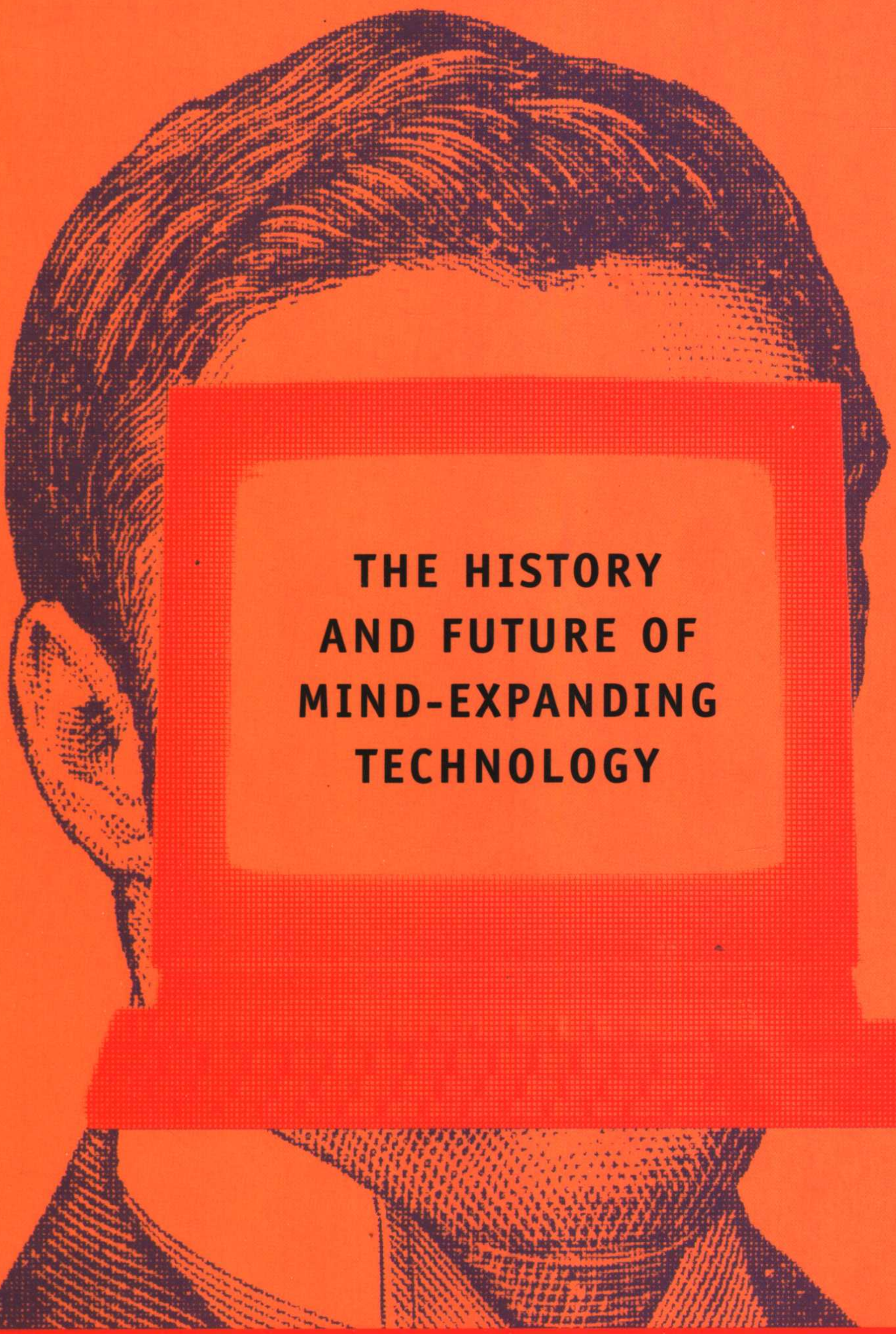
TOOLS FOR THOUGHT



THE HISTORY AND FUTURE OF MIND-EXPANDING TECHNOLOGY

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Preface to the MIT Press Edition

At the beginning of the 1980s, powerful personal computers and global computer networks of millions of computers were not the fact of life they became at the end of the 1990s. Indeed, the world of information and communication technology that influences so much of our lives today was not created by the existing computer industry, nor was it championed by the orthodoxy of computer science. Rather, it was built by a handful of rebels who weren't seeking fame or fortune, but spent their lives creating a new tool for enhancing human thought. They created it because they wanted it for their personal use, because it was a cool thing to do, and because they thought it would improve the human lot.

When Apple and Microsoft were fledgling companies, most of what was written about the emerging personal computer industry was about teenage millionaires. If you were to trust what you read in the popular press, the personal computer was invented by Steve Jobs and Bill Gates. In fact, any journalist could get a pretty good idea of what life might be like two decades in the future if they visited Xerox Palo Alto Research Center in the late 1970s—the place Jobs and Gates got all their best ideas. The real story of where PCs and networks came from was, to me, both more interesting and more fundamentally important than the popular mythology of Silicon Valley. Seventeen years ago, I sought out PARC's Alan Kay, ARPA's J. C. R Licklider and Bob Taylor, and SRI's Doug Engelbart, because I was personally fascinated with the idea that computers could one day be used to help people think, communicate, and solve problems together.

In 1999, I revisited Engelbart, Kay, Taylor, and others I first encountered in 1983. We talked about the way the future looked when they started creating it, the way it has actually turned out, and the possible futures for mind-amplifying technology. Retrospective futurism about technology is considerably easier than trying to foresee where our tools are really going to take us next. It's particularly tasty if MIT Press pays you to do it. At the end of this edition is an afterword that attempts to look back on how we looked forward in 1983, when the book was written.

Acknowledgments

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To Nathan Rheingold,
who gave me the most important thing a man
can ever give his son—an example.

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CHAPTER ONE:

The Computer Revolution Hasn't Happened Yet

South of San Francisco and north of Silicon Valley, near the place where the pines on the horizon give way to live oaks and radiotelescopes, an unlikely subculture has been creating a new medium for human thought. When the mass-production models of present prototypes reach our homes, offices, and schools, our lives are going to change dramatically.

The first of these mind-amplifying machines will be descendants of the devices now known as personal computers, but they will resemble today's information processing technology no more than a television resembles a fifteenth-century printing press. They aren't available yet, but they will be here soon. Before today's first-graders graduate from high school, hundreds of millions of people around the world will join together to create new kinds of human communities, making use of a tool that a small number of thinkers and tinkerers dreamed into being over the course of the past century.

Nobody knows whether this will turn out to be the best or the worst thing the human race has done to itself, because the outcome of this empowerment will depend in large part on how we react to it and what we choose to do with it. The human mind is not going to be replaced by a machine, at least not in the foreseeable future, but there

is little doubt that the worldwide availability of fantasy amplifiers, intellectual toolkits, and interactive electronic communities will change the way people think, learn, and communicate.

It looks as if this latest technology-triggered transformation of society could have even more intense impact than the last time human thought was augmented, five hundred years ago, when the Western world learned to read. Less than a century after the invention of movable type, the literate community in Europe had grown from a privileged minority to a substantial portion of the population. People's lives changed radically and rapidly, not because of printing machinery, but because of what that invention made it possible for people to know. Books were just the vehicles by which ideas escaped from the private libraries of the elite and circulated among the population.

The true value of books emerged from the community they made possible, an intellectual community that is still alive all over the world. The printed page has been a medium for the propagation of ideas about chemistry and poetry, evolution and revolution, democracy and psychology, technology and industry, and many other notions far beyond the ken of the people who invented movable type and started cranking out Bibles.

Because mass production of sophisticated electronic devices can lag ten years or more behind the state of the art in research prototypes, the first effects of the astonishing achievements in computer science since 1960 have only recently begun to enter our lives. Word processors, video games, educational software, and computer graphics were unknown terms to most people only ten years ago, but today they are the names for billion-dollar industries. And the experts agree that the most startling developments are yet to come.

A few of the pioneers of personal computing who still work in the computer industry can remember the birth of the dream, when the notion of personal computing was an obscure heresy in the ranks of the programming priesthood. Thirty years ago, the overwhelming majority of the people who designed, manufactured, programmed, and used computers subscribed to a single idea about the proper (and possible) place of computers in society: "Computers are mysterious devices meant to be used for mathematical calculations." Period. Computer technology was believed to be too fragile, valuable, and complicated for nonspecialists.

In 1950, you could count the people who took exception to this dogma on the fingers of one hand. The dissenting point of view shared by those few people involved a different way of thinking about how comput-

ers might be used. The dissenters shared a vision of *personal* computing in which computers would be used to enhance the most creative aspects of human intelligence—for everybody, not just the technocognoscenti.

Those who questioned the dogma of data processing agreed that computers can help us calculate, but they also suspected that if the devices could be made more interactive, these tools might help us to speculate, build and study models, choose between alternatives, and search for meaningful patterns in collections of information. They wondered whether this newborn device might become a communication medium as well as a calculating machine.

These heretical computer theorists proposed that if human knowledge is indeed power, then a device that can help us transform information into knowledge should be the basis for a very powerful technology. While most scientists and engineers remained in awe of giant adding machines, this minority insisted on thinking about how computers might be used to assist the operation of human minds in nonmathematical ways.

Tools for Thought focuses on the ideas of a few of the people who have been instrumental in creating yesterday's, today's, and tomorrow's human-computer technology. Several key figures in the history of computation lived and died centuries or decades ago. I call these people, renowned in scientific circles but less well known to the public, the *patriarchs*. Other cocreators of personal computer technology are still at work today, continuing to explore the frontiers of mind-machine interaction. I call them the *pioneers*.

The youngest generation, the ones who are exploring the cognitive domains we will all soon experience, I call the *infonauts*. It is too early to tell what history will think of the newer ideas, but we're going to take a look at some of the things the latest inner-space explorers are thinking, in hopes of catching some clues to what (and how) everybody will be thinking in the near future.

As we shall see, the further limits of this technology are not in the hardware, but in our minds. The digital computer is based on a theoretical discovery known as "the universal machine," which is not actually a tangible device but a mathematical description of a machine capable of simulating the actions of any other machine. Once you have created a general-purpose machine that can imitate any other machine, the future development of the tool depends only on what tasks you can think to do with it. For the immediate future, the issue of whether machines can become intelligent is less important than learning to deal with a device that can become whatever we clearly imagine it to be.

The pivotal difference between today's personal computers and tomor-

row's intelligent devices will have less to do with their hardware than their *software*—the instructions people create to control the operations of computing machinery. A program is what tells the general-purpose machine to imitate a specific kind of machine. Just as the hardware basis for computing has evolved from relays to vacuum tubes to transistors to integrated circuits, the programs have evolved, as well. When information processing grows into knowledge processing, the true personal computer will reach beyond hardware and connect with a vaster source of power than that of electronic microcircuitry—the power of human minds working in concert.

The nature of the world we create in the closing years of the twentieth century will be determined to a significant degree by our attitudes toward this new category of tool. Many of us who were educated in the precomputer era shall be learning new skills. The college class of 1999 is already on its way. It is important that we realize today that those skills of tomorrow will have little to do with how to operate computers and a great deal to do with how to use augmented intellects, enhanced communications, and amplified imaginations.

Forget about "computer literacy" or obfuscating technical jargon, for these aberrations will disappear when the machines and their programs grow more intelligent. The reason for building a personal computer in the first place was to enable people to do what people do best by using machines to do what machines do best. Many people are afraid of today's computers because they have been told that these machines are smarter than they are—a deception that is reinforced by the rituals that novices have been forced to undergo in order to use computers. In fact, the burden of communication should be on the machine. A computer that is difficult to use is a computer that's too dumb to understand what you want.

If the predictions of some of the people in this book continue to be accurate, our whole environment will suddenly take on a kind of intelligence of its own sometime between now and the turn of the century. Fifteen years from now there will be a microchip in your telephone receiver with more computing power than all the technology the Defense Department can buy today. All the written knowledge in the world will be one of the items to be found in every schoolchild's pocket.

The computer of the twenty-first century will be everywhere, for better or worse, and a more appropriate prophet than Orwell for this eventuality might well be Marshall McLuhan. If McLuhan was right about the medium being the message, what will it mean when the entire environment becomes the medium? If such a development does occur as pre-