstormed the country whipping up enthusiasm for the wildest scheme of all: the creation of self-contained space colonies, a "high frontier" where the pioneer spirit might be reborn.

At one point or another during the 1960s and 1970s, each of these became countercultural favorites; O'Neill especially became for a few years the pet project of Stewart Brand and the *Co-Evolution Quarterly,* successor to the *Whole Earth Catalog.*[10] Permeating each of these visionary schemes, one sees the same interplay of values and fantasies, the same hope that the technophiliac road forward will lead to a reversionary future. When H. G. Wells envisioned *Things to Come,* he saw a gleamingly sterile urban world run by a benevolent technocratic elite. But for many in the counterculture, the result of high industrial technology would be something like a tribal democracy where the citizenry might still be dressed in buckskin and go berry picking in the woods.

At times, this wished-for synthesis of rustic savvy and advanced technology seemed to stem from nothing more than some very slippery metaphors. Thus, McLuhan's conception of the urbanized mass media, pressed to its extreme, becomes a "village." For O'Neill, the space rocket and satellite, developed on a gargantuan scale, return us to a "frontier," which its enthusiasts seemed to think might be something like the world of the log cabin and wood-burning stove. The fans who organized the L-5 Society to promote O'Neill's ideas liked to imagine vistas of homesteads and organic gardens stretching for miles inside their orbiting steel canisters, plus no end of weightless fun and games skydiving and wind surfing in zero gravity. Even Soleri's high-rise human beehives were seen as a way of preserving the threatened wilderness in its pristine condition—though one can only shudder at the prospect of tens of thousands of his arcological tenants lined up at the elevator shafts, waiting to get to the picnic grounds.

Finally, for the surviving remnants of the counterculture in the late 1970s, it was digital data, even more so than domes, arcologies, and space colonies, that would usher the world into the postindustrial promised land. The personal computer would give the millions access to the data bases of the world, which—so the argument went—was what they most essentially needed in order to become a self-reliant citizenry. Computerized networks and bulletin boards would keep the electronic villages in touch, exchanging the vital data that the power elite was denying them. At the same time, clever hackers would penetrate the classified data banks that guarded corporate secrets and the mysteries of state. Who would have predicted it? By way of IBM's video terminals, AT&T's phone lines, Pentagon space shots, and Westinghouse communications satellites, a worldwide movement of computer-literate rebels would arise to build the organic commonwealth. They might even outlast the total collapse of the high industrial system that had invented their technology. For there was a bleak vision of thermonuclear holocaust deeply mixed into the survivalist instincts of the counterculture. It can be seen in one of the more bizarre expressions of the guerrilla hacker worldview, that of Lee Felsenstein, a founder of the Homebrew Computer Club and Community Memory, later the designer of the Osborne portable computer. Felsenstein's technological style—emphasizing simplicity and resourceful recycling—arose from an apocalyptic view of the industrial future. As he saw it,

The industrial infrastructure might be snatched away at any time, and the people should be able to scrounge parts to keep his machine going in the rubble of the devasted society; ideally, the machine's design would be clear enough to allow users to figure out where to put those parts.

As Felsenstein once said, "I've got to design so you can put it together out of garbage cans."[11]

DOMES, DATA, AND DOPE

It is important to appreciate the political idealism that underlay the hopes of the guerrilla hackers. It is quite as important to recognize that the reversionary-technophiliac synthesis on which those hopes were grounded is as naive as it is idealistic. So much so that one feels the need of probing deeper to discover the secret of its strange persuasiveness for so many bright minds. For how could anyone believe something so unlikely?

If we delve a bit further into the origins of the counterculture—back to the late 1950s and early 1960s—we find what may be the most revealing connection between its reversionary and technophiliac values. In the beginning was the music—always the major carrier of the movement: folk, then rock and roll, then rock in all its permutations. Early on, the music, as it was performed in concert and in the new clubs of the period, took on a special mode of presentation, which has now come to be taken for granted on the popular music scene: it was electronically amplified. Its power was borrowed from the apparatus. The youthful audience that crowded the clubs may have looked grungy in the extreme; it may have come brandishing emblems of disaffiliation from industrial society. But that audience wanted its music explosively amplified and expertly modulated by the best means available; it wanted to feel the beat through its pores. Therefore, the music needed machines. And as time went on over the next decade, the music would need more and more machines as the aesthetic tastes of the period summoned a whole new recording technology into existence that began to replace the performers and their instruments with sound engineering of the most

complex kind, and finally with various kinds of digital enhancement. The style of the performers may at times have sought to be raw, unadorned, "natural." As in the case of Bob Dylan, it may have wanted to come across with an unwashed and uncouth authenticity. But the technicians were steadily taking control of the music. They would make sure it came out sounding *professionally* unwashed, *expertly* uncouth.

Just as a sound experience, with nothing added, rock was supposedly sufficient to produce mind-blowing results. As one rock connoisseur of the period put it,

> By itself, without the aid of strobe lights, day-glo paints, and other subimaginative copouts, [rock] engages the entire sensorium, appealing to the intelligence with no interference from the intellect. . . . Rock is a tribal phenomenon . . . and constitutes what may be called a twentieth century magic.[12]

But soon enough, the audience wanted the strobe lights and the day-glo paints as well: ecstasies for the eye as well as the ear. Hence the light shows that became an adjunct of rock performances everywhere. The shows were more than a visual accompaniment to the music. They were seized upon at once as a way of reproducing and/or occasioning psychedelic experience. They were the visible signature of dope. And from the outset, the premier dope of the era was LSD, which was itself a technology, a laboratory product that emerged from the advanced research of the Swiss pharmaceutical house of Sandoz and Company.

In the early postwar period, LSD and other laboratory hallucinogens belonged to a small, elite public made up primarily of top dollar psychiatrists and their high society clientele. At that time, before LSD had acquired a criminal aura, mainstream publications like *Time* and *Life* were prepared to celebrate its many therepeutic benefits. But by the early 1960s, the hallucinogens had found another, less respectable public; they were being touted among the beat poets and dropped out youth in the streets of Haight-Ashbury and Greenwich Village as the salvation of our troubled culture. Soon Timothy Leary was proselytizing for dope across America; in the San Francisco Bay Area, as of 1966, Ken Kesey and his Merry Pranksters were blithely dosing whole audiences on this mysterious elixir (or

promising to do so) at such public events as the Acid Tests and the Trips Festival.

The assumption underlying these mass distribution efforts was blunt and simple: dope saves your soul. Like the Catholic sacraments, it takes effect *ex opere operato*—by its very ministration. Once this promise crossed wires with the growing interest in oriental mysticism, the psychedelics had been launched as a cultural force. It seemed clear that the research laboratories of Western society—including those of the giant pharmaceutical corporations—had presented the world with a substitute for the age-old spiritual disciplines of the East. Instead of a lifetime of structured contemplation, a few drops of homebrewed acid on a vitamin pill would do the trick. It was the shortcut to enlightenment.

"Better Things for Better Living Through Chemistry" ran the slogan of the Dupont Company. And thousands of youthful acidheads were ready to agree. They had heard the music; they had seen the colored lights; they had sampled the dope. Nothing did more to tilt the counterculture toward a naive technophilia than this seductive trio of delights. If the high tech of the Western world could offer so great a spiritual treasure, then why not more?

Here is the reason why Buckminster Fuller, Marshall McLuhan, and the others struck such a responsive chord among the countercultural young. Acid and rock had prepared an audience for their message, and prepared it in an especially persuasive way that undercut the cerebral levels. For the psychedelics are a powerful, even a shattering experience. Combined with the music and the lights in a total assault upon the senses, they can indeed make anything seem possible. They can induce a sense of grandeur and a euphoria that may make the grimmest political realities seem like paper tigers. At the same time, the experience connects—or so its proselytizers always insisted—with primordial mystical powers of the mind that still flourish, or *might* still flourish, in exotic quarters of the globe, among native practitioners and traditional peoples like Carlos Castaneda's legendary Don Juan. This experience, purchased out of the laboratories of our industrial culture, somehow allied its disciples with the ancient, the primitive, the tribal. Here, then, we find the same surprising blend of the sophisticated-scientific and the natural-communal that Buckminster Fuller claimed for the geometry of the geodesic dome and that the Silicon Valley hackers would eventually claim for the personal computer.

In a 1985 interview, Stewart Brand is quoted as saying, "This generation swallowed computers whole, just like dope." There may be more literal truth to the metaphor than he intended. [13]

DECLINE AND FALL

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The meteoric history of the microcomputer "revolution" might be summarized in two sensational advertising efforts. At the beginning of 1984—and in recognition of the year's Orwellian association—Apple Computer ran a million dollar, one minute television spot commercial during the broadcast of the Superbowl game. The ad was meant to be seen only once, strategically located toward the climax of the fourth quarter—an unprecedented extravagance which, in itself, provoked a great deal of comment in the media. Echoing the theme of the year, the commercial showed the face of Big Brother glowering down from a monumental television screen, haranguing a pathetic mass of uniformed minions. Whatever else the scene signified, it represented the monolithic corporate structure of the computer industry, most obviously the dominance of IBM, by then Apple's foremost competitor, and moving up fast in the home computer market. Suddenly, from the ranks of Big Brother's cowering audience, a rebellious spirit emerges. It is a muscular young woman. She rushes forward and flings a Thor-sized hammer at the screen. It shatters. The enslaved millions are free.

These are powerful images of defiance and liberation. With some allowances for histrionic exaggeration, the commercial catches the spirit of the guerrilla hackers who launched the Apple Company with such high hopes for the electronic populism they might help encourage.

But by the end of 1984, things had significantly changed in the microcomputer industry. Its sales had stalled; its market seemed to be all but saturated. One sees the crisis reflected in Apple's major year-end advertising effort. Again, with much fanfare, the company did something unprecedented in its extravagance. It bought out every inch of advertising space in the November election special issue of *Newsweek* and filled the pages with its own copy. The theme of the issue was boldly announced as being "the principle of democracy as

it applies to technology: one person, one computer"—in this case, Apple's new Macintosh. But what was it Apple now had to say in behalf of the personal computer? Throughout the magazine, it featured the fictitious story of a clever young entrepreneur (a "yuppie," as he is designated), presumably one of IBM's former chattels, now able to exercise the freedom which Apple has won for him. He has a hot idea and wants to go into business. A sharp, well-informed tycoon, he selects Apple computers and software to design his product and keep his accounts. And what is his product? "Splendora Gourmet Baby Food."

Quite a descent from the idealistic attack upon Big Brother that opened the year. But no doubt a more realistic assessment of where the microcomputer market was to be found.

By early 1985, Steven Jobs, then still president of Apple, was prepared to admit what many critics had long suspected: that the market for the home computer had been vastly overestimated. Lacking the specific, well-recognized use that every household appliance must have, it had been turned into a bewilderingly all-purpose machine, many of whose proposed applications (balancing checkbooks, storing recipes, filing addresses) were plain silly. Too many people— and they were perhaps the major part of those who could afford to buy the machine in the first place—had brought their computer home without any idea of how they would put it to use. The instructions that came with the hardware (quaintly called "documentation" —already a sign of technical mystification) were often incomprehensible; too many times, the computer made simple things inanely complex. And then, no matter how carefully users might select their software from the bewildering clutter that fills the stores, within a few months there was always bound to be something newer and better on the market. The cost, with all the accessories and necessary programs included, was never as cheap as advertised. Indeed, the home computer never gets wholly and completely bought; there is always one more thing to add on in order to get the full benefit. At least where the ordinary consumer is concerned, the prolific dynamism of the computer industry—new companies, new products, whole new concepts—was proving to be self-defeating. *Now* seems never the time to buy.

Facing up to the sagging prospects of the home market, Jobs was prepared to believe that the future of the microcomputer lay in the office and the school. If that much is true, it still marks out a prodi-

gious territory for information technology, one that will continue to exert a powerful influence upon our economy, our educational policies, our work life. But this was, nonetheless, a dramatic change of course in the career of the microcomputer. Something important had been lost, possibly the most idealistic vision of information and its social uses to appear since the technology began. In a dizzying ten years between the mid-1970s and mid-1980s, the ideal of an electronic populism based upon the near-universal distribution of personal computers had faded. Apple Computer, the champion of the cause, found its hard-won commercial territory under attack not only by the indomitable IBM (now merged with MCI Telecommunications, ROLM telephone, and the Merrill Lynch MarketNet System) but with a new thrust by the giant AT&T into the home and office computer market. The technology was reverting to its original colossalism. As one computer executive has put it, "There's a real change in the world now that makes it hard for the guy in the garage to become the next Apple." In fact, the renewed dominance of IBM has been seen by some as America's only chance to compete against the Japanese. The company has been portrayed as "a corporate Rambo, a living symbol that the American industrial system still has a little life in it." One almost hears a sigh of relief throughout the business world as the invulnerability of the big corporation proves itself again.[14] Meanwhile, the society of citizen-hackers has gone the way of the dome village, and with it a colorful and challenging chapter in the politics of information has come to an end.

E I G H T

THE POLITICS OF INFORMATION

∎

NOTHING BUT THE FACTS

Facts alone are wanted in life. Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon Facts: nothing else will ever be of any service to them.

Mr. Gradgrind in *Hard Times*
by Charles Dickens

Without the computer, the cult of information would be unthinkable. Yet well before even the most primitive data processing machinery existed, there was one well-organized political movement that precociously recognized the persuasive force of facts and figures in the modern world. These were the English Utilitarians of the early nineteenth century, the true-believing disciples of the eccentric philosopher Jeremy Bentham. Their career as one of the most far-reaching intellectual influences of modern times offers an instructive critical model. All the essential elements of the cult of information are there—the facade of ethical neutrality, the air of scientific rigor, the passion for technocratic control. Only one thing is missing: the computer. The Benthamites lacked a spectacular machinery that could dazzle the public with godlike authority and win its bewildered acquiescence. Ultimately, this absence of an intimidating technology made their ideological bias apparent. They can therefore serve as a case study, reminding us that information is never neutral; it is political through and through.

The Benthamites are one of the first distinctly modern move-

ments in political philosophy; they are inextricably part of an industrial system. The very name they took for themselves—Utilitarianism—reflects the hard-headed practicality, the unsentimental assertion of material values that dominated the new economic order of their day. England was the first society to enter the age of the machine and the factory. It did so gropingly, blindly, by fits and starts. Through the early nineteenth century, industrial towns were springing up like strange, overnight growths on the land, producing convulsive dislocation. The population of the society mushroomed in numbers and began to shift massively across the countryside. Whole new forms of labor, property, marketing, invention rose suddenly into existence, and with them new social values, new political forces. The Utilitarians were among the first to grasp the historical importance of this swift, confusing transformation and to send up a cheer for what many others saw as a social calamity. Also, intuitively, they grasped that in societies as chronically dynamic as England was becoming, the control of facts—or even the *apparent* control of facts—begets power. It creates the impression of competence; it confers the very ability to govern.

In an industrial society, change is the order of the day. But change destroys old certainties; it bewilders and makes anxious. In the midst of the seeming chaos that arrived with the industrial revolution, the Utilitarians boldly seized the philosophical initiative, insisting that change could become progress if it was used as the opportunity for reform. And the secret of reform was the control of facts, lots of facts. In their own time, the Utilitarians were also known as "philosophical radicals" precisely because they were among the strongest champions of reform in all fields—law, economics, education, welfare, prisons, sanitation. In their many campaigns for public improvement, intensive fact-finding was always the first order of business. They were driven by the conviction that the facts, if gathered in sufficient quantity, could be trusted to speak for themselves. Line them up on the page, and they will reveal waste, corruption, inefficiency, wherever it exists.

The historian G. M. Young describes what he calls "the Benthamite formula" as consisting of "inquiry, legislation, execution, inspection, and report."[1] The inquiry, inspection, and report stages of that formula gave rise to the great public investigations of the Victorian period by parliamentary and royal commissions. Today, we take it for granted that governments are in the business of col-

lecting data. But this was a strange new idea in Bentham's time, when no society as yet even troubled to take an accurate census. The Utilitarians changed all that. "In a few years," Young observes, "the public mind had been flooded with facts and figures bearing on every branch of national life . . . No community in history had ever been submitted to so searching an examination." It was not unusual for a single Victorian commission to produce several printed volumes crammed with data and statistics. And if the inquiry resulted in the creation of a new administrative agency, as was usually the case, then the record keeping would snowball, as year by year the government's fact finding continued. Before the century was halfway through, these vast quantities of information were being compiled into the famous Victorian Blue Books, the densest collection of social statistics in human history.

The Blue Books were the source from which Karl Marx would later draw all the damning evidence he needed for his indictment of capitalism. He did not feel he had to budge from his desk at the British Museum in order to do the job. All the data he required were there in black and white before him. By Prime Minister Gladstone's time at the end of the century, thanks to the ingrained Benthamite style, the practice of politics had been dramatically reshaped. "Knowledge of the facts," Young observes, "and an apt handling of figures was . . . the surest proof of capacity" in public life. Gladstone, whose carefully wrought budgets were the new world standard of modern statecraft, was perhaps the first politician to build a career on the magisterial control of social statistics. He would make an admirable showing these days in an American presidential debate, spouting numbers in all directions.

In their fascination for the collection of data, the Utilitarians may be seen as the distant heirs of Francis Bacon. Bacon's interest, of course, was science; Bentham's was legal affairs and economics. But there is a connection between the two. Just as Bacon believed that little bits and pieces of data would conveniently arrange themselves into laws of nature, so the Utilitarians believed that the social facts produced by sound inquiry would instantly prove the failures of existing laws and institutions, and so point directly to the obvious solution. This conviction lent the Utilitarians a certain brash but refreshing air of supreme confidence. They stood ready to investigate everything with a sharp, critical eye, no matter how time-honored and hoary with tradition. They reveled in their intellectual insur-

gency, delighting to show up the folly and confusion of ancient customs, of which there were many still actively alive in English society. They took courage from their peculiar weapon: the fact, the omnipotent fact, against which neither sentiment nor emotional rhetoric could stand.

Yet despite their stance of studied objectivity, the Utilitarians actually worked from a definite political ideology, a not-so-very-hidden agenda of ideas and ideals that served to animate the information they collected. It is important to underscore this aspect of their work because it reveals the inevitable interplay of ideas and information. In the case of Bentham's followers, this can be seen vividly in their most ambitious official fact-finding campaign: the nationwide survey of the British Poor Law in 1833. This was the largest investigative project every undertaken. The inquiry covered the nation, descending to such fine points as weighing out the bread and gruel served in poorhouses across the land.

We now know that the Utilitarians who served on this great inquiry were determined from the outset to scuttle the system. So they assiduously documented the waste, the inconsistency, the ineptitude of the Old Poor Law. That was hardly difficult to do. The Poor Law was, in reality, not a single law but a centuries-old jumble of statutes and regulations for dealing with every form of social dependency: the sick, the aged, the handicapped, the jobless, the orphaned, the insane. Over the generations, this all-purpose program had compounded into an incoherent tangle of contradictions and improvisations. The Utilitarians, documenting the mess, quickly convinced the government that the law should be replaced by a new, uniform, centralized, and far cheaper program of their own design. They won their point. The result was the draconian workhouse system we find depicted in the novels of Charles Dickens. While the Poor Law Commission sought to make its survey look totally neutral—a purely professional inquiry based on principles of sound economy—it was shaped from the beginning by a well-structured social philosophy, based, for example, on the assumption that poverty was a form of criminal parasitism which deserved to be punished and that too generous a system of relief will only corrupt the people's will to work. Lurking behind the investigation was a perfectly dismal vision of human nature and a grim obsession with cash values. The Utilitarians firmly believed that the poor must be whipped to work. This made them the allies of factory owners, who had reduced the condi-

tions of labor to an inhuman level. It would be no exaggeration to say that, with the lash of pure fact in their hands, the Benthamites helped produce the work force of the industrial revolution.

Thus, the Utilitarians, who made so important an early contribution to the cult of information, were as morally and politically motivated as any political pressure group. They might be seen as the forerunners of all the think tanks and policy study centers of our day which continue to fill the political arena with ideologically biased pronouncements decked out to look like purely academic exercises. Indeed, it was because the Utilitarians linked their passion for social research to a coldblooded, unfeeling social philosophy that they succeeded in making their principled concern for the facts obnoxious to a more humane spirit like Dickens. In *Hard Times,* his classic tale of an early industrial town, Dickens takes the Utilitarians severely to task, portraying them as heartless drudges and hypocrites who believe that facts are more real than flesh. Dickens's stereotypic Utilitarian is Mr. Gradgrind the schoolmaster, who believes the essence of education is filling his pupils' minds with as much information as possible. Facts, nothing but facts. It is the school system, as Dickens shrewdly recognized, that forms the mind of the times. And in Mr. Gradgrind's school, there is no room for anything but atomistic data and quantities.

What is a horse? he asks his pupils. The answer gets down to the facts of the matter.

> Quadruped. Graminivorous. Forty teeth, namely twenty-four grinders, four eye-teeth, and twelve incisive. Sheds coat in the Spring; in marshy country, sheds hoofs too. Hoofs hard, but requiring to be shod in iron. Age known by marks in mouth.

If computers had existed in his day, Mr. Gradgrind would have hastened to fill his school with them. They would have delivered all the data he wanted at the stroke of a key, perhaps with animated graphics in a three-dimensional simulation. But his purely statistical quadruped would still have been no living creature.

DATA GLUT

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The new power is not money in the hands of the few, but information in the hands of the many.
John Naisbitt, *Megatrends*

When it comes to data mongering, our politics has become a Utilitarian dream come true. The relentless fact finding that Bentham and his followers recognized as a necessity of life in an urban-industrial society has been permanently installed in an ever-growing contingent of government agencies and bureaus. With the advent of the computer, it has grown into a major service industry of the private sector. Decision makers both private and public now enjoy limitless supplies of information delivered with lightning speed.

We might learn a valuable and seemingly obvious political lesson from the early example of the Utilitarians at work in the arena of public policy. Namely, it is not facts that determine policy, but more often policy that determines the facts—by selection, adjustment, distortion. Nevertheless, it is part of the folklore of the Information Age that the computer, especially in the form of the personal computer, will bring us a democratic renaissance. The machine that makes an abundance of data available to every man and woman in their home is supposedly destined to be a liberating force. The idea traces back to Marshall McLuhan, who predicted in the mid-1960s that the several electrical media would transform the planet into a global village where "instant information creates involvement in depth."

McLuhan primarily had television in mind; he insisted that people sitting passively in front of cathode ray tubes, watching a steady display of images from around the world, were somehow becoming more participative citizens. Computer enthusiasts have expanded the idea to a new use of the video screen: its capacity to function interactively with its viewer, producing an endless supply of material from data bases everywhere in response to the viewer's demand. "The computer will smash the pyramid," John Naisbitt tells us. "We created the hierarchical, pyramidal, managerial system because we needed it to keep track of people and things people did; with the computer to keep track, we can restructure our institutions horizontally."

This prospect is surely based on an odd diagnosis of our social ills. It assumes that the body politic is starving for lack of information and that only the computer can make good that shortage. One must picture the newsstands, the bookstores, the libraries of the nation picked clean by a population that has consumed their precious stores of data and now hungers for more than these sources can provide.

Obviously this is not so. The public has hardly exhausted the information that is now readily available to it. For the price of subscribing to one of the country's better newspapers and a few well-selected magazines, most households could easily and cheaply increase their information supply severalfold. For that matter, a letter to one's representatives in Washington will bring a spate of free government publications filled with information in any field one cares to name: committee hearings, special reports, brochures, booklets. All of this, the reams of research and statistics pumped out by official agencies both state and federal, is available to any interested citizen. Some of what these sources send may be reliable, some of it not. There is no way around the problem of personal evaluation. After all, many of the data base services accessed by computer have been compiled from the same sources. A government report that gets written up in the *New York Times* and is then digested into the NEXIS data base (there available for a $50 monthly fee, plus service charges that may run to $28 an hour) does not automatically gain credibility by being computerized. As for official secrets and classified data, which may often be what citizens most need, these are not apt to be accessible except to clever hackers who can infiltrate well-guarded government files.

One might argue that if the public took advantage of all the information the U.S. Post Office could deliver to its front door from public and private providers, it would soon be awash in data.[2] In some of the world's totalitarian societies, the great political problem may be an official censorship that works to choke off the flow of information. In ours, the problem is just the opposite. If anything, we suffer from a glut of unrefined, undigested information flowing in from every medium around us. Here is a problem the Utilitarians never foresaw: that there can be *too much* information. So much that the forest gets lost among the trees. The result is then a new variety of politics in which governments do not restrict the flow of

information but flood the public with it. One is reminded of Orwell's *1984*, where Big Brother's ubiquitous loud speakers steadily drone on with bewildering statistics of production and consumption. To be sure, in *1984* the information was monolithic; there was no critical competition. But where competing sources do exist, as in our society, the strategy of government is not to censor but to counter fact with fact, number with number, research with research. It even becomes advantageous to have lots of contention about facts and figures, a statistical blizzard that numbs the attention.

In the view of some computer enthusiasts, data glut is no worse than an unfortunate, temporary imbalance in the system. So John Naisbitt tell us, "We have for the first time an economy based on a key resource that is not only renewable but self-generating. Running out of it is not a problem, but drowning in it is. Data is now doubling every twenty months." However, he confidently predicts, the problem will soon be corrected. How? By computers. "Information technology brings order to the chaos of information pollution and therefore gives value to data that would otherwise be useless." More specifically, an "on-line information selection business" is fast appearing; it will serve to filter the glut and organize it to our personal specifications.

What Naisbitt has in mind are various specialized data bases and bibliographic services to which home computer users can subscribe, often at a hefty price. By one count, there were some 2,200 data bases on the market in early 1985.[3] But these services are "selective" only in the sense that they arrange material by subject matter, in the same way that a library card catalog or newspaper index does. Nothing about quality, honesty, or pertinence is implied by the service. Ultimately, data bases, like all reference aids, are the creation of people who have decided what should or should not be entered into the system. Data base compilers are also capable of mistakes due to boredom and burnout. The mysterious, oracular character of the computer—its impersonal, efficient operation—may disguise that fact from many users, but it remains so. The companies that assemble data bases are apt indiscriminately to include anything that offers their service the look of respectable expertise; certainly they will include official sources and statements, congressional hearings, government reports and documents. Suppose, then, one wants to research the debate over the MX missile. A computerized data base

will dutifully deliver everything it holds on the subject, including all the Pentagon materials that have been produced for public consumption. Any more refined "selection"—say, with respect to who's making sense and telling the truth—must inevitably be left up to users. If they are inclined to trust their government in such matters, access to a standard data base like NEXIS or the Bibliographic Reference Service will only strengthen the government's case in their view. If they are prone to be mesmerized by a flashy show of facts by experts in the field, they will still be the victims of data glut. No data base will ever be invented that answers to the command: "Show me everything that is true and relevant."

What computer enthusiasts overlook is the fact that data glut is not some unforeseen, accidental fluctuation of supply, like a bumper crop of wheat. It is a strategy of social control, deliberately and often expertly wielded. It is one of the main ways in which modern governments and interest groups obfuscate issues to their own advantage; they dazzle and distract with more raw data than the citizenry can hope to sort through. Since the Kennedy–Nixon debates of 1960, the prevailing rhetorical style of our political leadership has been to saturate the public attention with information—usually numbers: economic indicators, budgetary projections, social statistics, throw weights, megatonnage, body counts, ratios, percentages, trends. . . . It worked for Kennedy, who seemed to have a computerized brain. In the late 1980s, Ronald Reagan was still at it, reading often senseless or fictitious numbers off his teleprompter at a mile a minute. Politicians to come will continue to do the same for as long as the public stands ready to be impressed or intimidated by a barrage of facts and figures.

The computer did not generate this treacherous style of political discourse. As we have seen, the Utilitarians were masters at it when data processing was no more than a matter of scratching things down with a pen on paper. Behind the style stands the mystique of scientific expertise that lends authority to those who marshal facts in a cool, objective manner. The computer is simply a mechanical embodiment of that mystique; it borrows upon our deference to scientistic jargon and our weakness for machine dependence. But it also allows information to be compiled and manipulated in far more befuddling ways, always with the assumption that whatever comes out of a computer must be reliable.

In the 1980 presidential elections, the American public was con-

fronted by candidate Ronald Reagan with a dire assessment of the national defense. His arguments brimmed with figures. There was supposedly a "window of vulnerability" in our defenses which placed the nation in immediate danger of annihilation. The "window" had been discovered by computer-simulated war games. The Reagan administration used this scenario and the resulting public anxiety to initiate the largest military buildup in history, only later to admit under critical pressure that many of its facts, figures, assumptions, and deductions were erroneous.[4] But by the time the opposition had caught up with the errors and deceptions, the Defense Department had opened a whole new front filled with more studies and scenarios and simulations. It was called the Strategic Defense Initiative: "Star Wars."

It is hardly novel that governments should yield to the temptation of lying or misleading. But to deceive by glutting the public with more expertly engineered information than it can digest is a decidedly new and highly effective twist, one to which the computer makes an indispensable contribution.

ISSUES BEFORE INFORMATION
■

The politics of information makes strange bedfellows. Left, right, and center—by the Sunbelt conservatives, the high tech liberals, the guerrilla hackers—we are assured that information will empower the citizenry and save democracy. But in all cases, we are confronted by sprawling conceptions of information that work from the assumption that thinking is a form of information processing and that, therefore, *more* data will produce *better* understanding. The result is that the computer enthusiasts quickly fall victim to the strategy of data glut and then seek to defend themselves by once again turning to the computer for a solution.

But there is no solution to be found in mechanized methods of organizing the glut. Rather, we must insist upon a new standard of political discourse. In a vital democracy, it is not the quantity but the *quality* of information that matters. What are the criteria of quality? Relevance, coherence, and insight. How do we bring these criteria into play? By shaping information into issues. Issues, in turn,

are well formulated when they help to focus attention, raise questions, facilitate criticism, and finally allow us to make choices with the sense that we have intelligently discriminated among all the available options.

Once again we arrive at the all-important distinction between information and ideas. Information is transformed into a political issue when it is illuminated by an idea—about justice, freedom, equality, security, duty, loyalty, public virtue, the good society. We inherit ideas like these out of our rich tradition of political philosophy: from Plato and Aristotle, Machiavelli and Hobbes, Jefferson and Marx. Very little of what these minds offer is connected with information. If it were, the data would long since have been antiquated; but the ideas live on, a rock-solid ethical substructure on which laws, programs, and policies continue to be based, even by politicians who may never have read these thinkers. In addition to discursive philosophy, mythic themes provide some of the most durable ideas in our political repertory. The legendary image of the Biblical prophet Nathan challenging King David in the name of a higher law, the folk memory of Adam and Eve living in an original anarchic equality, have had more to do with stirring revolutionary energies than any body of sociological research. For that matter, wholly fabulous characters in our popular culture—Horatio Alger's virtuous street urchins or the gunslingers of the Old West—have everything to do with the creation of popular political values. The great utopias of More and Bellamy and the dystopias of Huxley and Orwell similarly have nothing to do with "facts"; but these are the living images of the good (or evil) society which sway people's imaginations. Such ideas live on because they are powerful answers to universal political questions; the depth of experience, the quality of thought, the magnitude of the aspirations that went into those answers infuses them with a special persuasiveness. Facts, if they are to be of any value, need to be used in the service of images and ideas like these. When that happens, one good fact can be worth a thousand irrelevant details.

For a number of years, until it stopped circulating, I subscribed to *I. F. Stone's Weekly,* a landmark of American journalism. To its loyal readership, the *Weekly* was of greater value than a dozen ordinary newspapers; none of us would have traded it for free subscriptions to the major news magazines. Yet it was only four pages long. Obviously, it did not carry much information; but it was the

work of a razor-sharp political intelligence. Behind it, there was a mind that confronted the affairs of the day, knowing what questions to ask and how to tell the relevant from the worthless. One did not have to agree with Stone in order to appreciate his journalism; one profited from his guidance in showing where the contours of public debate lay. Investigative reporting of Stone's caliber reminds us that news, which is the daily pulse of politics, is never simply information; it is not raw factual material that simply drops out of the world into a data base. It is focused inquiry and interpretation based upon a solid set of ideas about the world: what matters, where is the history of our time heading, what's at stake, what are the hidden agendas, what is the big picture? The answers to these questions are the ideas that determine the value of information. Often what a good journalist must do is cast out tons of obfuscating data glut in order to get down to the living truth.

It is the vitality of issues that saves democracy. At most the computer makes a limited and marginal contribution to that goal. Certainly the snippets and summaries its so-called new services offer (such as the Compuserve Information Service and The Source Newswire, edited from the United Press International) are inconsequential for anything that goes beyond weather and stock market reports. As a political nation, we would be better off if the mainstream public were actively in touch with a few good journals of opinion (left, right, and center) than if we had a personal computer in every home.

ON-LINE COMMUNITIES: THE PROMISE OF NETWORKING

■

There is another, more promising use to which computers can be put besides that of struggling to overcome data glut. Indeed, that has always been a strictly secondary item on the agenda of many politically engaged hackers. The information they have wanted most to access has not been data bases but other people's ideas. Their hope has been that the networking capacity of the technology—the ability to tie personal computers together through the phone lines—might be a means of building communities of citizenly concern. The result

would be an expanding forum of opinion and debate. Most notably, Seymour Papert has championed the ideal of "alternative computer cultures," not only among minorities and special interest groups within the advanced industrial societies, but also within and between Third World nations. In large measure, his programming language Logo is meant to help children and meagerly educated adults achieve enough computer literacy so that they can build their own computer culture. His hope is that computer networks might serve to leapfrog the underdeveloped societies into the twentieth century by gaining them access to many kinds of expertise (education, medicine, trade, agriculture) as well as to one another's experience.[5]

Unfortunately, but typically, networking of this kind also gets swept under the sprawling rubric of "information"; yet it is a distinctly different use of the computer, one that offers possibilities well worth exploring. Some of these are already available in a pioneering form. Commercial networks like Compuserve (with some 75,000 subscribers) and The Source (with some 40,000) now make it possible for home computer owners to join together in nationwide teleconferencing on a variety of topics. Compuserve's SIGs (special interest groups) include ongoing discussions of numerous political and social issues. The Source's PARTI conference line has been used by Representative Edward Markey (Democrat-Massachusetts) to solicit views on the nuclear freeze. PARTI has also been called into service by its subscribers following such crises as the Grenada invasion or the Soviet downing of the Korean airliner 007. Teleconferences are similarly available by way of the Electronic Information Exchange System (EIES), run by the New Jersey Institute of Technology, and the University of Michigan's Confer II, both of which can be used either as open discussions among all subscribers or by smaller groups pursuing a specific project.[6]

The cheaper local versions of these national networks are the hundreds of bulletin board systems (BBSs) which can now be found in new, computer-created constituencies that are usually about the size of telephone area codes. For the additional cost of a modem, a terminal program, and possibly a special dedicated phone line, any computer owner can become a "sysop" (systems operator) and run a BBS for any purpose. All one needs to do in order to draw a following is to pass one's phone number around, perhaps by placing it on other, existing bulletin boards in the area. Some of these electronic forums have a political focus; all of them can be used to send

out community alerts, raise local issues, and work up discussions of current affairs.[7] One BBS that has been much praised as a model of computerized democracy is The Chariot, organized in the Colorado Springs area by political activist Dave Hughes. He has used his regional network to campaign successfully on several issues before the state and local legislatures. One of Hughes's objectives is to have every elected representative in the state on line for instant communication night and day—though it is difficult to understand why politicians should be more responsive to electronic mail than to ordinary letters.

While they are similar to citizen band radio and to phone-in radio programs, computer networks are in many ways a unique form of communication. There is no other way in which a great number of people over an area as large as the world's telephone system can exchange ideas in so unstructured a way at all hours of the day and night, and even preserve a transcript in the form of hard copy. The mode of discourse—words typed on to a video screen—may be an awkward substitute for face-to-face conversation, but, strangely enough, there are those who find the anonymity of the medium peculiarly attractive. Supposedly, the impersonality which personal computers make possible to networkers has a liberating and leveling effect; it blanks out race, age, gender, looks, timidity, and handicaps and encourages frankness. No doubt it also encourages a certain amount of role playing; networkers, like CB radio broadcasters, tend to use colorful, made-up "handles" rather than their names. That, in turn, can lead to pranks and irresponsible outbursts. Some BBS printouts I have seen carry a striking amount of rather nasty material: racist and sexist slurs, dirty jokes, profanity. The medium weakens toward becoming electronic graffiti. Cost might also be seen as a liability, though most networkers I have met seem to be quite casual about that. The start-up charge for running a Compuserve SIG can range between $500 and $1,000. The EIES network requires a $75 monthly fee, plus hourly charges; it gets used mainly by corporations and academic institutions. Even a local BBS can easily equal the monthly cost of keeping a second telephone exchange going, if not a great deal more for any extensive use that involves tolls. There is obviously a significant political public for whom the connect-time charges, let alone the price of the basic equipment, would be prohibitive. Networking may for some time to come remain a strictly middle-class medium. Even at that level, not all the uses are encouraging.

While there are racist, white power, and American Nazi networks that fall within the constitutional limits of free speech, a child pornography network came to light in 1985 which was transmitting the names and addresses of children who were available for sexual exploitation.[8] The medium never guarantees anything about the quality of its messages.

Still, even as a relatively costly means of communication, networking can do valuable service and surely deserves to be explored fully for all it is worth. I will offer only two cautionary notes that networkers might bear in mind; both are based on historical experience.

First, it is worth remembering that the original computer network—it dates back to the early 1970s—was the ARPAnet, which began as soon as "packet switching" telecommunications was able to link computer terminals across the country. The ARPAnet was developed to allow military computers to transfer data; but almost at once it was appropriated by people—namely, the military contractors and consultants at major laboratories and universities. This unintended, human ARPAnet sprang up spontaneously to exchange information about weapons and strategies among the experts.[9] This is precisely the sort of computer abuse that guerrilla hackers feared; but it is an application invented and utilized by those social forces that have bankrolled most of what computers can do, including networking. Members of the military-industrial complex continue to innovate applications which ordinary citizens will never be able to afford or exploit; in all its most advanced uses, the computer is *their* machine. Using it for more citizenly purposes has always been a matter of outsmarting or outflanking those who dominate the technology.

Second, the promise that networkers see in the computer is much like that offered by citizen band radio in the 1960s and 1970s. While its range was restricted to the immediate locality, CB radio could have been used to build local communities. In this respect, it offered the benefit of actual speech between people: the human reality of tone, nuance, emphasis—all of which are indispensable to the most effective exchange of ideas. CB radio was also cheaper and freer than computer networking since, unlike computers which are restricted to privately owned phone lines, it made use of an open public utility: the broadcast air.

But CB radio was rarely used for anything more politically sig-

nificant than giving speeding truckers the chance to elude the highway patrol, a sort of minimally anarchist gesture of rebellion. For the most part, it became another consumer novelty. There are many signs that home computers will repeat that pattern, wasting their promise in frivolous, lightweight uses that have no great political relevance. The shelves of the computer retailers are packed with video games, exercise programs, household budgeting, recipes, horoscopes. It is the proliferation of such funware, gameware, and a great deal of junkware that presently passes for the "information revolution." Similarly, those who package and sell networking services are not apt to have much interest in encouraging controversial political uses. Compuserve is owned and operated by H & R Block, the tax consultants; The Source belongs to the *Reader's Digest*. It is no surprise that networks run by such interests are overwhelmingly taken up with shop talk among hobbyists, travel tips, dating and purchasing services, sexual banter, and long-range "interactive telegaming."

At the local level, the major preoccupation of bulletin board subscribers seems to be "user groups." These are networks made up of people who use the same brand of computer and who are in search of advice about the equipment that brought the network into existence in the first place: a strangely incestuous aspect of computing. Beyond this, there are numerous amusements: film and restaurant reviews, jokes, occult lore, soap opera summaries, Dungeons and Dragons. . . . In most of the BBS hard copy I have seen, the gems of thought lie scattered through a dense thicket of trivia, cute limericks, snippets of opinion, off-the-wall outbursts, illegible fragments. I would be inclined to see much of this as simply another source of data glut, requiring more time to sort through and glean than it is worth. Is networking really better than gathering of an evening at a nearby coffeehouse, or pub, or cafe to make conversation?

There is nothing wrong with the sort of diversions that presently fill the networks; but there is nothing magnificent about it either. It leaves one to ponder: what information did the computer enthusiasts think the American public was waiting to receive from this medium before it became an enlightened democracy? And how much of that information really had to be provided by an expensive piece of electrical equipment? Certainly very little of what gets done by way of computer networks *has* to be done that way. For the price of the network subscription fee, the connect time, and the cost of a modem,

one could subscribe to a dozen magazines and newsletters. The computer can perhaps function as a flashy replacement for the printed word. It can keep countless bits and bytes of data sizzling across the global power grid. But what has that got to do with rebuilding democracy?

THE PUBLIC LIBRARY: THE MISSING LINK
OF THE INFORMATION AGE
■

It is a curious fact that the contemporary discussion of information so rarely touches upon the library. Yet America's city, county, and state libraries represent the best-developed reference and reading service available to the general public. A genuinely idealistic institution, the library has been offering intellectual sustenance to our society since the days of Benjamin Franklin; indeed, as a concept, it grows out of that Age of Reason which invented the democratic politics the Age of Information is now supposed to serve.

Perhaps the library has become the missing link between the computer and the public because, in the minds of computer enthusiasts, it is too closely associated with print-on-paper to seem part of the technology that fascinates them. But the library's commitment to books hardly precludes its use of electronic apparatus; a great deal of the material that has gone into the major data bases was formerly embodied in the reference books that have long been the librarian's major tools. Accordingly, libraries have followed where their reference sources have led; they can and do use computers, where they can find the funding to buy into the technology.

There may be other reasons why computer enthusiasts so often ignore the library. The major commercial thrust behind the cult of information is to sell computers. Library sales count for very little compared to the prospect of putting a privately owned microcomputer into every home. Indeed, if computers were readily available free of charge in the library, that might dissuade some potential customers from buying. There is also the matter of marketing imagery. The personal computer has been dressed up as an affluent, middle-class appliance—like the Cuisinart and the stereo set. Its use in the library associates it with ideas of public budgeting and thrifty

purchasing, a sensible investment meant to serve a distinctly lower status populace. In its democratic outreach, the library contacts a clientele that may even include the genuinely poor, whom the data merchants do not regard as any sort of market at all. Significantly, the computer industry has given its product away as free samples in the schools in order to seed its market, but never to the libraries.

There may be one more, rather revealing reason why the library enjoys such low visibility in the Information Age. It is distinctly a female workplace, one of the traditional women's professions. Stereotypically, the library is associated with a certain prim and mannerly feminine subservience that is bound up with the age-old culture of books. In contrast, high tech deals with powerful machines that represent billion dollar investments. High tech is an aggressive masculine operation, a world of high-rolling entrepreneurs, bustling executives, and world-beating decision makers. In the near background, there are the inspired inventors and genius hackers of the technology, more male types. The sexual stereotype overlaps with the class stereotype of the library, lending it an unlikely image for ambitious futuristic brainstorming. The futurologists, for example, who have done so much to popularize the notion of the Information Age, give it no attention whatever.

All this is unfortunate because if computerized information services have any natural place in society, it is in the public library. There, the power and efficiency of the technology can be maximized, along with its democratic access. In preparing this book, I found myself dependent at numerous important points on the reference services of librarians. It is help I have long taken for granted as a teacher and writer, so readily available and convenient to use that one may not even register its value. But this time, because I was involved with a critique of the ethos and economics of information, I found myself giving more attention to the librarians I worked with.* On several occasions, they performed data base searches for

*The services I drew upon and which I am using as models here are SCAN (Southern California Answering Network, which operates out of the Los Angeles Public Library Main Branch) and BARC (Bay Area Reference Center, which operates from the San Francisco Public Library Main Branch). Both these excellent services are federally funded projects which date back to the early 1970s; it is, in fact, almost too good to be true that the government should have put any of our money to use in so enlightened a way. Among the data base vendors to which these two opera-

me that produced a wealth of material I would have been hard-pressed to uncover for myself even on a well-connected personal computer. For one thing, the librarians had access to many more data bases than I could afford to rent. For another, their use of the data bases was far more expert than mine could ever be. They knew the protocols and peculiarities of different data base services; they knew which it paid to try, and they knew the best strategies for tapping them quickly. Some data bases are quite tricky to use; an amateur might wander about in them for many expensive minutes or hours, finding little of value. It takes daily hands-on experience to go hunting for information in just the right way in just the right places. It is a special skill that few home computer users will ever be able to develop to a professional librarian's level of speed and precision.

There was another advantage the librarians enjoyed. By virtue of their training and experience, they knew when *not* to use the computer. As a fully stocked information service, the library includes a multitude of standard reference books which are often the best, quickest, cheapest place to look up a fact. For that matter, librarians know where to look beyond their own resources: special archives, private collections, authorities and experts in the field. Most librarians have built up a file of such less visible sources over the years. One inquiry that was made for me for this book culminated in a phone call to the Office of the Joint Chiefs of Staff in Washington, where the librarian had a contact. I have had searches run which have extended to queries (by letter or phone) to out-of-the-way government agencies, journalists, hobbyists, and enthusiasts. Librarians know what many dedicated hackers overlook: as an information-processing instrument, the computer supplements other sources, it does not replace them.

Here, then, in the libraries of the nation, we have an existing

tions subscribe are NEXIS, Dialog, the Bibliographical Retrieval Service, Orbit, the Magazine Index, Vu-Text, and Hispanex. Vendors of this kind provide access to hundreds of data bases; Dialog alone includes some 300 data bases, Orbit another 200 or so. This range of information as well as the expense is far greater than the ordinary home computer user could handle. If operations like SCAN and BARC existed simply as a showcase to set a high professional standard of democratic reference service in the computer age, they would be well worth the public investment.

network spread across the society, stationed in almost every neighborhood, and in the charge of experienced people who have always honored a strong ethic of public service. If the equipment for computerized reference facilities were concentrated in local libraries or, better still for reasons of economy, if every local library were linked to a generously funded regional reference center, this would be the fastest and cheapest way for the general public to gain open access to whatever benefits the Information Age may have to offer. Private, profit-making, computer-based information services (of which there are a growing number) are not viable substitutes for what the library can provide as a public reference service, if it is given the chance to show what it can do. Such businesses simply take the service out of the public domain. How painful it is, then, to realize that so much of the money that might have gone out in tax dollars to libraries has been diverted into the purchase of home computers, an approach that finishes by buying the public less information for its dollars. Interestingly, this repeats the economic pattern that has worked to degrade Benjamin Franklin's other great contribution to democratizing information: the post office. There, too, the public utility has been left underfunded, its money diverted toward the more expensive telecommunications and overnight delivery systems of the private sector, all of which operate primarily for the benefit of heavy users in the corporate economy. These examples should remind us that making the democratic most of the Information Age is a matter not only of technology but also of the social organization of that technology. If many libraries cannot provide the first class information services they would wish to offer, it is only for lack of the funds to do so. They cannot buy the equipment, rent the services, and hire the personnel.

It should not be thought, incidentally, that the work reference librarians do for the public needs to be limited to academic and intellectual matters. In the course of the last generation, many public libraries have expanded their information services to include referrals, pamphlets, contacts that cover a wide range of community social needs: legal assistance, tenants' rights, unemployment benefits, job training, immigration, health, welfare, and consumers' problems. The object is to put members of the public in touch with groups and agencies that can help with daily matters of livelihood and survival. This is not the kind of information one finds in most commercial

data bases; and while the service may overlap the function of some electronic bulletin boards, the library can make it available to those who cannot afford to own a computer.

One more point. The library is not only there as a socially owned and governed institution, a true people's information service; it is staffed by men and women who maintain a high respect for intellectual values. Because they are also the traditional keepers of the books, the librarians have a healthy sense of the hierarchical relationship between data and ideas, facts and knowledge. They know what one goes to a data base to find and what one goes to a book to find. In their case, the computers might not only generate more information for the public, but information itself is more likely to stay in its properly subordinate place in the culture. [10]

IN THE WRONG HANDS

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I have seriously considered the possibility of giving up my scientific productive effort because I know of no way to publish without letting my inventions go to the wrong hands.

Norbert Wiener, October 1945 [1]

THE FOUNDATIONS OF INFORMATION TECHNOLOGY

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For the foreseeable future, the democratic uses of the home computer are apt to remain at a rudimentary and struggling stage, burdened by the cost of the equipment and the commercial trivia that surround the technology in the marketplace. No doubt principled hackers, who are still with us, will continue to find valuable political applications for computers; their efforts deserve to be supported. But meanwhile, outside the small, still underdeveloped world of politically relevant networks and bulletin boards, the information economy does not stand still. Larger forces that have little interest in the citizenly uses of computers are at work molding the technology to suit their purposes. The progress they are making in that direction is by no means an unfortunate accident, something that need not have happened. On the contrary, the "wrong hands" which Norbert Wiener feared might capture his brainchild are precisely the hands that brought cybernetics and information theory into existence in the first place. For this reason, Wiener's qualms, while morally admirable, were wholly unrealistic.

Wiener had two potential abuses of information technology in

view: its military exploitation as a means of making war, and its industrial exploitation as a means of deskilling and disemploying workers. Wiener, the conscience of his much-compromised profession, did what he could to resist these evils; it was surely as much as any single person might be expected to do. With respect to the first, he resolutely refused to accept any research support that came from military sources and agitated among his colleagues to do the same, though with no success. With respect to the second, he made his services available as a consultant to the labor movement as early as 1950. In that year, he wrote to Walter Reuther, head of the United Auto Workers Union, warning him of "the very pressing menace of the large-scale replacement of labor by machines" to which automation would surely contribute. Cybernetics in the workplace, he observed, will "lead to the factory without employees" and the corresponding reduction of union power. "I do not want to contribute in any way to selling labor down the river, and I am quite aware that any labor which is in competition with slave labor, whether the slaves are human or mechanical, must accept the conditions of work of slave labor." In this prospect, Wiener saw the lineaments of nothing less than "fascism."[2]

As it turned out, these evils—the military and industrial applications of cybernation—were not two separate abuses needing to be fought on separate fronts. They have been intimately related all along. David Noble makes the case in his study, *Forces of Production,* that the government's continued heavy military investment in computers, electronics, and information theory following World War II was fully intended to alter the American industrial system radically. It was meant to advance automation as a way of offsetting the labor unrest and the assertiveness of labor unions that emerged from the war years. Automation would "rationalize" the economy by strengthening the control of management, especially the management of big firms. Techniques developed during the war, primarily in the defense industries to compensate for the wartime lack of skilled labor, would be extended to create the "factory of the future," where less and less labor would be needed. Industry could thus replace manpower with machine power and so discipline an increasingly obstreperous work force. As Charles Wilson of General Motors, vice chairman of the War Production Board and later secretary of defense, put it in 1949, America had two major problems: "Russia abroad, labor at home."[3]

This alliance of the military and the industrial for the purpose of advancing information technology continues in the era of high tech. The Defense Department remains a major source of research and development funding not only for specific weapons systems but for furthering the general use of automative methods. The program called ICAM (integrated computer assisted manufacturing) begun in 1979 by the Air Force is among the most ambitious efforts to bring capital-intensive, labor-saving high tech, including robotics, into the production process. It is the backbone of all CAD/CAM (computer assisted design and manufacturing) efforts in American industry. Other modernization programs (Techmod and Mantech) are similarly dependent on Pentagon money. As Noble observes regarding the thrust toward high tech automation, "the role of the military, with its emphasis upon performance and command rather than cost, remains primary."

> Grounded still upon an impoverished view of human beings and a systematic denial of their potential, the search for total control consists in an ever more elaborate and costly effort to construct a profitable, militarily effective, and technically elegant apparatus that is not dependent upon the cooperation and resources of the mass of the population.[4]

The ongoing military-industrial drive toward rationalizing, disciplining, and ultimately dehumanizing the workplace is among the foundation stones of information technology. This is the shop floor, board room, and marketplace reality that is so treacherously clouded over by the futurologists with their frivolous chatter about an "information economy" filled with push-button consumer gadgets and gimmicks, where, seemingly, the physical conditions of life and work will be etherealized into an electronic Shangri-La. Their superficial celebration of this great transition, like that of high tech conservatives and liberals alike who draw so freely upon them for buzz words and catch phrases, leaves out the true forces and motives behind the economic process.

If information technology is to be rescued for its most humane uses, one must at some point face the hard, unpleasant fact that the computer lends itself all too conveniently to the subversion of democratic values. This threatening liability arises precisely from what has always been advertised as the technology's greatest power: the

ability to concentrate and control information. This is where the efficiency and all the promised benefits of computerized systems lie. It is what we endorse whenever we praise the computer for the speed and thoroughness of its services. That endorsement is deepened when we agree that, in providing those services, the computer is proving itself to be a "thinking machine," indeed one that thinks better than a human brain.

As we have stressed throughout this study, the cult of information that has formed around the computer is based upon a powerfully rationalized philosophical assumption that has gained a great deal of public acceptance and is gaining more as it penetrates our schools and universities: namely, that the human mind in all its aspects can be fully and accurately described by the information processing model. Historically, the first important applications of that model came during and just following World War II in the areas of warfare and war-related assembly line production. Since then, such applications have steadily expanded, primarily under military auspices, into more areas of production and higher levels of skill so that more and more labor has been eliminated from the manufacturing economy, or—quite as important—credibly threatened with such elimination. The thinking that was earliest and most significantly processed into machine-readable and reproducible information was the skill of workers, the talent of their hands, the acuity of their perception, the judgment of their minds. Wherever this has happened and as often as it has happened, the result has been the transfer of power to the technicians, managers, and owners.

Once information technology had demonstrated its ability to achieve that transfer, it had found a rock-solid foundation in our economy and was in the position to attract all the prestige and money it needed. If computer science had not promised a handsome payoff to the military and corporate buyers who could afford its costly research and development, there would have been no chess-playing programs, no Pac-Man games, no NEXIS data base, no Turtle Graphics. Nor would there have been the several professions and fields of study—artificial intelligence, cognitive science, information theory—that have grown up around the technology and have become some of the most influential disciplines represented in the universities. So there have been more and more applications of the technology. A few of these, like the networking capacity and educational possibilities of the microcomputer, have been seized upon by

hopeful democratic spirits like the guerrilla hackers; but such minimal and marginal uses of the computer are simply dwarfed into insignificance by its predominant applications, many of which seriously endanger our freedom and survival.

What follows is a brief checklist of those dangers.

THE SURVEILLANCE MACHINE
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The invasion of privacy has been the single most widely publicized and discussed social issue surrounding computers. In Europe and America, there is a good-sized body of research on the subject, some of it stemming from concerned legislators and official sources and intended as the basis for law. Despite this awareness, it is all too obvious that none of these legal safeguards has any reliable force. Most of them are broad spectrum legislation filled with exceptions and loopholes and lacking any effective means of enforcement. It is very nearly a principle of nature that where law seeks to keep pace with technology, technology wins. It is like a race between an ox cart and a supersonic jet.[5]

We can see this discrepancy nowhere more dramatically than in the area of computers and telecommunications. In little more than a generation, information transfer technology has simply become too big and too dynamic to be tightly regulated. This has not happened simply because the technicians move so fast in so many unpredictable directions. That would be enough of a problem in itself. There is also the paramount fact that their efforts are fueled by the profit and power-seeking motives of those who command their skills and wares. In this area as in so many other sectors of our industrial economy, the uses of technology are shaped by the values of those who salary the technicians and own their products.

We may not be living in anything that can sensibly be called an information economy, a term that has always had more journalistic glitter than social substance; but it is the case that, within our economy, an information industry of sizable proportions has grown up over the past twenty years. It is made up not only of the computer and electronics firms who manufacture the machinery, but of ambitious new service companies—credit bureaus, data managers, direct

mailers, marketing and public opinion experts. These enterprises, in turn, have helped to create a thrusting new profession of computer systems specialists whose assignment is to brainstorm more and more applications for information technology and to sell those applications to every business on the scene. The cult of information is nowhere more deeply entrenched than on this bustling, highly competitive, entrepreneurial frontier, where many of the brightest young minds of the time are hard at work merchandising the promise of the computer, cleverly maneuvering its services into every slightest need that an eager, often gullible business community might present.

Much of this was inevitable; many businesses—banking, insurance, brokerage, public administration—are inherently data intensive. But why should the phone company keep track of every number a subscriber calls? Only because it got sold a piece of equipment that can do the job; so it records the numbers, which gives it more records to keep. These days, every corner drugstore and dry cleaner confronts its customers with an electronic marvel of a machine that is a combination cash register, inventory control, credit card verification, mailing list, banking and accounting apparatus. It beeps and blinks and finally prints out a sales receipt that looks like a statistical abstract. And every inscrutable little cipher on it represents a record that is being filed somewhere.

By far the richest and most welcoming customer for the information industry is the government, still the greatest data minder of all. Among them, five major federal agencies (Health, Education and Welfare, Commerce, which handles the census, Defense, Internal Revenue, and Social Security) now hold somewhere between 2 billion and 4 billion overlapping files on the American public.[6] Keeping files is nothing new for governments in the modern world; but the scale on which the state now documents the lives of its citizens is unprecedented. More importantly, the files these agencies hold are no longer separate, single purpose records sealed off from one another. They are becoming interconnected by way of the more than 300 computer networks through which the government now shuttles data as part of its routine business. This integration of data makes a difference; it increases the utility of information exponentially. In the context of the networks, every scrap of data has the possibility of multiple connections and so acquires an expanding, unpredictable number of applications. For example, the networks permit, even encourage the use of "matching programs" that can relate, let us say,

tax information with unpaid student loans or welfare disbursements: a promising means of clamping down on cheats and delinquents. Moreover, with minimal and feeble restrictions, all the information in the federal government's 20,000-plus computers is routinely available to federal security agencies and local law enforcement, which can then make multiple matches with data in their own files. Thus, a driver pulled over for a faulty brake light may soon have his whole life run through a battery of integrated data banks that will contain anything anybody ever cared to put on file: alimony and child support, delinquent loans, welfare violations, etc.

Beyond this, more and more official information is being coordinated with privately owned information services. The Commerce Department routinely sells census data to marketing and public relations companies. Under the Reagan administration, the Internal Revenue Service began to use private data bases, such as banking records, to catch tax evaders. Similarly, starting in 1982, the General Services Administration began to negotiate contracts to exchange records with private credit bureaus in order to identify those who default on federal loans. There are some 100 federal agencies that now freely share data with the seven major credit-reporting companies, covering such matters as liens, bank loans, divorce records, and credit cards.[7] Ironically, the justification for this integration of data resources by the Reagan administration was that, by tightening up on government programs, the president was achieving one of his prime ideological goals: getting the government off the people's back. At first sight, this may seem inconsistent. But not so. Robert Bedell, a deputy head of the Office of Management and Budget, is quoted as saying that the government would like nothing better than to protect the citizen's right to privacy. The administration's suggested way of doing this is to avoid recording information about individuals in the first place by reducing the size of government programs. "There isn't a better protection against government invading privacy than not to have the information to begin with."[8]

These are ominous words. They imply that the only way to steer clear of the sort of surveillance and intrusions which the government's matching programs produce is to stay off federal records entirely. In other words, don't apply for government assistance at all. The implicit threat can be a highly effective way of clearing the welfare rolls.

As one might expect, it is the security and law enforcement arm

of government that has the largest appetite for information. At the federal level, the National Security Agency, whose budget exceeds that of the CIA, not only operates one of the government's largest computer networks, but serves as a prime funding source for some of the most advanced research in electronics and telecommunications. For example, it is the NSA which is financing pioneering work in computer voice recognition; it purportedly has devices that can pick up key words like "bomb" and "assassination" while routinely monitoring phone calls, a principal activity of the agency. Similarly, NSA's duties in the field of cryptography have led it to invest heavily in the superfast Josephson-junction switchers that may one day replace the semiconductor. NSA cooperated in setting up the FBI SEARCH program: the System for Electronic Analysis and Retrieval of Criminal History, the nation's largest data-gathering network dealing with criminal activities. SEARCH, in turn, has filtered data into the Interstate Organized Crime Index, a burgeoning data bank that, despite its title, includes political dissidents. IOCI is prominently used by police intelligence officers and has been implicated in some cases of extralegal harassment.[9]

In the private sector, the credit bureaus, with which the government now cooperates in several ways, have become major data-collecting operations in their own right. There are nearly 2,000 of these. The 5 largest (they include companies like TransUnion of Chicago and TRW of California) hold some 450 million files. It is estimated that 80 percent of Americans over the age of eighteen are in their computers somewhere. Some of these files include entries under the heading "life style"—personal habits that have to do with drinking, marriage and divorce, trouble with the police, complaints by neighbors about noise or unusual activities, anything that may satisfy the curiosity of prospective employers, financial institutions, landlords. Landlords specifically have developed "illegal detainer" data banks which keep track of court records naming anyone who ever had legal problems as a tenant. These files, too, deal in life style data. Such information is especially valuable for "block modeling," another practice made possible by the integration of data bases. Like computer matching, block models bring together scraps of information from many sources that could not have been tapped and coordinated before electronic networks existed. But block modeling adds a new twist. It runs the information through programs (they take the

form of cheap, commercially available software) that compare it with generalized personality profiles. These programs are now used by employers or landlords who are on the lookout for deviant types. Block modeling allows its users to "X-ray" tenants and employees so that troublemakers and bad risks may be eliminated.

There is no limit to how much data such matching and modeling systems can absorb. Conceivably, no pool of information is too small to be sponged up by the technology. In the summer of 1984, the Selective Service dispatched a curt letter to an eighteen-year-old boy in California who was several months delinquent in registering for the draft. As it turned out, there was no boy by that name at the address used. The name was fictitious. It had been invented by two teenagers who had, some seven years before, filled out a card at a local ice cream store which was offering free birthday treats to its young customers. The name went into the store's computerized mailing list. The company which owned the store then sold its list (a common practice) to one of the country's many direct mailing businesses, which, in turn, made it available to Selective Service. Selective Service makes a practice of routinely collating such lists precisely to pin down names, addresses, and birthdays. When the fictitious boy's eighteenth birthday came round, it promptly got on his case. Or rather, the computer did, generating the warning letter it had been programmed to send.[10]

As the number of computers and computer networks used by the government mounts, some officials have expressed fears for the security of their data banks, anticipating their penetration by unauthorized parties. This is more a law enforcement officer's worry than a matter of citizenly concern. Thus, as one might guess, the government's solution to the problem is hardly encouraging. Under the terms of a 1985 National Security Directive (No. 145) which was adopted by the Reagan administration with no congressional consultation, the National Security Agency has been made solely responsible for the control and use of all federal computers and data banks. The powers contained in the directive permit the NSA to have access to all government computerized files with no provision made for the protection of privacy. The directive also implies that the NSA has the right to pursue its mandate into all private data banks linked to government operations. In late 1985, this led the NSA's National Computer Security Center into a broad investigation of the vote-

counting program used in electronic polling machines in several states, an unprecedented departure for a military security service.[11]

Alvin Toffler has celebrated the computer's omnivorous appetite for data as the creation of an electronic "social memory" that will one day give us "a civilization with total recall." "An information bomb is exploding in our midst," he tells us. It is producing an "infosphere" which will provide our society with "more information and more finely organized information about itself than could have been imagined even a quarter-century ago."[12]

No doubt he is right. But I am at a loss to understand his enthusiasm for this prospect. Most of what will fill that social memory will be the dross of daily life: every phone call, every check passed, every credit card purchase, every traffic citation, every airline ticket. Of what use is this to a healthy culture and a vital political life? Obviously none. But there are those to whom just this sort of trash data is supremely valuable: the professional eavesdroppers whose infatuation with "total recall" stems from an obsessive need to keep track of everybody's least significant movement.

A survey like this of computerized surveillance by private and public sources inevitably reads like a blur of agencies, laws, programs, decked out with statistics about files and records. But one should not let the central meaning of these developments be lost among the details. Something very big, new, and threatening is permeating our political life. It makes use of the computer as its vehicle, but more important than the means is the mentality that uses the machine. However ambitiously "information" may be defined by its enthusiasts and specialists, all that the data banks and their attendants are after is data at the most primitive level: simple, atomized facts. For the snoops, the sneaks, the meddlers, data glut is a feast. It gives them exactly what their services require. They exist to reduce people to statistical skeletons for rapid assessment: name, social security number, bank balance, debts, credit rating, salary, welfare payments, taxes, number of arrests, outstanding warrants. No ambiguities, no subtleties, no complexities. The information that data banks hold is life stripped down to the bare necessities required for a quick commercial or legal decision. *Do or don't give the loan. Do or don't rent the property. Do or don't hire. Do or don't arrest.* This is human existence neatly adapted to the level of binary numbers: off/on, yes/no. What we confront in the burgeoning surveillance machinery of our society is not a value-neutral technological process; it

is, rather, the social vision of the Utilitarian philosophers at last fully realized in the computer. It yields a world without shadows, secrets, or mysteries, where everything has become a naked quantity.

THE POLLING MACHINE
■

In the 1980 presidential elections, candidate Ronald Reagan took a hard line on defense. In stern and urgent tones, he lashed out at the Soviet menace, calling for a vastly expanded military buildup. His opponent sought to use this stance to characterize Reagan as a warmonger, even a mad bomber. It was one of the weak spots in Reagan's public image.

At a certain point in the campaign, Reagan's handling of foreign and defense policy shifted noticeably. His tone became more reasoned and calm; the word *peace* began to appear more prominently in his speeches; references to "war" and the "arms race" faded. A new phrase emerged to cover his position on armaments, something bland and noncommittal, but seemingly prudent: "a margin of safety."

What caused this change of tone and rhetoric? It was done in response to a key campaign advisor, Richard Wirthlin. The advice might have been based, as such advice usually has been, on pure political instinct, which may or may not have been persuasive with the candidate and his many other counselors. Politicians always work at the center of rumors, guesswork, hunches, tested savvy, gut feelings. But in this case, Wirthlin's advice was based on something else: numbers, lots of numbers. It arose from a barrage of public opinion polling all across the nation. Wirthlin commanded statistics. That gave his advice the appearance of something more than guesswork. It looked like science.[13]

In the late 1960s, Wirthlin, a former economist at Brigham Young University in Utah, opened a market research firm in southern California called Decision Making Information. Like many such firms which measure consumer tastes, DMI easily moved into political polling, where Wirthlin was first hired on by Ronald Reagan to guide his gubernatorial campaign in California in 1970. DMI provided the usual services: voter surveys, sampling, simulations. The

value of this statistical juggling is supposedly to discover where candidates are weakest or strongest—in which regions, among which ethnic, age, income groups—and then to target their campaigning accordingly. Polling can also identify which issues matter most to voters, what their likes and dislikes are, which candidates and policies have fared best or worst with them in the past.

John Kennedy was the first national candidate to make important use of polling. That was in 1960; his hired pollster was Louis Harris, who then became an independent expert. By the late 1970s, every serious candidate for office in the United States who could afford the price was following Kennedy's lead; expensive polling along with lots of media exposure had become the prevailing campaign style. But by then, the top dollar figures in the business, like Wirthlin, had gone on to new heights of push-button statistical precision. DMI had developed important connections. Its clients included government agencies like Health and Human Services, the Department of Labor, the Office of Education. In turn, the firm was tapped into nearly forty federal data banks that make their information publicly available. Wirthlin, with the aid of a large staff—as many as 300—was able to mobilize this wealth of data through an intricate computer method called PINS, Political Information Service. He had put together the most ambitious electronic sampling and simulating service ever developed, a new standard for the profession. His telephone surveys—which included automated, tape-recorded polls—were larger, more intense, and constant. He developed "tracking" techniques that involved nightly phone interviews with between 500 and 1,000 randomly selected voters toward the end of the campaign. There were even devices which allowed the phone interviewer to enter answers directly into computers, assuring results within milliseconds. Wirthlin's carefully prepared interviews and computer programs, which divided the U.S. population into 108 demographic categories, could neatly single out any item of the candidate's platform or personal image—"the nice guy factor," "the meanness factor," "the dangerous and uncaring factor"—and rapidly assess its "trend line" fluctuations in specific voter groups, providing overnight reactions to a speech, a debate, a press conference, even an offhand remark. The same refined and prompt polling could be done to assess the progress of the opposition, and the campaign could be adjusted as the numbers dictated: more of this, less of that, push

harder here, lay off there, smile more, keep your left side to the camera.[14]

With each election, the influence and the visibility of the pollsters grows. Some, like Wirthlin and Patrick Caddell, have assumed a good deal of personal prominence in the public eye as the new generation of political strategist. Having honed the business of polling and simulation to a fine methodological edge in the marketplace, they can employ the same skills to sell candidates as they do to sell commodities. The secret of their success is the mystique of computerized information, their ability to generate and confabulate with prodigious quantities of data, and so to come up with "hard numbers" on any issue, any policy, any incident, gesture, turn of phrase. Wirthlin, for example, was able to present his presidential client with a dizzying array of computerized quantities. By the time the election took place in 1980, his PINS program had run 400 simulations based on every conceivable combination of assumptions about what candidate Reagan should and should not do. Nor need the pollster's services end with the election. Wirthlin remained on the Reagan administration payroll after the candidate's victory, continuing to provide public opinion research and advice at a cost of up to $1 million a year.

The pollsters are available to anyone who can afford them; they have been used by groups of every political persuasion. But they obviously bias elections in favor of those who can spend the most for the best services. Congressional incumbents, who have access to government-financed computers and free mailing privileges, also have an edge. Their franking privilege can be nicely combined with the services of another booming new information business: the direct mailers. These are the people who stand behind the rising tide of junk mail that now arrives in American mailboxes at the current rate of some 10 million pieces a day. The direct mailers deal in lists. They accumulate computerized lists of names and addresses from hundreds of sources, then analyze and refine them so that they will target specific populations for advertising, fund raising, political campaigns. The largest of these firms (Metromail of Lincoln, Nebraska, R. L. Polk Company of Detroit, the Donnelley Marketing Service of Stamford, Connecticut) routinely enter whole city directories, phone books, county records, motor vehicle data into their computers, integrating the information with census and zip code

data. This has resulted in some 70 million of the country's 85 million households being on file to be arranged in custom-tailored mailing lists.

Do the pollsters make that much difference for the candidates? They are, of course, quite expert at selling their own services and so, as one might imagine, ready to insist that no candidate can do without them—even though (obviously) at least half the candidates who run for office, even with their aid, will always lose. But the question is largely beside the point. What matters is that the candidates *think* the pollsters make a difference and now plan their campaigns in response to computerized information. The result is a dismal style of politics that grows more and more obsessively focused on imagery, sloganeering, rhetorical legerdemain—in fact, on the huckstering skills of the marketplace.

To be sure, politics has always been dogged by these vices in America, but the pollsters only ingrain the corruption deeper by claiming they can maneuver their candidates with pinpoint accuracy. No doubt a great deal of the advice the pollsters offer candidates is sheer nonsense: shallow discussions of ephemeral public perceptions, illusory projections, statistical figments. For of course, none of the information is any better than the assumptions that program it. But it is nonsense garbed in quantities, quantities in intricate combinations that have been flushed out of computers. Such "demographics" —or better still, "psychographics," a new public relations fad that purports to integrate quantified consumer/voter values and aspirations—have come to hold the same authority for politicians that spreadsheets hold for the business community. The numbers lend enchantment. They make it *look* as if the pollsters know what they're talking about, and they give the pollsters an intimidatingly scientistic air. "I am primarily a scientist," says pollster Jonathan Robbin. "That is my calling. By scientist, I mean I am interested in the problems of measurement and interpretation and the concept of understanding how things work." Robbin is the inventor of a computer-based marketing method called Geodemographics based on zip codes and social statistics. He has done polling for Sears, for General Motors, for the Army, and for labor unions during elections.[15]

In fact, there may sometimes be a certain cunning effectiveness to the advice such experts give, experienced as they are at the media-mediated level of fickle public preferences, whims, prejudices, inse-

curities. After all, their marketing techniques do succeed in selling a lot of worthless merchandise the public never knew it wanted. More to the point: there exists a pollster, Richard Wirthlin, who succeeded in making Ronald Reagan president. Any technique that can make a winner out of such unlikely material is bound to look impressive to the rest of the field.

As so often happens when the computer's narrow mechanical powers are applied to a complex problem, the success that results comes mainly by way of downgrading the task into something the computer can do—and then cheering loudly enough to drown out the sensible reservations. What pollsters claim for their methods results from a drastic cheapening of the democratic process. In effect, they deflect attention from issues of substance by turning debate and electoral judgment into a vacuous statistical game. That, of course, is the one best use they can make of their computers: they poll to see who's "ahead." Not just ahead in an overall sense, but in ever more meticulously refined measures: with this group, in that area, on this issue. And they poll repeatedly and elaborately—perhaps even on a daily basis. The result is a steady stream of distracting numbers which are now normally released to the public as newsworthy items. The pollsters are followed in this effort by the media, which have also become highly computerized. So the polls and the surveys and the simulations are matched up and compared and debated. Pollsters are pitted against pollsters; computers are pitted against computers —as if the principal issue in the election were the reliability of polls. This is not even politics reduced to the level of a horse race; it is a contest between racing touts comparing their track records.

Over the past decade, as computers have become more proficient and prominent, we have developed a popular culture obsessed with rankings and ratings. Even beauty contests are now elaborately tabulated on esoteric programs that flash the totals across the television screen from second to second. Sports and athletics have become a morass of instant statistics. The newspapers feature the latest ratings of television shows; movies and records are ranked by their weekly earnings. In the business world, we have day-to-day printouts of corporate performance. It was inevitable that this ethos of quantitative competition should finally assimilate politics.

In recent elections in the United States, the main question under feverish discussion, in the media and in the camps of the candidates, has become: *who's winning*. Who's winning in California . . . in

Florida . . . among the senior citizens . . . among the yuppies . . . among the blue collar ethnics. The campaign itself, as it is measured by these ratings, becomes the obsessive concern of the commentators and experts—not the issues for which the campaign presumably serves as a vehicle. Issues are, after all, matters of subjective judgment. But the state of the campaigns, as reflected in the polls, is a matter of hard numbers, and hard numbers allow for easy evaluations. A candidate is a "good" choice if he is "ahead"; he is a "bad" choice if he is "behind." Candidates who are "out front" are treated with the respect and admiration due to winners; their campaigns are in "good shape." Candidates who are "falling behind" are "in trouble." They look like losers and are treated with a wised up skepticism. Their campaigns are "in disarray," "falling apart," "going broke." A point made in a debate is "good" if it scores high in the next day's polling, even though it may have been no more than a joke or a clever comeback. A slip of the tongue, a show of temper or fatigue may be a "mistake"; it is at once identified as a major item for polling. Did it "hurt"? Can the candidate "recover" and "catch up"? Voters are encouraged to pay close attention to how candidates look or sound. Do they seem relaxed, in command, ill at ease?

Such are the transient trivialities that register in computerized polling. They have nothing to do with thought or conviction; asking about them does not encourage thought or conviction. These are nothing more than low-grade verbal reflexes, ephemeral emotional twitches. But once the queries have been collected, totaled up, computed, printed out, they take on the authority of exact numbers. The media report them solemnly. The public and the candidates read the numbers and ponder them. Pundits draw sober conclusions. But more and more what everybody is responding to is the polling itself. The polls are measuring the polls.

None of this stops when the elections are over. It now continues as a full-time professional activity. On each issue that comes along, on each incident that breaks into the news, the public is polled. It learns that other members of the public "like" or "don't like," "approve" or "don't approve." We are encouraged to believe that politics is about "opinions"—not the *forming* of opinions, but their mere tabulation. This can be made to seem admirably democratic. After all, *everybody* has an opinion, and isn't one opinion as good as the next? If you ask the right question, you can whittle that opinion down to a single word: yes or no. Everybody can say yes or

no. What validates an opinion? The act of polling itself, which fuse all the opinions together, counts them, and then serves them up as significant findings for public consideration. The electorate is placed in the absurd position of becoming spectators to their own predicted political behavior.

Perhaps one day an author with the involuted surrealist touch of the Argentine Nobel laureate Jorge Luis Borges will write a story about this bizarre state of affairs. It will begin with a poll asking people if they approve of the way the polls have been handling the president's approval rating. Then there will be a poll measuring the public's opinion about the results of that poll. Then there will be a poll about the poll about the poll. At last there will be an election in which the public will vote for the poll that it thinks most accurately reflects the public's opinion.

Politics in the Information Age.

THE WAR MACHINE
∎

If the measure of political power is the magnitude of the decisions one makes, then we may be only inches away from entrusting the computer with our society's supreme governing authority. Both in the United States and the Soviet Union, more and more control over the world's thermonuclear arsenal is being lodged in computerized systems, along with the programmed scenarios that determine how, when, where that arsenal is to be used. This is nothing less than the power over our collective life and death.

At their annual conference held in San Francisco in the fall of 1984, members of the Association for Computing Machinery—the oldest computing society in America—were urged to reflect critically upon the place their profession holds in the nation's deterrence system. They were told, "We cannot hide from the fact that information technology plays as great a role in nuclear forces as does nuclear physics technology and rocket technology. We, too, design the machines of nuclear war. That means that we have moral responsibilities that can hardly be exaggerated." [16]

At the same time, in fall 1984, an activist group called Computer Professionals for Social Responsibility, headquartered on the San

Francisco peninsula, was giving this challenge a more pointed relevance. Their concern was the strategic concept called "launch on warning" (LOW). This strategy involves the preprogrammed launch of thermonuclear missiles, like the Minuteman and the MX, when computers receive information indicating a *possible* Soviet attack. If such an attack were underway, the response time on the part of the United States would be so short that the missiles would have to be fired at the earliest possible moment. Otherwise, they would be destroyed in their silos. Missiles from Soviet submarines off the coasts of America can reach targets like Washington and New York in about six minutes; they can reach vulnerable land-based missiles farther inland in less than half an hour. There would be no time to secure a presidential decision. As the military puts it, with respect to missiles like the MX: "Use them or lose them."

The Defense Department has never admitted to having a LOW policy. But if it existed—so the Computer Professionals for Social Responsibility argue—this would clearly violate the Constitution, which reserves the authority to make war to the president and Congress. LOW would seem to mean that the nation's war-making powers had been delegated to machines, or rather to nameless, unelected programmers who would have scripted the software of the deterrence system with the decision to fire history's most destructive weapons. In June 1984, the members of CPSR filed a lawsuit in federal court on this issue, demanding that automatic computer-launched nuclear attacks be declared unconstitutional. (The case was dismissed.)[17]

The Pentagon maintains that the United States does not have the capability for LOW. But this may be no more than a temporary gap in the nation's military establishment. Over the period 1985 to 1990, the Department of Defense will be spending $600 million on a highly touted strategic computing initiative, which will explore the military uses of the most advanced computer systems with a view to creating fully automated weapons, possibly including new additions to the deterrence system. The weapons that can do the job are no longer referred to as "smart," but as "brilliant."[18] Strategic computing is the American response to Japan's research in so-called fifth generation computer technology. Reportedly, the Japanese have committed themselves to radically rethinking computer design so that it can integrate several forms of artificial intelligence, especially expert systems. Military technology based on AI will have to process millions

of times more data through vastly more complicated programs than anything now in existence. The Pentagon's agenda includes such items as robotic tanks and a complete "battle management system" mounted on board an aircraft carrier. Both will be equipped for autonomous action without human intervention. They will see, hear, speak, and make judgments based upon the prediction of "likely events." The military promises that research for these weapons systems will have unlimited economic spinoff. The Defense Advanced Research Project Agency has convinced Congress that "the domestic commercial applications of this new technology will certainly complete the transformation of U.S. society to the information age."[19]

Research of this kind will doubtless intensify as the United States moves further into development of its "Star Wars" strategic defense initiative. Such an antimissile defense would be based upon multilayered computer systems of dazzling complexity, all of which would have to operate in combat (with no significant prior testing beyond computer simulations) free of human supervision. Secretary of Defense Caspar Weinberger described the task of SDI (optimistically) as the ability to "reliably identify, track, and destroy several thousand targets in a very, very short space of time." How short? About two to three minutes. The programs which orchestrate the amalgamation of such advanced (mainly still to be invented) technologies will have to anticipate hundreds of combat contingencies that might arise in the heat of battle: evasive tactics, equipment failure, mishap, climatic changes. No human brains could process so much information rapidly enough. It is estimated that the SDI programs would run to tens of millions of lines of coding—a thousand times more than the most complex programs that now exist. They would require teams of programmers working for years.[20]

Even short of SDI, the military's computer dependence is well advanced. The Strategic Air Command's nuclear deterrence strategy is masterminded by the world's largest single information processing and telecommunications complex: the Worldwide Military Command and Control System. WIMEX is a global network of sensors, satellites, and computer facilities that ties together twenty-six major American command centers around the world. Since the mid-1970s, WIMEX has been the subject of frequent and urgent criticism for its many vulnerabilities, which include some questionable original computer purchases.[21] The doubts are well founded; the system has malfunctioned repeatedly. In 1977, during a systemwide test, more than

60 percent of its messages failed to get transmitted. During one eighteen-month period in the late 1970s, the North American Air Defense reported 150 "serious" false alarms, 4 of which resulted in B-52 bomber crews starting their engines; missile crews and submarine commanders were placed on high alert.

Most of these mistakes were traced to improper identifications on radarscopes, or to faulty parts, sometimes small, cheap electronic components. In one instance in November 1979, a training tape of a simulated Soviet attack was played by mistake and was read by the system as a real alert. All these crises were finally corrected by the intervention of military commanders who simply knew this had to be a mistake. Fortunately, they had the time—at least several minutes—to make up their slow-moving human minds and to stop the alert. But as the response time allowed by the weapons grows shorter, the system will have to become more hair-triggered and autonomous.

Currently, the key locus for advanced military automation is not the nation's intercontinental missile system but the more limited European theater. There, the new generation of Soviet intermediate-range missiles and the American Pershing II and Cruise missiles are based within a few minutes' flight time of one another. On both sides, the weapons have first strike capability, meaning the accuracy or undetectability necessary to destroy the other side's weapons by a preemptive attack. The situation is so touchy that the Pentagon is presently seeking to develop an artificial intelligence expert system that might be placed in full control of the weapons. The project has been contracted with TRW Defense Systems of California.[22] TRW's feasibility study takes the approach that has become standard in the design of expert systems: it examines the way experts do things, in this case generals making war. Superior generals are identified and their "judgmental ability" is then translated into a computer program, in the same way that the experience of several superior doctors might be compiled into an expert medical diagnostic program. Of course, there is a difference. No general has ever waged thermonuclear war, let alone proven himself a winner. So where are such "experts" to be found? They are selected by their performance at war games, computerized simulations of battle, which are presumably based upon somebody's nonexpert conception of what a thermonuclear war would be like. Thus, the computer programs of this

expert system will not be based on hard-won and tested experience but upon evaluations made by other computer programs.

The goal of research like this is (in the words of the Defense Department) to achieve "completely autonomous land, sea, and air vehicles capable of complex, far-ranging reconnaissance and attack missions . . . In contrast with previous computers, the new generation will exhibit human-like intelligent capabilities for planning and reasoning."[23]

Information technology is the child of military necessity; it has been part of the war machine from the very beginning, when the first primitive computers were used during World War II to assist with ballistics and gunnery and to make the calculations for the atomic bomb. That connection continues. In the United States, the nation's most ambitious research and development effort is the new Microelectronic and Computer Technology Corporation in Austin, Texas.[24] This is a twelve-company consortium which clearly violates the antitrust laws. If it is allowed to survive by the Justice Department, that will be thanks to the clout of the Pentagon, which created and largely bankrolls the operation for the specific purpose of exploiting the military applications of computers. As Jonathan Jacky observes, "The Department of Defense is now subordinating computer science to military needs as completely as nuclear physics, aeronautics, and rocketry were subordinated in the 1940s." He estimates that by 1990, the Pentagon will be spending over $30 billion a year on software programming alone, 10 percent of the entire defense budget.[25]

No doubt every computer enthusiast would dismiss video games like Space Invaders as among the most trivial uses of this remarkable technology that so cleverly counterfeits human intelligence. But there is an intimate connection between these childish amusements and the most Promethean extensions of information technology which we find in the SDI. That connection is the psychology of warrior bravado, the chauvinist foundation of the nation-state system. This fascination with manly violence first emerges in the agonistic rough-and-tumble of adolescent boys, where one might wish it would soon exhaust itself. But too many of the boys never grow up; their passion for combat simply becomes more disciplined, more regimented. And at last the nerds of the world have presented the soldier boys with the biggest video arcade of all—the planet Earth.

Thanks to the split-second speed of modern weapons, the last, tentative political constraints upon the thermonuclear war machine are falling away. Soon even the residues of fear, pity, compassion, self-doubt that must survive in the souls of soldiers will be eliminated, too. The weapons will lie wholly in the province of machines whose artificial intelligence will be an unfeeling, one-dimensional caricature of soldierly will. The honor, the daring, the personal heroism that were the only redeeming qualities of the military vocation will be gone. The final, most decisive act of war conceivable will come down to the logic of numbers processed coldly and swiftly through the inscrutable silicon cells of a machine.

MACHINE À GOUVERNER
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As far back as 1950, when the "ultra-rapid computing machine" was still a clumsy beast, Norbert Wiener speculated upon the eventual social and political applications of cybernetics. He confronted the question:

> Can't one imagine a machine to collect this or that type of information, as for example information on production and the market, and then to determine as a function of the average psychology of human beings and of the quantities which it is possible to measure in a determined instance, what the most probable development of the situation might be? Can't one even conceive a State apparatus covering all systems of political decisions . . . ? We may dream of the time when the *machine à gouverner* may come to supply—whether for good or for evil—the present obvious inadequacy of the brain when the latter is concerned with the customary machinery of politics.[26]

At the time these words were written, they might have been taken for science fiction. Even among the cybernetic experts, there would have been few who believed that matters possessing the moral complexity of international conflict or economic planning would ever be

entrusted to machine intelligence. Wiener himself, after scrutinizing the prospect from several angles, finished with the warning:

> Woe to us if we let it decide our conduct, unless we have previously examined the laws of its action, and know fully that its conduct will be carried out on principles acceptable to us!

But Wiener's restraint was not shared by all of his colleagues, especially not by those who were busily opening the fields of artificial intelligence and later cognitive science. As early as 1960, Herbert Simon was confidently looking forward to the day "much less than twenty-five years" in the future when "we shall have the technical capability of substituting machines for any and all human functions and organizations," including those that require "emotions, attitudes, and values."[27]

This forecast, like so much of the opportunistic self-advertising that issues from the artificial intelligence community, has of course not come to pass; its fulfillment is nowhere in sight. Nonetheless, buoyed up by exuberant, professional promises like this, the province of information technology has expanded aggressively into several areas of our political life, including the highest levels of policy and decision making.

The beginnings of this development were small and scattered, reaching back to the systems (or operations) analysis teamwork of World War II. Following the war, applied systems theory found a new home in military think tanks like RAND and Mitre, where social scientists were often allied with physicists and strategists to work on ad hoc research projects like assessing the effects of thermonuclear war or civil defense planning. During the Kennedy years, counterinsurgency warfare was a hot focus of social science research, drawing upon teams of political scientists, anthropologists, and psychologists. By that time, the dominant form of social science in the universities was behavioral and heavily statistical, an ungainly caricature of the physical sciences. The style cried out for computerization, but at the universities the social scientists tended to be treated like second-class citizens when it came to sharing time on the few machines available.

It was not until the later 1960s that the breakthrough came— and then on two fronts. In 1967, the International Institute for Ap-

plied Systems Analysis was established in Vienna. IIASA was a well-financed, computer-equipped center supported by both the Eastern and Western blocs. It has served to pioneer several efforts in the area of "world" or "global modeling" for long-range social planning.[28] A few years later, in 1969, social scientists at Harvard and MIT teamed up to organize what they saw as a Manhattan Project for their disciplines. They succeeded in drawing a five-year, $7.6 million grant from the Defense Department to explore new programming techniques. The grant set up Project Cambridge, whose research was supposed to be of the most general kind, and therefore useful for a variety of social science studies. The effort was advertised as a search for "neutral computer tools."[29] But Defense Department funding inevitably linked Project Cambridge to the needs of the Pentagon, which expected value for its money. As a result, the project soon became involved in Cold War–related assignments like developing "indications and warnings" programs for military intelligence. Another of its studies sought to construct computer models of friendly and hostile villages in Thailand and then to recommend policy accordingly. A similar form of modeling used computers to select bombing targets in Vietnam during the war years. Villages that met the parameters of the friendly model were left standing; those that modeled hostile were marked for obliteration. Computerized social science had at last found its way into a life-and-death application.[30]

A 1971 report on Project Cambridge makes clear its wide-ranging political intentions:

> With these techniques, it would be possible in a few days to consider all possible strategies for an invasion of Cuba or North Vietnam. Probably further off, but still in the foreseeable future, such techniques could be used to decide whether or not to intervene in a foreign revolution or election.[31]

Perhaps the most ambitious effort at applying information technology to the art of government took place in Chile in the early 1970s. Then President Salvador Allende brought in the British cybernetics expert Stafford Beer to develop and administer an optimum economic order for the country. Working from the formula "information is what changes us; information constitutes control," Beer had brainstormed an intricate computerized system which he quaintly called the Liberty Machine. Its purpose was to concentrate

every scrap of data available from a national, or even from the world economy, and from this to fashion a "cybernetic model." The computers governing the model would "receive real-time data from the systems which they monitor, and they would distill the information content." It would then be possible to "formulate hypotheses, undertake simulations, and make predictions about world trajectories." Between 1971 and 1973, Beer, working in secret for the Ministry of Finance, sought to establish something like the Liberty Machine in Chile. The effort was a serious one, installed at great expense in a central control room (the "Opsroom") in Santiago, where it succeeded at the height of its powers in bringing 60 percent of the Chilean economy into its data gathering and governing network.[32] The system included the ability to anticipate and break strikes. Beer has reported: "We used every scrap of relevant scientific knowledge in designing the place—neurocybernetic knowledge of brain processes, knowledge from applied and group psychology, knowledge from ergonomics."[33] The exercise entailed an interesting new conception of "freedom." "Liberty," Beer decided, "may indeed be usefully redefined for our current technological era. It would say that competent information is free to act—and that this is the principle on which the new Liberty Machine should be designed." It is a definition that makes the computer an integral part of the concept.[34]

Beer's great project collapsed with the fall of the Allende government in a CIA-sponsored coup, but even in its aborted form it is a measure of how much a true-believing cybernetic utopian is willing to take on. Schemes of this magnitude should be viewed as simply the most ambitious projections of research that has been seeking ways to computerize a variety of human services and institutions: medicine, law, psychiatry, counseling, public administration. All these efforts are based on one root assumption: that human thought, even at its most subtle and intricate levels, is a kind of information processing; therefore, the more data and the faster the processing, the better.

Currently, many of the computerized modeling techniques developed by social scientists since the days of Project Cambridge have found their way into government under the catch phrase *crisis management*. In 1983, the Reagan administration gave this new discipline a special dignity by setting up a highly computerized Crisis Management Support and Planning Group within the National Security Council. The operation was entrusted to Richard Beal, a polit-

ical scientist from Brigham Young University in Utah, who had been an employee of Richard Wirthlin, the president's political pollster. Beal's assignment was to create computer data bases for some twenty global trouble spots. One of the proudly publicized achievements of the operation is its capacity to generate information in a "composite video form" using "state of the art graphics." The graphics include maps, bargraphs, and symbols depicting such activities as negotiations and warfare. The objective of these clever computer and video inventions is to offer the president, on short notice, a simple, graphic representation of an international crisis, with supposedly all the data he needs in a televised form for choosing a line of policy. Perhaps it looks something like a video game, plotted upon a map of the world.[35]

The facility is far from a purely academic experiment. It was the headquarters from which the president and his key advisors worked during the Grenada invasion of October 1983.[36] The result of that exercise, which included careful censorship of the press as part of managing the crisis, was deemed a success. (Wirthlin's polling after the event vouched for that.) Perhaps in part this was what influenced the National Security Agency a year later to make one of the largest single computer purchases by the government in its history: several hundred machines bought from AT&T for nearly a billion dollars. The computers will be distributed to NSA outposts worldwide and tied into crisis management headquarters in Washington.

The Joint Chiefs of Staff have also decided to invest in computerized modeling and simulating. Their project, begun in 1984, is called FORECASTS and is designed to use "country-specific information" to project probable futures in over 130 nations up to a distance of twenty to thirty years hence. The data base for FORECASTS reviews over a thousand indicators for each country, "most of them consisting of a time series of values for each indicator for each of the years from 1960 to 1980." FORECASTS can then extend the trend lines of these data into the future and can simulate "the interplay between variables over time." The project is regarded as a major "tool for decision making," primarily in a "heuristic" sense, "helping to suggest the range of possible shapes the future may assume."

Forecasts will be useful in considering how the United States will relate to the rest of the world, what U.S. interests might

be, where conflict is likely to originate, and to what extent U.S. capabilities will depend on external sources of energy, materials, and manufactures. . . . There is also a data base management system which enables the data to be queried and updated.[37]

AT THE LIMITS OF SANITY: THE PSYCHOTIC MACHINE

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Attempts to install the day-to-day, on-line, computerized equivalent of government on the scale of Stafford Beer's Liberty Machine are apt to be rare experiments. But efforts like the Crisis Management Center of NSA and FORECASTS are likely to become more prominent—and more dangerous—applications of computer power at high decision making levels. The danger lies in the discrepancy that exists between the seemingly rational expectations with which such projects are launched and the situation in which they may finally be required to do their job. For when they are at last called upon by political leaders to perform as advertised in a true crisis, when time is racing by and the peace of the world may hang in the balance, the machines may have drifted out of touch with their users' reality principle. They may literally have gone crazy: minds—albeit artificial ones—that have become a chaos of conflicting imperatives. How can this come about?

At the outset, when a project like the Crisis Management Group is initiated, the leaders involved are likely to regard the effort as the pursuit of a defensible, high priority objective in the contemporary world: the simple act of gathering data, lots of data. The cult of information presses in that direction with its full force; the opportunity to use state-of-the-art computers for that purpose is apt to make the undertaking all the more attractive by lending it an aura of precision and futuristic sophistication.

As more and more machines and networks go into operation, the kind and amount of data they gather begins to expand exponentially. It is like a hunger that cannot be satisfied. Indeed, it becomes one of the favored ploys of the computer virtuosos who mastermind the system to seek out unlikely and exotic kinds of data, the sort that no

unaided human intelligence could have taken into account. For example, Paul Bracken tells us that the COMINT program of the National Security Agency now collects "millions of messages that flow through the Soviet military and political bureaucracies" by tapping the phone lines of the Soviet Union. And this is only one of several surveillance programs pouring data into the NSA computers. "In the 1980s," Bracken observes, "the aggregate collection and comparison of information from hundreds of programs across an enemy's entire command has been made possible using computers." He suggests the possibilities may be extended still farther, to such fine points as monitoring the laundry facilities at Soviet ports, information that may give "excellent strategic warning of when surface and submarine forces were about to put to sea."[38] In the near future, then, somewhere in the depths of the Pentagon's war machine, a computer may be tabulating the dirty underwear of the Soviet Navy, analyzing the meaning of this key indicator, working it up graphically into a dynamic decision making model on which the peace of the world depends.

In type and amount, the data that is concentrated in the government's computers is far beyond anything a single human brain can process. The leaders who use the machines in time of crisis may have no idea why certain forms of information have been collected at all or assigned the weight they carry. Nevertheless, those who sit before the scintillating video screens, stroking keys, calling up authoritative charts and graphs and simulations, are bound to feel briskly in step with the times. They are masters of the world's data, working at the leading edge of the Information Age. What easily drops out of sight is the fact that all the machines they confront are operating in obedience to programs that are based upon assumptions and values. What they have before them is not, in some purely neutral sense of the term, "raw data" that are being offered up for their judicious consideration—though that is how the crisis managers tend to describe the matter, with total professional detachment. They purport simply to be providing objective information on demand. But this information has been edited, shaped, weighted, and ordered; it reflects priorities perhaps of a highly ideological kind. The more simplified and graphic the computerized representations become, the more densely interpretive they will have to be. A summary, after all, condenses more tightly, shapes more arbitrarily. Thus, the graphics that were presented to President Reagan by his crisis managers dur-

ing the Grenada invasion must have been shot through with assumptions about Caribbean politics, worldwide Communist intentions, America's role in the Western hemisphere. Values must have been at play balancing diplomatic against military options. Was it clear to the president at every point where the data left off and these values and assumptions began? Was it clear whose assumptions and whose values they were? Could the programs that shaped the information be traced to the minds responsible for creating them? Will presidents in the future be dealing with the same crisis programs that were created when the project began under Ronald Reagan's auspices?

As time goes on in the history of every computer system, questions like these become more difficult to answer. To begin with, large computer programs are rarely the work of a single, identifiable individual; they are put together by teams of programmers and researchers. At any given time, the team will be a mix of styles and preferences; there will be different approaches, different levels of competence. Not many of these personal quirks will be apparent; the programmers are likely to present a façade of professional objectivity and uniformity. Nevertheless, they are fashioning an intellectual artifact that reflects the tastes, choices, judgments of its makers.

In time, the system needs updating and adjustments; other programmers who may reflect the standards of a later generation will bring their judgment to bear as they take up the job. In just this fashion, the programs that now govern the Pentagon's weapons systems have been stitched and patched together over the course of several presidential administrations. There have had to be major overhauls that were rough compromises with existing, antiquated hardware. The system is not simply a technical, but an historical artifact shaped by a vast number of programmers, most of whose contributions could no longer be identified, and many of whom would probably not be able to reconstruct the work of the team on which they served. What assumptions about strategy and world politics were foremost in the minds of those who were on the job in 1962 . . . 1968 . . . 1974? What theories and methods were in fashion among computer scientists in those years?

Joseph Weizenbaum has raised the point that many super-scale computer systems are now governed by "incomprehensible programs," electronic palimpsests for which no one can any longer be held responsible.

These often gigantic systems are put together by teams of programmers, often working over a time span of many years. But by the time the systems come to use, most of the original programmers have left or turned their attention to other pursuits. It is precisely when gigantic systems begin to be used that their inner workings can no longer be understood by any single person or by a small team of individuals. [39]

The near disaster at the Three Mile Island nuclear plant is an example of just this sort of incomprehensible program at work in a single, only medium-sized facility. It took the plant's operators several fateful hours before they could understand the meaning of computer-controlled alarm signals whose governing program was beyond their immediate comprehension. Situations like this may soon become even more densely impenetrable. Techniques are now being developed that allow computers *to program themselves* without any human intervention. These techniques—self-programming programs that supposedly "learn" from their own operations—are among the latest applications of artificial intelligence research. One of them, IBM's Query-By-Example programming language, is making its way into the business community as a way of saving the costs of certain forms of programming. One expert in the field, Donald Michie of Edinburgh University, has warned that such automatic programming procedures could lead to a "technological black hole" in which "humans will not be able to understand the reasoning behind computer results that make key decisions." [40] While self-programming programs must still be programmed by a human mind, they further remove the machine that uses them from human responsibility.

Machines that run by incomprehensible programs are approaching a kind of technological madness. They are on their way to becoming disintegrated intelligences, split and fragmented, a psychotic stew of assumptions and standards that can no longer be given a rational order. Yet, if the machine is part of a crisis management project, it will continue to process data, packaging it neatly into charts, graphs, simulations, giving the surface appearance of rationality. Computers are gifted with such a facade of impersonal precision; they have no way to look or sound or act crazy. Of course, the true madness would be that of the decision makers and the society at large that elected to become dependent on mechanical systems

that bring these liabilities with them. And yet that act of delivering over one's responsibility to a supposedly infallible mechanism can be a real temptation, one that is deeply rooted in our culture.

The effort to build a *machine à gouverner* stems from an article of faith that has long been part of Western society's scientific tradition: the belief that all the secrets of nature can be fully understood by reductive analysis and mechanistic modeling. Translated into a program of research and development, this conviction has yielded striking results along many lines in our time. The organs of the body are being replaced by mechanical substitutes, though with varying degrees of success. Genetic engineering is finding ways to rebuild, and supposedly improve, living structures by rearranging the mechanisms of heredity. The human mind has been on the agenda of the mechanists since the first crude clockwork models of mentality appeared in the eighteenth century. Now that paradigm of intelligence has matured along with our technology into the data processing model of thought. The mind in all its aspects can now be seen as "nothing but" a rather complicated information-shuffling machine that works up its highest powers from simple, formal procedures that organize data points. And just as the ultimate proof of the mechanistic model in medicine is the invention of a mechanical heart or kidney that will sustain life, so in cognitive science the effort is to invent a machine that will convincingly imitate the highest functions of the minds—its power to reason, to judge, to decide.

It would be one thing if AI and cognitive science claimed, more humbly, that computer models might help us understand certain, limited applications of the mind. Even this would be a dubious proposition, based upon the assumption that two things which perform roughly the same function, the biological brain and the mechanical computer, must be equal in nature. But it would at least exhibit a becoming modesty. There are people in the field who claim no more than this; there may even be those who are prepared to reach a more self-effacing conclusion: that the real significance of the computer model is that it tells us how much we *don't* understand about the mind and *cannot* understand on the terms of that model. [41]

But modesty of this kind draws no professional plaudits; it attracts no grants and awards. It makes a poor showing alongside the dramatic advances being registered in other sciences. It will not build a rich career. Where corporate money and military-industrial power offer stunning rewards, it is difficult to hold back from making the

claims these sources invite one to make. The cult of information has many members; not the least of these are the academic professionals who have committed themselves to mastering the mind. The data processing model is all they have to work with; they will push it as far as it can go.

That may not be very far. There is no possibility that computers will ever equal or replace the mind except in those limited functional applications that do involve data processing and procedural thinking. The possibility is ruled out in principle, because the metaphysical assumptions that underlie the effort are false. But it *is* possible to redefine the mind and its uses in ways that *can* be imitated by machines. Then we have a mechanical caricature which levels the activity down to a lower standard. That is what the *machine à gouverner* would be should it ever be built. We can see the outline of that caricature already in the social applications of computer power reviewed in this chapter. In each case, a complex social phenomenon has been reduced to something brutally simple that falls within the province of the machine. Politics is revised to become opinion mongering; war is revised to become the calculation of velocities and trajectories, throw weights and megadeaths.

It is important to realize, however, that these foolish simplifications, just as they stand, even without the hope of eventual elaboration, are useful to certain forces in our society. The bureaucratic managers, the corporate elite, the military, the security and surveillance agencies are able to make good use of computerized data to obfuscate, mystify, intimidate, and control. Because they overwhelmingly own the sources and machinery of data, the cult of information lends a mystique to their dominance.

The reason they can exploit the information they control so effectively should be obvious. These social elements have deeply rooted, long-standing interests to which information can be assimilated and from which programs can be deduced. In military affairs, they work to preserve the nation-state system; in economics, they work in response to the entrepreneurial ethic; in politics, they work to further Utilitarian managerialism. All these are well-rationalized commitments, never questioned by those who hold them, never needing public avowal or discussion. From them, a clear and simple political agenda arises: to concentrate more profit and power in the hands of those who already have profit and power. As long as that agenda can be conveniently kept out of sight, the massive collection

of information into ever larger data banks and its ever more efficient processing through global networks can be made to seem necessary, even socially beneficial. It is simply the unfolding of a technological imperative. It is the coming of the Information Age, dawning upon us like a change of season.

But no matter how high the promise of that age is pitched, the price we pay for its benefits will never outweigh the costs. The violation of privacy is the loss of freedom. The degradation of electoral politics is the loss of democracy. The creation of the computerized war machine is a direct threat to the survival of our species. It would be some comfort to conclude that these liabilities result from the abuse of computer power. But these are the goals long since selected by those who invented information technology, who have guided it and financed it at every point along the way in its development. The computer is *their* machine; its mystique is *their* validation.

DESCARTES'S ANGEL

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Reflections on the True Art of Thinking

On the night of November 10, 1619, René Descartes, then an aspiring philosopher still in his early twenties, had a series of three dreams which changed the course of his life and of modern thought. He reports that in his sleep, the Angel of Truth appeared to him and, in a blinding revelation like a flash of lightning, revealed a secret which would "lay the foundations of a new method of understanding and a new and marvelous science." In the light of what the angel had told him, Descartes fervently set to work on an ambitious treatise called "Rules for the Direction of the Mind." The objective of his "new and marvelous science" was nothing less than to describe how the mind works. For Descartes, who was to invent analytical geometry, there was no question but that the model for this task was to be found in mathematics. There would be axioms ("clear and distinct ideas" that none could doubt) and, connecting the axioms in logical progressions, a finite number of simple, utterly sensible rules that were equally self-evident. The result would be an expanding body of knowledge.

Descartes never finished his treatise; the project was abandoned after the eighteenth rule—perhaps because it proved more difficult than he had anticipated. He did, however, eventually do justice to the angel's inspiration in the famous *Discourse on Method,* which is often taken to be the founding document of modern philosophy. [1] Descartes' project was the first of many similar attempts in the modern world to codify the laws of thought; almost all of them follow his lead in using mathematics as their model. In our day, the fields of artificial intelligence and cognitive science can be seen as part of this tradition, but now united with technology and centering upon a physical mechanism—the computer—which supposedly embodies these laws.

The epistemological systems that have been developed since the time of Descartes have often been ingenious. They surely illuminate many aspects of the mind. But all of them are marked by the same curious fact. They leave out the Angel of Truth—as indeed Descartes himself did. For he never returned to the source of his inspiration. His writings spare no time for the role of dreams, revelations, insights as the wellsprings of thought. Instead, he gave all his attention to formal, logical procedures that supposedly begin with zero, from a position of radical doubt. This is a fateful oversight by the father of modern philosophy; it leaves out of account that aspect of thinking which makes it more an art than a science, let alone a technology: the moment of inspiration, the mysterious origin of ideas. No doubt Descartes himself would have been hard pressed to say by what door of the mind the angel had managed to enter his thoughts. Can any of us say where such flashes of intuition come from? They seem to arise unbidden from unconscious sources. We do not stitch them together piece by piece; rather, they arrive all at once and whole. If there are any rules we can follow for the generation of ideas, it may simply be to keep the mind open and receptive on all sides, to remain hospitable to the strange, the peripheral, the blurred and fleeting that might otherwise pass unnoticed. We may not know how the mind creates or receives ideas, but without them—and especially what I have called the master ideas which embody great reserves of collective experience—our culture would be unimaginably meager. It is difficult to see how the mind could work at all if it did not have such grand conceptions as truth, goodness, beauty to light its way.

At the same time that Descartes was drafting his rules of thought, the English philosopher Francis Bacon was also in search of a radical new method of understanding. Bacon, who was a mathematical illiterate, preferred to stress the importance of observation and the ac-

cumulation of facts. He too was a man with a revolutionary vision—the intention of placing all learning on a new foundation of solid fact derived from the experimental "vexing" of nature. Before the seventeenth century was finished, these two philosophical currents—the Rationalism of Descartes, the Empiricism of Bacon—had formed a working alliance to produce the intellectual enterprise we call science: observation subjected to the discipline of an impersonal method designed to have all the logical rigor of mathematics. As Bacon once put it, if one has the right method, then "the mind itself" will "be guided at every step, and the business be done as if by machinery."

Since the days of Descartes and Bacon, science has grown robustly. Its methods have been debated, revised, and sharpened as they have thrust into new fields of study; the facts it has discovered mount by the day. But the angel who has fired the minds of great scientists with a vision of truth as bold as that of Descartes has rarely been given her due credit, and least of all by the computer scientists who seem convinced that they have at last invented Bacon's mental "machinery" and that it can match the achievements of its human original without the benefit of unaccountable revelations.

The gap that has so often been left by philosophers between the origin of ideas and the subsequent mechanics of thought—between the angel's word and the analytical processes that follow—simply reflects the difference between what the mind can and cannot understand about itself. We can self-consciously connect idea with idea, comparing and contrasting as we go, plotting out the course of a deductive sequence. But when we try to get behind the ideas to grasp the elusive interplay of experience, memory, insight that bubbles up into consciousness as a whole thought, we are apt to come away from the effort dizzy and confounded—as if we had tried to read a message that was traveling past us at blinding speed. Thinking up ideas is so spontaneous—one might almost say so *instinctive*—an action, that it defies capture and analysis. We cannot slow the mind down sufficiently to see the thing happening step by step. Picking our thoughts apart at this primitive, preconscious level is rather like one of those deliberately baffling exercises the Zen Buddhist masters use to dazzle the mind so that it may experience the inutterable void. When it comes to understanding where the mind gets its ideas, perhaps the best we can do is to say, with Descartes, "An angel told me." But then is there any need to go farther than this? Mentality is

the gift of our human nature. We may use it, enjoy it, extend and elaborate it without being able to explain it.

In any case, the fact that the origin of ideas is radically elusive does not mean we are licensed to ignore the importance of ideas and begin with whatever we *can* explain as if that were the whole answer to the age-old epistemological question with which philosophers have struggled for centuries. Yet that, I believe, is what the computer scientists do when they seek to use the computer to explain cognition and intelligence.

The information processing model of thought, which has been the principal bone of contention in these pages, poses a certain striking paradox. On the basis of that model, we are told that thinking reduces to a matter of shuffling data through a few simple, formal procedures. Yet, when we seek to think in this "simple" way, it proves to be very demanding—as if we were forcing the mind to work against the grain. Take any commonplace routine of daily life—a minimal act of intelligence—and try to specify all its components in a logically tight sequence. Making breakfast, putting on one's clothes, going shopping. As we have seen in an earlier chapter, these common-sense projects have defied the best efforts of cognitive scientists to program them. Or take a more extraordinary (meaning less routine) activity: choosing a vocation in life, writing a play, a novel a poem, or—as in Descartes's case—revolutionizing the foundations of thought. In each of these exercises, what we have first and foremost in mind is the whole, global project. We *will* to do it, and then—somehow, seemingly without thinking about it—we work through the matter step by step, improvising a countless series of subroutines that contribute to the project. Where something doesn't work or goes wrong, we adjust within the terms of the project. We understand projects: whole activities. They may be misconceived activities, but they are nevertheless the ends that must come before the means. When we get round to the means, we remain perfectly aware that these are subordinate matters. The surest way any project in life goes wrong is when we fixate on those subordinate matters and lose sight of the whole. Then we become like the proverbial centipede who, when he was asked to explain how he coordinated all his parts, discovered he was paralyzed.

What I am suggesting is that, in little things and big, the mind works more by way of gestalts than by algorithmic procedures. This is because our life as a whole is made up of a hierarchy of projects,

some trivial and repetitive, some special and spectacular. The mind is naturally a spinner of projects, meaning it sets goals, choosing them from among all the things we might be doing with our lives. Pondering choices, making projects—these are the mind's first order of activity. This is so obvious, so basic, that perhaps we are only prompted to reflect upon it when a different idea about thinking is presented, such as that thought is connecting data points in formal sequences.

Now, of course, the mind takes things in as it goes along. We do register data. But we register information in highly selective ways within the terms of a project which, among other things, tells us which facts to pay attention to, which to ignore, which deserve the highest and which the lowest value. Thinking means—most significantly—forming projects and reflecting upon the values that the project involves. Many projects are simply given by the physical conditions of life: finding food, clothing the body, sheltering from the elements, securing help in time of danger. But all of us at least hope we will have the opportunity in life to function at a higher level than this, that we will spend as much of our time as possible beyond the level of necessity, pursuing what John Maynard Keynes once called "the art of life itself." Forming projects of this kind is the higher calling that comes with our human nature. Teaching the young how to honor and enjoy that gift is the whole meaning of education. That is surely not what we are doing when we load them down with information, or make them feel that collecting information is the main business of the mind. Nor do we teach them the art of life when we ask them "to think like a machine." Machines do not invent projects; they are invented by human beings to pursue projects. What Seymour Papert calls "procedural thinking" surely has its role to play in life; but its role is at the level of working out the route for a trip by the close study of a road map. It is an activity that comes into play only after we have chosen to make a journey and have selected a destination.

The substance of education in the early years is the learning of what I have called master ideas, the moral and metaphysical paradigms which lie at the heart of every culture. To choose a classic model in the history of Western pedagogy: in the ancient world, the Homeric epics (read or recited) were the texts from which children learned the values of their civilization. They learned from adventure tales and heroic exemplars which they could imitate by endless play

in the roadways and fields. Every healthy culture puts its children through such a Homeric interlude when epic images, fairy tales, *chansons de geste,* Bible stories, fables, and legends summon the growing mind to high purpose. That interlude lays the foundations of thought. The "texts" need not be exclusively literary. They can be rituals—as in many tribal societies, where the myths are embodied in festive ceremonies. Or they may be works of art, like the stained glass windows and statuary of medieval churches. Master ideas may be taught in many modes. In our society, television and the movies are among the most powerful means of instruction, often to the point of eclipsing the lackluster materials presented in school. Unhappily, these major media are for the most part in the hands of commercial opportunists for whom nobility of purpose is usually nowhere in sight. At best, a few tawdry images of heroism and villainy may seep through to feed the hungry young mind. The rudiments of epic conduct can be found in a movie like *Star Wars,* but the imagery has been produced at a mediocre aesthetic and intellectual level, with more concern for "effects" than for character. At such hands, archetypes become stereotypes, and the great deeds done are skewed with an eye to merchandising as much of the work as possible.

Those cultures are blessed which can call upon Homer, or Biblical tales, or the Mahabharata to educate the young. Though the children's grasp of such literature may be simple and playful, they are in touch with material of high seriousness. From the heroic examples before them, they learn that growing up means making projects with full responsibility for one's choices. In short, taking charge of one's life in the presence of a noble standard. Young minds reach out for this guidance; they exercise their powers of imagination in working up fantasies of great quests, great battles, great deeds of cunning, daring, passion, sacrifice. They craft their identities to the patterns of gods and goddesses, kings and queens, warriors, hunters, saints, ideal types of mother and father, friend and neighbor. And perhaps some among them aspire to become the bards and artists of the new generation who will carry forward the ideals of their culture. Education begins with giving the mind images—not data points or machines—to think with.

There is a problem, however, about teaching children their culture's heroic values. Left in the hands of parents and teachers, but especially of the Church and the state where these institutions become dominant, ideals easily become forms of indoctrination, idols

of the tribe that can tyrannize the young mind. Heroism becomes chauvinism; high bright images become binding conventions. Master ideas are cheapened when they are placed in the keeping of small, timid minds that have grown away from their own childish exuberance.

In the hands of great artists like Homer, images never lose the redeeming complexity of real life. The heroes keep just enough of their human frailties to stay close to the flesh and blood. Achilles, the greatest warrior of them all, is nevertheless as vain and spoiled as a child, a tragically flawed figure. Odysseus can be more than a bit of a scoundrel, his "many devices" weakening toward simple piracy. It is the fullness of personality in these heroes that leaves their admirers balanced between adulation and uncertainty. The ideal has more than one side; the mind is nagged with the thought "yes, but. . . ." Where such truth to life is lost, the images become shallow; they can then be used to manipulate rather than inspire.

The Greeks, who raised their children on a diet of Homeric themes, also produced Socrates, the philosophical gadfly whose mission was to sting his city into thoughtfulness. "Know thyself," Socrates insisted to his students. But where else can self-knowledge begin but with the questioning of ancestral values, prescribed identities?

Here is the other significant use of ideas: to produce critical contrast and so to spark the mind to life. Homer offers towering examples of courage. Ah, but what is *true* courage? Socrates asks, offering other, conflicting images, some of which defy Homer. At once, idea is pitted against idea, and the students must make up their own minds, judge, and choose. Societies rarely honor their Socratic spirits. Athens, irritated beyond tolerance by his insistent criticism, sent its greatest philosopher to his death. Still, no educational theory that lacks such a Socratic counterpoint can hope to free the young to think new thoughts, to become new people, and so to renew the culture.

In a time when our schools are filling up with advanced educational technology, it may seem almost perverse to go in search of educational ideals in ancient and primitive societies that had little else to teach with than word of mouth. But it may take that strong a contrast to stimulate a properly critical view of the computer's role in educating the young. At least it reminds us that all societies, modern and traditional, have had to decide *what* to teach their children

before they could ask *how* to teach them. Content before means, the message before the medium.

The schooling of the young has always been a mixture of basic skills (whether literacy and ciphering or hunting and harvesting) and high ideals. Even if our society were to decide that computer literacy (let us hope in some well-considered sense of that much-confused term) should be included among the skills we teach in the schools, that would leave us with the ideals of life still to be taught. Most educators surely recognize that fact, treating the computer as primarily a means of instruction. What they may overlook is the way in which the computer brings with it a hidden curriculum that impinges upon the ideals they would teach. For this is indeed a powerful teaching tool, a smart machine that brings with it certain deep assumptions about the nature of mentality. Embodied in the machine there is an idea of what the mind is and how it works. The idea is there because scientists who purport to understand cognition and intelligence have put it there. No other teaching tool has ever brought intellectual luggage of so consequential a kind with it. A conception of mind—even if it is no better than a caricature—easily carries over into a prescription for character and value. When we grant anyone the power to teach us *how* to think, we may also be granting them the chance to teach us *what* to think, where to begin thinking, where to stop. At some level that underlies the texts and tests and lesson plans, education is an anatomy of the mind, its structure, its limits, its powers and proper application.

The subliminal lesson that is being taught whenever the computer is used (unless a careful effort is made to offset that effect) is the data processing model of the mind. This model, as we have seen, connects with a major transition in our economic life, one that brings us to a new stage of high tech industrialism, the so-called Information Age with its service-oriented economy. Behind that transition, powerful corporate interests are at work shaping a new social order. The government (especially the military) as a prime customer and user of information technology is allied to the corporations in building that order. Intertwined with both, a significant, well-financed segment of the technical and scientific community—the specialists in artificial intelligence and cognitive science—has lent the computer model of the mind the sanction of a deep metaphysical proposition. All these forces, aided by the persuasive skills of the advertisers, have fixed upon the computer as an educational instrument; the machine

brings that formidable constellation of social interests to the class-rooms and the campus. The more room and status it is given there by educators, the greater the influence those interests will have.

Yet these are the interests that are making the most questionable use of the computer. At their hands, this promising technology—itself a manifestation of prodigious human imagination and inventiveness—is being degraded into a means of surveillance and control, of financial and managerial centralization, of manipulating public opinion, of making war. The presence of personal computers in millions of homes, especially when they are used as little more than trivial amusements, does not in any meaningful way offset the power the machine brings to those who use it for these purposes.

Introducing students to the computer at an early age, creating the impression that their little exercises in programming and game playing are somehow giving them control over a powerful technology, can be a treacherous deception. It is not teaching them to think in some scientifically sound way; it is persuading them to acquiesce. It is accustoming them to the presence of computers in every walk of life, and thus making them dependent on the machine's supposed necessity and superiority. Under these circumstances, the best approach to computer literacy might be to stress the limitations and abuses of the machine, showing the students how little they need it to develop their autonomous powers of thought.

There may even be a sound ecological justification for such a curriculum. It can remind children of their connection with the lively world of nature that lies beyond the industrial environment of machines and cities. Sherry Turkle observes that, in times past, children learned their human nature in large measure by comparing themselves to the animals. Now, increasingly, "computers with their interactivity, their psychology, with whatever fragments of intelligence they have . . . bid to take this place."[2] Yet it may mean far more at this juncture in history for children once again to find their kinship with the animals, every one of which, in its own inarticulate way, displays greater powers of mind than any computer can even mimic well. It would indeed be a loss if children failed to see in the nesting birds and the hunting cat an intelligence as well as a dignity that belongs to the line of evolutionary advance from which their own mind emerges. It is not the least educational virtue of the traditional lore and legends that so much of it belongs to the preindustrial era, when the realities of the nonhuman world were more vividly present.

How much ecological sense does it make to rush to close off what remains of that experience for children by thrusting still another mechanical device upon them?

There is a crucial early interval in the growth of young minds when they need the nourishment of value-bearing images and ideas, the sort of Homeric themes that open the adventure of life for them. They can wait indefinitely to learn as much as most schools will ever teach them about computers. The skills of unquestionable value which the technology makes available—word processing, rapid computation, data base searching—can certainly be saved for the later high school or even college years. But once young minds have missed the fairy tales, the epic stories, the myths and legends, it is difficult to go back and recapture them with that fertile sense of naive wonder that belongs to childhood. Similarly, if the taste for Socratic inquiry is not enlivened somewhere in the adolescent years, the growing mind may form habits of acquiescence that make it difficult to get out from under the dead hand of parental dominance and social authority.

As things now stand, there is a strong consensus abroad that our schools are doing a poor to mediocre job of laying these intellectual foundations. The reasons for the malaise of the schools are many. Teachers are often overworked and underappreciated; many students come to them bored, rebellious, distracted, or demoralized. Some of the children in our inner cities are too disadvantaged and harassed by necessity to summon up an educative sense of wonder; others may have been turned prematurely cynical by the corrupted values of commercialism and cheap celebrity; many, even the fortunate and affluent, may be haunted by the pervasive fear of thermonuclear extinction that blights all our lives. The schools share and reflect all these troubles; perhaps, at times, the troubles overwhelm the best efforts of the best teachers, driving them back to a narrow focus on basic skills, job training, and competitive grading. But it is at least worth something to know where the big problems lie and to know there is no quick technological fix for them. Computers, even when we reach the point of having one on every desk for every student, will provide no cure for ills that are social and political in nature.

It may seem that the position I take here about the educational limits of the computer finishes with being a humanist's conservative appeal in behalf of the arts and letters. It is that. Scientists and

technicians, whose professional interests tend to make them computer enthusiasts, may therefore see little room for their values in the sort of pedagogy I recommend. But as the story of Descartes's angel should remind us, science and technology at their highest creative level are no less connected with ideas, with imagination, with vision. They draw upon all the same resources of the mind, both the Homeric and the Socratic, as the arts and letters. We do not go far wrong from the viewpoint of any discipline by the general cultivation of the mind. The master ideas belong to every field of thought. It would surely be a sad mistake to intrude some small number of pedestrian computer skills upon the education of the young in ways that blocked out the inventive powers that created this astonishing technology in the first place. And what do we gain from any point of view by convincing children that their minds are inferior to a machine that dumbly mimics a mere fraction of their native talents?

In the education of the young, humanists and scientists share a common cause in resisting any theory that cheapens thought. That is what the data processing model does by closing itself to that quality of the mind which so many philosophers, prophets, and artists have dared to regard as godlike: its inexhaustible potentiality. In their search for "effective procedures" that can be universally applied to all aspects of culture, experts in artificial intelligence and cognitive science are forced to insist that there is nothing more to thought than a conventional mechanistic analysis will discover: data points shuffled through a small repertory of algorithms. In contrast, my argument in these pages has been that the mind thinks, not with data, but with ideas whose creation and elaboration cannot be reduced to a set of predictable rules. When we usher children into the realm of ideas, we bring them the gift of intellectual adventure. They begin to sense the dimensions of thought and the possibilities of original insight. Whether they take the form of words, images, numbers, gestures, ideas unfold. They reveal rooms within rooms within rooms, a constant opening out into larger, unexpected worlds of speculation.

The art of thinking is grounded in the mind's astonishing capacity to create beyond what it intends, beyond what it can foresee. We cannot begin to shape that capacity toward humane ends and to guard it from demonic misuse until we have first experienced the true size of the mind.

NOTES

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1. "Information, Please"

1. For a survey of the early history of the computer industry, see Joel Shurkin, *Engines of the Mind* (New York: Norton, 1984). Shurkin details the first use of UNIVAC at CBS in 1952 (pp. 250–253).

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3. Newell and Simon, quoted in Joseph Weizenbaum, *Computer Power and Human Reason* (San Francisco: W. H. Freeman, 1976), p. 169.

4. Ibid., p. 138.

5. Simon, quoted in John Pfeiffer, *The Thinking Machine* (New York: Lippincott, 1962), p. 174.

6. Warren Weaver, "The Mathematics of Communication," *Scientific American,* July 1949, p. 12.

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11. For Barbara McClintock's work, see Evelyn Fox Keller, *A Feeling for the Organism* (New York: W. H. Freeman, 1983).

2. The Data Merchants

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7. Herman Kahn, *The Coming Boom* (New York: Simon & Schuster, 1982).

8. See "Defense Men Take Control of America's Computers," *New Scientist* (London), May 26, 1983, p. 526.

9. The statistics for 1985 defense expenditures come from a report on National Public Radio by David Malthus, July 8, 1985.

10. See Henry Levin and Russell Rumberger, "The Low-Skill Future of High Tech," *Technology Review*, August–September 1983. Also see James Fallows, "America's Changing Economic Landscape," *Atlantic*, March 1985, for an optimistic assessment of the rise of the Sunbelt and high tech, but one which does not question the fact that the low-paying service sector is where most displaced industrial workers now have to look for jobs. For the AFL-CIO reading of the situation, see *Deindustrialization and the Two Tier Society*, Industrial Union Department (AFL-CIO) Publication (Washington, D.C., 1984).

11. Rogers and Larsen, *Silicon Valley Fever: Growth of High Technology Culture* (New York: Basic Books, 1984), p. 189.

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23. Avron Barr, "AI: Cognition as Computation," in Machlup, *The Study of Information,* p. 261.

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3. The Hidden Curriculum

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5. *Of Ideas and Data*

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1. G. M. Young, *Victorian England: Portrait of an Age*, 2d ed. (Oxford: Oxford University Press, 1964), pp. 11, 32–33.

2. For a sampling of the materials available from government sources, see Matthew Lesko, *Information USA*, a guide and manual available from 12400 Beall Mt. Road, Potomac, MD 20854. Also see Susan Osborn and Jeffrey Weiss, *The Information Age Sourcebook* (New York: Pantheon, 1982), which was compiled from some 500 government agency books and brochures.

3. John Lamb, "Confusion Among the Databases," *New Scientist* (London), February 21, 1985, p. 23. Lamb also deals with the problem of incoherence among the many data bases (different codes, protocols, and command languages) as well as the increasing expense of subscriptions and access charges. It should be mentioned that the U.S. government is one of the largest operators of data bases, many of them cheap or free. For a guide to this veritable jungle of information, see *The Federal Database Finder*, also available in Lesko, *Information USA*.

4. As early as January 1982, military experts were questioning the simulations on which Ronald Reagan had campaigned. See the report by Ian Mather in *The Observer*, January 24, 1982. Both the CIA and the Arms Control Association eventually challenged the figures used by Reagan on the Soviet arms buildup. See *New York Times*, March 3, 1983, p. 1, March 9, p. 23; and the Knight News Service report, *San Francisco Examiner*, June 18, 1984, p. 1.

5. For a discussion of Papert's idea of computer cultures, see James Dray and Joseph Menosky, "Computers and a New World Order," *Technology Review,* May–June 1983. Also see Papert's first chapter in *Mindstorms.*

6. For a review of services like EIES and Compuserve as well as data base resources, see the "Telecommunicating" section in Brand, ed., *Whole Earth Software Catalog.* This section also offers some bibliographic guides on the subject.

7. Mike Cane, *The Computer Phone Book* (New York: New American Library, 1983), surveys a few hundred computer bulletin boards. On networking generally with or without computers, see *The Networking Newsletter* (Box 66, West Newton, MA 92165).

8. Associated Press report, *San Francisco Chronicle,* June 12, 1985, p. 11.

9. On the ARPAnet, see *The Networking Newsletter* 1, no. 3 (1984): 15.

10. For a report on the services available from SCAN, see Evelyn Greenwald, "Reference Power," *American Libraries,* November 1984, p. 698.

9. *In the Wrong Hands*

1. Wiener, quoted in Noble, *Forces of Production,* p. 73.

2. See Noble, *Forces of Production,* pp. 71–76, for a full account of Wiener's heroic efforts to defend cybernetics from misuse.

3. Wilson, quoted in Noble, *Forces of Production,* p. 21. See especially his chapters 2, 3, and 4 on automation in the immediate postwar period.

4. Noble, *Forces of Production,* p. 328. For a fuller description of these programs, see the epilogue to *Forces of Production.*

5. For a survey of the legal and political problems that arise from computerized forms of surveillance, see James Rule et al., *The Politics of Privacy: Planning for Personal Data Systems as Powerful Technologies* (New York: Elsevier, 1980); and David Burnham, *The Rise of the Computer State* (New York: Random House, 1983).

6. For a survey of government and private use of data banks, see the series by Scott Winokur, "Nowhere to Hide," *San Francisco Examiner,* October 7–12, 1984.

7. Associated Press report, "Credit Records Open to U. S. Security Soon," *San Francisco Chronicle,* April 11, 1984.

8. Quoted by Winokur, "Nowhere to Hide," October 7, 1984, p. 14.

9. On the activities of the NSA, see Loring Wirbel, "Somebody Isn't Listening," *The Progressive,* November 1980, pp. 16–19.

10. The incident is recounted in Winokur, "Nowhere to Hide," October 11, 1984, p. B-4.

11. Comprehensive NSA control of data banks was reported on Na-

tional Public Radio's "Morning Edition," July 1, 1985. Also see the report in *New York Times* for September 24, 1985, reprinted in *San Francisco Chronicle,* September 25, 1985, p. 12.

12. Toffler, *The Third Wave,* pp. 192–194.

13. For a somewhat overdramatized account of Richard Wirthlin's services in the 1980 Reagan campaign, see Roland Perry, *Hidden Power* (New York: Beauford Books, 1984). The general outlines of Perry's narrative are confirmed by a report, "The Marketing of a Candidate," *Advertising Age,* December 15, 1980, and in accounts given below.

14. For discussions of Wirthlin's methods, see Mark Levy, "Polling and the Presidential Election," *Annals of the American Academy of Political and Social Sciences,* March 1984; and Wirthlin's own account of the 1980 campaign, "The Republican Strategy and Its Electoral Consequences," in *Party Coalitions in the 1980s,* ed. Seymour Lipset (San Francisco: Institute for Contemporary Studies, 1981). On polling generally, see Dom Bonafede, "Campaign Pollsters—Candidates Won't Leave Home Without Them," *National Journal,* May 26, 1984; Bruce E. Altshuler, *Keeping a Finger on the Public Pulse* (Westport, Conn.: Greenwood Press, 1982); and Steven J. Rosenstone, *Forecasting Presidential Elections* (New Haven: Yale University Press, 1983).

15. Robbin, quoted in Burnham, *The Rise of the Computer State* (p. 90), which gives an illuminating account of how a labor union used Robbin's technique to defeat right-to-work legislation.

16. See the report, "Nuclear War and the Computer," *Datamation,* February 1984, pp. 50–51, and in *New Scientist* (London), October 25, 1984.

17. See the report in *New Scientist* (London), October 25, 1984, p. 7. Also see the report in *San Francisco Chronicle,* July 11, 1985, p. 17. A news item on Computer Professionals for Social Responsibility appears in *Datamation,* February 1984, pp. 58–60, and a discussion of their lawsuit appears in Laura Fraser, "Can a Computer Declare War?" *This World* magazine, *San Francisco Chronicle,* November 24, 1985, p. 19.

18. On the Strategic Computing Initiative, see reports in *New York Times,* June 18, 1984, p. 17, October 23, 1984, p. C-1; and *Washington Post,* November 4, 1983, p. 1, and September 5, 1984 p. F-1. Also see "Military Computing: DARPA's Big Push in AI," *Datamation,* February 1984, pp. 48–50.

19. U.S., Congress, House Appropriations Committee, Department of Defense Appropriations for 1985, pt. 5, 98th Cong. 2d sess., p. 495.

20. On the strategic defense initiative, see Jonathan Jacky, "The Star Wars Defense Won't Compute," *Atlantic,* June 1985, pp. 18–29; Jeff Hecht, "Star Wars: An Astronomical Bribe for Scientists," *New Scientist* (London), June 20, 1985, pp. 14–18; "Reagan's Star Wars," Report by the Union of Concerned Scientists, *New York Review of Books,* April 26, 1984, pp. 47–52.

21. On WIMEX and the computer problems of the U.S. early warning

system generally, see Daniel Ford, *The Button: The Pentagon's Strategic Command and Control System* (New York: Simon & Schuster, 1985).

22. See "General Computer Takes Charge," *New Scientist* (London), April 21, 1983, p. 153.

23. DARPA Report, *Strategic Computing*, quoted by Jacky, "The Star Wars Defense Won't Compute," p. 20.

24. See John Lamb, "Defense Men Take Control of America's Computers," *New Scientist* (London), May 26, 1983, p. 526.

25. Jacky, "The Star Wars Defense Won't Compute," p. 26.

26. Wiener, quoting Pere Dubarle, in *The Human Use of Human Beings*, pp. 178–180.

27. Quoted in Weizenbaum, *Computer Power and Human Reason*, p. 244.

28. On IIASA, see the report in *New Scientist* (London), July 19, 1973, p. 27.

29. Judith Coburn, "Project Cambridge: Another Showdown for Social Sciences?" *Science*, December 5, 1969, pp. 1250–1253.

30. On computerized bombing in Vietnam, see Weizenbaum, *Computer Power and Human Reason*, pp. 238–240.

31. Joseph Hanlon, "The Implications of Project Cambridge," *New Scientist* (London), February 25, 1971, pp. 421–423.

32. See the report on Beer's project in *New Scientist* (London), October 25, 1973, p. 260. Also see "Economy by Computer," *This World* supplement, *San Francisco Chronicle*, January 21, 1973, p. 15.

33. Beer quoted in John Adams, "Everything Under Control," *Science for the People*, April–May 1973, p. 4. This article as a whole is a good critical review of Beer's theories.

34. Stafford Beer, "The Liberty Machine," *Futures*, December 1971, pp. 338–348.

35. See "Crisis Management Under Strain," *Science*, August 31, 1984, pp. 907–909, which describes Richard Beal's basic plans for the project and his video-graphics innovations.

36. Ralph K. Bennett, "Grenada: Anatomy of a 'Go' Decision," *Reader's Digest*, February 1984, pp. 72–77. There is also a somewhat fictionalized reconstruction of the computerized assault on Grenada in Roland Perry, *Hidden Power*, ch. 22.

37. This description of FORECASTS comes from a personal letter from the Public Affairs Office of the Joint Chiefs of Staff, July 29, 1985.

38. Paul Bracken, *The Command and Control of Nuclear Weapons* (New Haven: Yale University Press, 1983), pp. 39–41.

39. Joseph Weizenbaum, "On the Impact of the Computer on Society," *Science*, May 12, 1972, pp. 612–613. Also see his chapter "Incomprehensible Programs," in *Computer Power and Human Reason*.

40. "Computers That Learn Could Lead to Disaster," *New Scientist* (London), January 17, 1980, p. 160.

41. Joseph Weizenbaum would be the most prominent example of a

computer scientist who takes this position. It is also the position taken by Hubert Dreyfus, *What Computers Can't Do* (New York: Harper & Row, 1973); and John Searle, *Minds, Brains and Science* (Cambridge: Harvard University Press, 1985).

10. *Descartes's Angel: Reflections on the True Art of Thinking*

1. Jacques Maritain offers a lengthy analysis of Descartes's fateful dream in *The Dream of Descartes* (New York: Philosophical Library, 1944).

2. Turkle, *The Second Self*, p. 313.

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