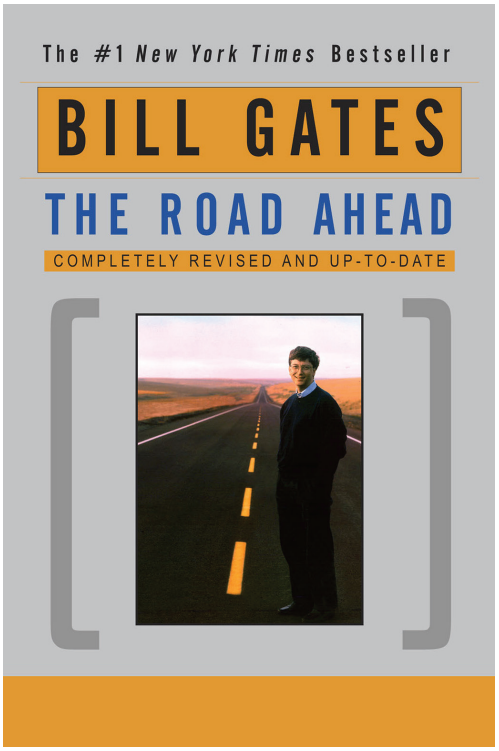


Gates Notes

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CHAPTER 4

INFORMATION APPLIANCES AND APPLICATIONS

When I was a kid, *The Ed Sullivan Show* came on at eight o'clock on Sunday nights. Most Americans with television sets tried to be at home to watch it because that might be the only time and place to see the Beatles, Elvis Presley, the Temptations, or that guy who could spin ten plates simultaneously on the noses of ten dogs. But if you were driving back from your grandparents' house or on a Cub Scout camping trip, too bad. Not being at home on Sunday nights at eight meant that you also missed out on the Monday morning talk about Sunday night's show.

Conventional television allows us to decide what we watch but not when we watch it. The technical term for this sort of broadcasting is "synchronous." Viewers have to synchronize their schedules with the time of a broadcast that's sent to everybody at the same time. That's how I watched *The Ed Sullivan Show* thirty years ago, and it's how most of us will watch the news tonight.

In the early 1980s videocassette recorder gave us more flexibility. If you cared enough about a program to fuss with timers and tapes in advance, you could watch it whenever you liked. You could claim from the broadcasters the freedom and luxury to serve as your own program scheduler—and millions of people do. When you tape a television show, or when you let your answering machine take an incoming message so that you don't have to pick up the phone, you're converting synchronous communications into a more convenient form: "asynchronous" communications.

It's human nature to find ways to convert synchronous communications into asynchronous forms. Before the invention of writing 5,000 years ago, the only form of communication was the spoken word and the listener had to be in the presence of the speaker or miss his message. Once the message could be written, it could be stored and read later by anybody, at his or her convenience. I'm writing these words at home on a summer evening, but I have no idea where or when you'll read them. One of the benefits the communications revolution will bring to all of us is more control over schedules.

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Once a form of communication is asynchronous, you also get an increase in the variety of selection possibilities. Even people who rarely record television programs routinely rent movies from the thousands of choices available at local video rental stores for just a few dollars each. The home viewer can spend any evening with Elvis, the Beatles—or Greta Garbo.

Television has been around for fewer than sixty years, but in that time it has become a major influence in the life of almost everyone in the developed nations. In some ways, though, television was just an enhancement of commercial radio, which had been bringing electronic entertainment into homes for twenty years. But no broadcast medium we have right now is comparable to the communications media we'll have once the Internet evolves to the point at which it has the broadband capacity necessary to carry high-quality video.

Because consumers already understand the value of movies and are used to paying to watch them, video-on-demand is an obvious development. There won't be any intermediary VCR. You'll simply select what you want from countless available programs.

No one knows when residential broadband networks capable of supporting video-on-demand will be available in the United States and other developed countries, let alone in developing countries. Many corporate networks already have enough bandwidth, but as I'll explain in chapter 5, even in the U.S. most homes will have to make do for some time—maybe more than a decade—with narrowband and midband access. Fortunately, these lower-capacity bandwidths work fine for many Internet-based services such as games, electronic mail, and banking. For the next few years, interactivity in homes will be limited to these kinds of services, which will be delivered to personal computers and other information appliances.

Even after broadband residential networks have become common, television shows will continue to be broadcast as they are today, for synchronous consumption. But after they air, these shows—as well as thousands of movies and virtually all other kinds of video—will also be available whenever you want to view them. If a new episode of *Seinfeld* is on at 9:00 P.M. on Thursday night, you'll also be able to see it at 9:13 P.M., 9:45 P.M., or 11:00 A.M. on Saturday. And there will be thousands of other choices. Your request for a specific movie or TV show episode will register, and the bits will be routed to you across the network. It will feel as if there's no intermediary machinery between you and the object of your interest. You'll indicate what you want, and presto! you'll get it.

Movies, TV shows, and other kinds of digital information will be stored on "servers," which are computers with capacious disks. Servers will provide information for use anywhere on the network, just as they do for today's Internet. If you ask to see a particular movie, check a fact, or retrieve your electronic mail, your request will be routed by switches to the server or servers storing that information. You won't know whether the movie, TV show, query response, or e-mail that arrives at your house is stored on a server down the road or on the other side of the country, and it won't matter to you.

The digitized data will be retrieved from the server and routed by switches back to your television, personal computer, or telephone—your "information appliance." These digital devices will succeed for the same reason their analog precursors did—they'll make some aspects of life easier. Unlike the dedicated word processors that brought the

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first microprocessors to many offices, most of these information appliances will be general-purpose, programmable computers connected to the network.

Even if a show is being broadcast live, you'll be able to use your infrared remote control to start it, stop it, or go to any earlier part of the program, at any time. If somebody comes to the door, you'll be able to pause the program for as long as you like. You'll be in absolute control—except, of course, you won't be able to forward past part of a live show as it's taking place.

Most viewers can appreciate the benefits of video-on-demand and will welcome the convenience it gives them. Once the costs to build a broadband network are low enough, video-on-demand has the potential to be what in computer parlance is called a "killer application," or just "killer app"—a use of technology so attractive to consumers that it fuels market forces and makes the underlying invention on which it depends all but indispensable. Killer applications change technological advances from curiosities into moneymaking essentials.

The term "killer application" is relatively new, but the idea isn't. Thomas Edison was as great a business leader as he was an inventor. When he founded the Edison General Electric Company in 1878, he understood that to sell electricity he had to demonstrate its values to consumers. Edison lit up the public's imagination with the promise that electric lighting would become so cheap that only the rich would buy candles. He correctly foresaw that people would pay to bring electric power in into their homes so that they could enjoy a great application of electric technology—light.

A number of additional applications for electricity quickly found popular acceptance. The Hoover Company sold an electric sweeping machine, and soon there were electric stoves, heaters, toasters, refrigerators, washing machines, irons, power tools, hair dryers, and a host of other laborsaving appliances. Electricity became a basic utility.

Sometimes an application that ends up being a killer application wasn't anticipated by the product's inventor. Avon Skin-So-Soft was just another lotion competing in a crowded market until somebody discovered that it repelled insects. Now it may still be sold for its original application—to soften skin—but its sales have increased because of its new application. And when Tim Berners-Lee invented the World Wide Web in 1989 as a way for high energy physicists to exchange information, he didn't foresee all the great applications that would be developed for it.

In the late 1970s the market for dedicated word processors grew incredibly fast, until it included more than fifty manufacturers with combined sales of more than $1 billion dollars annually. Word processing was a killer application of microprocessor technology. But within a couple of years personal computers appeared, and their ability to run different types of applications with something new. A PC user could quit WordStar (for years one of the most popular word processing applications) and start up another application, such as the spreadsheet program VisiCalc or the database management program dBASE. Collectively, WordStar, VisiCalc, and dBASE were attractive enough to motivate the purchase of a personal computer. They were killer applications for the first popular PCs.

The first killer application for the original IBM PC was Lotus 1-2-3, a spreadsheet tailored to the strengths of that machine. The Apple Macintosh's killer business applications were Aldus PageMaker for designing documents

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to be printed, Microsoft Word for word processing, and Microsoft Excel for spreadsheets. Early on, more than a third of the Macintoshes used in business and many of the Macs in homes were bought for one killer application—what became known as desktop publishing.

I use the term "application" quite broadly here. Microsoft Excel is an application, but so is home shopping or videoconferencing. Any type of World Wide Web use is an application, but no specific use is a killer application yet because none of them alone is driving large numbers of people to hook up to the Internet. The attraction of the Web is its breadth of uses and, in its early days at least, its novelty. But information retrieval, education, entertainment, shopping, and e-mail will in time become killer applications for the Internet.

Allowing people to connect to the Internet through a variety of information appliances will be critical to making Internet use a mainstream activity. In the years ahead we'll see a proliferation of digital devices that will take on different forms and communicate at different speeds, enabling each of us to stay in touch over the net with other people as well as with information of all kinds. We'll use new versions of familiar tools—telephones, TVs, PCs, white boards, notebooks, wallets—to take command of information and reshape the media that make up much of our daily life: books, magazines, newspapers, video, music, telephones, games, even the art on the walls. We don't know exactly what all of the successful appliances will look like, but we do know that as technology evolves an increasing number of the appliances will be general-purpose, programmable computers connected visibly or invisibly to the net.

This idea that general-purpose computers will prevail deserves more attention. When the multifaceted PC won the word processing market away from Wang's dedicated machines, it was the triumph of the general-purpose microcomputer over the special-purpose microcomputer. A "word processor" was no longer a physical machine; it was a software application. The telephone answering machine underwent the same transformation, evolving into voicemail, a software application running on a computer (often at a telephone company's central office). When video-on-demand finally becomes available, the home movie player will undergo the same evolution, from a special-purpose tape recorder (VCR) to a software application running on a computer connected to a communications network.

There are many other examples of the evolution of a tool from special-purpose hardware into software running on general-purpose hardware. The first wave of the microprocessor revolution brought us machines that imitated older tools: electronic cash registers replaced mechanical cash registers, electronic calculators replaced adding machines, and electronic games replaced a lot of physical objects including playing cards and pinball machines. In the second wave, microprocessors came into their own as the hearts of general-purpose PCs that made special-purpose machines unnecessary. Thanks to software, a single machine could assume many guises, with consumers benefiting from the consequent competition in mass-market economies. Software applications taught computers to function as cash registers, calculators, and games, not to mention word processors, spreadsheets, databases, and telephone answering systems. A general-purpose computing machine, the dream of Charles Babbage, could do it all.

As the Internet matures, there will be dozens of new consumer machines, many of them devoted to a single purpose. Home audio gear will evolve. New kinds of game machines will come and go, with many of the most popular models featuring modems and software that will let players connect up to the Internet and play or browse

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from different locations. High-end telephones will have screens that display information, including yellow pages advertising. Various companies will promote terminals specifically for Web browsing. Cellular phones and pagers will get more powerful. Some of these special-purpose devices will find a place in the market for a few years, but in the long run almost all of them will give way to programmable, general-purpose devices—"computers"—connected visibly or invisibly to the network.

This evolution from special-purpose devices to general-purpose devices will be apparent in the successive generations of set-top boxes that will connect TV sets to networks. Conventional set-top boxes are tuners that receive analog signals from as many as dozens of cable channels and pass signals from one of the channels at a time on to your television set. If you've paid to watch channels that are scrambled, the set-top box unscrambles them. A generation of set-top boxes reaching the mass market in about 1997 will have the additional ability to handle compressed digital video signals, which will substantially increase the number of channels that can be received and also support Internet browsing. Eventually your television set will connect to the net via a new set-top box that will be a very powerful general-purpose computer—and might not be set on the top of the TV at all. It might be located inside a television, behind a television, on top of a television, on a basement wall, or even outside the house. Your TV, like your PC, will connect to the network and conduct a "dialogue" with the net's switches and servers, relaying your choices and retrieving information and programming.

Personal computers will continue to evolve, getting easier to use and less expensive. Within a few years, many people won't think of a home PC as a computer as much as they'll think of it as a simple tool for accomplishing a number of tasks, including entertainment tasks.

However much like a PC the TV becomes, and vice versa, there will continue to be a critical difference between the way a PC is used and the way a TV is used: the distance from which they are viewed. Today more than a third of U.S. households have personal computers (not counting game machines). Eventually almost every home will have at least one PC connected directly to the net. This is the appliance you'll use when details count or when you want to type. It will put a high quality monitor a foot or two from your face so that your eyes can focus easily on text and other small images. A big-screen TV across the room doesn't lend itself to the use of a keyboard, and it doesn't give you any privacy, although it's ideal for applications that multiple people watch at the same time.

Set-top boxes and PC-interface equipment will be designed so that even the oldest television sets as well as the most current personal computers can be used on the interactive network, but new TVs and PCs will offer better pictures. The quality of the images on today's TV sets is quite poor compared to the quality of pictures in magazines or the quality of the images on movie theater screens. While U.S. television signals can transmit 486 lines of picture information, not all of those lines are distinguishable on most sets, and the typical home VCR can record or play back only about 280 lines of resolution. That's why it's so difficult to read the credits at the end of a movie on a television set. Conventional television screens are also a different shape from most movie theater screens. Our TVs have an "aspect ratio" (the relationship of picture width to height) of 4 to 3, meaning that a picture is somewhat wider than it is tall. Feature films are typically made with an aspect ratio of about 2 to 1—twice as wide as they are tall.

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High-definition television (HDTV) that offers more than 1,000 lines of resolution, with better color and a 16 to 9 aspect ratio, has been demonstrated, and it's beautiful to see. But despite the efforts of both government and industry in Japan, where the analog technology was created, HDTV didn't catch on because it required expensive new equipment for both broadcasting and receiving. Advertisers wouldn't pay extra to fund HDTV because it doesn't make ads measurably more effective. However, digital forms of HDTV might still catch on because the broadband network will allow video to be received at multiple resolutions and aspect ratios. The idea of adjustable resolution is familiar to users of personal computers, who can choose 480 lines of resolution (called VGA) or higher resolutions of 600, 768, 1,024, or 1,200 horizontal lines, depending on what their monitors and display cards can support.

Both TV screens and PC screens will continue to improve in quality. Most will be flat-panel displays. A new kind of screen will be the digital white board: a large wall-mounted screen, perhaps an inch thick, that will take the place of today's blackboards and white boards. The digital white board will display pictures, movies, and other graphical information, as well as text and other fine details. People will be able to draw or write notes and lists on it. The computer controlling the white board will recognize handwritten notes or lists and convert the handwriting into a readable typeface. The digital white board will show up first in conference rooms and then in private offices and even homes.

Telephones will connect to the same networks as the PCs and TVs. Many phones will have small, flat screens and tiny cameras. Otherwise, though, they'll look more or less like today's phones. Kitchens will continue to have wall phones that conserve counter space. You'll sit close to the phone and look at a screen that shows the person you're talking to—or at a stock picture he or she transmits instead of live video. Technologically, the phone hanging over a dishwasher tomorrow will have a lot in common with the set-top box in the living room and the personal computer in the den, even though it will assume the form of a phone. Under the hood, many of the information appliances will have pretty much the same computer architecture.

In a mobile society, people need to be able to work efficiently while they're on the road. Two centuries ago a traveler could carry a "lap desk," a hinged writing board attached to a thin mahogany box with a drawer for pens and ink. When folded, it was reasonably compact, and when opened, it provided an ample writing surface. *The Declaration of Independence* was written on a lap desk in Philadelphia, a long way from Thomas Jefferson's Virginia home. The need for a portable writing station is met today by the laptop, a folding, lap-size personal computer. Many people who work from both office and home—including me—choose a laptop (or a slightly smaller computer, known as a notebook) as their primary computer. In the office, the small computer can be connected to a large monitor and to the corporate network. Notebook computers will continue to get thinner until they are about the size of a tablet of paper.

Notebooks are the smallest and most portable real computers today, but we'll soon have pocket-size computers with snapshot-size color screens. When you whip one out, nobody will say, "Wow! You've got a computer!"

What do you carry on your person now? Probably at least keys, identification, money, and a watch. And maybe credit cards, a checkbook, traveler's checks, an address book, an appointment book, a notepad, something to

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read, a camera, a pocket tape recorder, a cellular phone, a pager, concert tickets, a map, a compass, a calculator, an electronic entry card, photographs, and maybe a loud whistle to call for help.

You'll be able to keep equivalent necessities—and more—in an information appliance I call the wallet PC. It will be about the same size as a wallet, which means you'll be able to carry it in your pocket or purse. It will display messages and schedules and let you read or send electronic mail and faxes, monitor weather and stock reports, and play both simple and sophisticated games. At a meeting, you might take notes, check your appointments, browse information if you're bored, or choose from among thousands of easy-to-call-up photos of your kids.

Rather than hold paper currency, the new wallet will store unforgeable digital money. Today when you hand somebody a dollar bill, a check, a gift certificate, or some other negotiable instrument, the transfer of paper represents a transfer of funds. But money doesn't have to be expressed on paper. Credit card charges and wired funds are exchanges of digital financial information. Tomorrow the wallet PC will make it easy for anyone to spend and accept digital funds. Your wallet will link into a store's computer to allow money to be transferred without any physical exchange at a cash register. Digital cash will be used in interpersonal transactions too. If your son needs money, you might slip five bucks from your wallet PC into his digitally.

When wallet PCs have become ubiquitous, we can eliminate the bottlenecks that plague airport terminals, theaters, and other places where people queue up to show their identification or a ticket. As you pass through an airport gate, for example, your wallet PC will connect you to the airport's computers and verify that you've paid for a ticket. You won't need a key or a magnetic card key to get through doors either. Your wallet PC will identify you to the computer controlling the lock.

As cash and credit cards begin to disappear, criminals may target wallet PCs, so that will have to be safeguards to prevent a wallet PC from being used in the same way a stolen credit card can be. The wallet PC will store the "keys" you'll use to identify yourself. You'll be able to invalidate your keys easily, and you'll be able to change them regularly. You might have to enter a password at the time of important transactions. Automatic teller machines ask you to provide a personal identification number, just a very short password, now. An option that would eliminate the need for people to remember passwords would be using biometric measurements—such as voiceprints or fingerprints—for security. A person's biometric measurements are more secure than passwords and will almost certainly protect some wallet PCs.

In a biometric security system, your wallet PC might demand that you read out loud a random word it flashes on its screen or that you press your thumb against its side whenever you're about to conduct a transaction that has significant financial implications. The wallet will compare what it "heard" or "felt" with its digital record of your voiceprint or thumbprint.

Wallet PCs with the right equipment will be able to tell you exactly where you are anyplace on the face of the earth. The Global Positioning System (GPS) satellites that orbit Earth right now broadcast signals that enable jetliners, oceangoing boats, cruise missiles, some cars—and even hikers with handheld GPS receivers—to know their exact locations. Such devices are currently available for a few hundred dollars, and eventually they'll be built into

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many wallet PCs.

The wallet PC will connect you to the interactive network while you travel and tell you where you are. A voice from its built-in speaker will let you know that a freeway exit is coming up or that the next intersection has frequent accidents. It will monitor digital traffic reports and warn you that you'd better leave for the airport early, or it will suggest an alternative route. The wallet PC's color maps will overlay your location with whatever kinds of information you want—road and weather conditions, campgrounds, scenic spots, even fast-food places. You might ask, "Where's the closest Chinese restaurant that's still open?" and the answer will be transmitted to your wallet by wireless network. Off the roads, on a hike in the woods, the wallet PC will be your compass and as useful as your Swiss Army knife.

In fact, I think of the wallet PC as the new Swiss Army knife. I had one of those knives when I was a kid. Mine wasn't the most basic, with just two blades, but it wasn't one of those with a workshop's worth of tools either. It had the classic shiny red handle with the white cross and lots of blades and attachments, including a screwdriver, a tiny pair of scissors, and even a corkscrew (although at the time I had no use for that particular accessory). Some wallet PCs will be simple and elegant and offer only the essentials— say, a small screen, a microphone, a secure way to transact business with digital money, and the capability to read or otherwise use basic information. Other wallet PCs will bristle with all kinds of gadgets—cameras, scanners that will be able to read type or handwriting, and receivers with the global positioning capability. Most wallet PCs will have a panic button you can press if you need emergency help. Some models will include thermometers, barometers, altimeters and heart-rate sensors.

Precursors of the wallet PC are on the market already. In addition to cellphones and pagers, hand-held computers pack a number of functions. Personal digital assistants (PDAs) are available from Sharp, Hewlett-Packard, PSION, and others. Some of the first generation PDAs were underpowered and didn't have software sophisticated enough to interest a broad set of users. Apple's Newton relied on handwriting and didn't live up to the high expectations Apple set for it. Microsoft didn't even bring its software for first generation PDAs to market. A better generation of PDAs is reaching consumers beginning in 1997, and I expect a big market to develop over time.

The simplest precursor of the wallet PC, already popular in Europe, is the so-called smart card. It resembles a credit card but has a microprocessor embedded right inside its plastic. The smart card of the future will identify its owner and store digital money, tickets, and medical information. It won't have a screen, audio capabilities, or any of the elaborate options of the more expensive wallet PCs. It will be handy for travel or as a backup to a wallet PC, and it may be sufficient by itself for some people's uses.

Prices for wallet PCs will vary widely, just as the prices of cameras vary today. Simple, single-purpose smart cards for digital currency will cost about what a disposable camera does now, whereas a really sophisticated wallet PC might cost what an elaborate camera does now, $1,000 or more.

If you aren't carrying a wallet PC, you'll still have access to the interactive network at kiosks—some free, some requiring payment of a fee—in office buildings, shopping malls, and airports, in much the same way that drinking fountains, rest rooms, and pay phones are available now. These kiosks will replace not only pay phones

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but also banking machines. They'll offer many other network applications, from sending and receiving messages to buying tickets. Some kiosks will display advertising links to specific services when you first log on—the way phones in airports connect you directly to hotel and rental car desks now. Kiosks will be rugged devices on the outside and PCs on the inside.

No matter what form the PC takes, from wallet to desktop to kiosk, users will still have to be able to navigate their way through its applications. Today's PCs and the Internet don't make this easy enough. Neither do television remote controls. Future systems with more choices will have to do better than make you go step-by-step through all the options. Instead of having to remember the channel of a TV program, you'll have the ability to use a graphical menu that will let you select what you want by pointing to an easy-to-understand image.

Eventually we'll be able to speak to televisions, personal computers, or other information appliances. At first we'll have to stick to a limited vocabulary, but eventually our exchanges with our appliances will become quite conversational. The speech recognition capability requires powerful hardware and software because talk that a human can understand effortlessly is very hard for a computer to interpret. Speech recognition works fine already for a small set of predefined commands, such as "Call my sister," but it's much more difficult for a computer to decipher a sentence it isn't prepared for. Within the next ten years computers will do a far better job, in part because they'll read your lips as well as listen to you speak (it's easier to understand someone if you can watch his lips move).

Lip reading will be one benefit of the video cameras that will become standard PC equipment once videoconferencing is popular. A camera will also let the PC recognize who is using it so that the PC can better anticipate the person's needs or carry out policies. For example, a PC might refuse to respond to a person it didn't know, or it might decline to connect to an adult Web site if it "saw" that a child was nearby. Video cameras will also allow "gesture input." When you nod or shake your head, turn thumbs down, or wave good-bye, your PC will know what you mean.

Some users will find it convenient to handwrite instructions to a computer. Many companies, including Microsoft, have spent some years working on what we call "pen-based computers" that are capable of reading handwriting. I was overly optimistic about how quickly we'd be able to create software that would recognize the handwriting of a broad range of people. The difficulties turned out to be quite subtle. When we tested the systems ourselves, it worked well, but new users continued to have trouble with it. We discovered that we were unconsciously making our handwriting neater and more recognizable than usual. We were adapting to the machine rather than demanding that the machine adapt to us. Once, when the development team thought they had finally created a program that worked, they rushed over to my office to demonstrate their achievement. But what had been working for them didn't work for me. It turned out that everybody on the project happened to be right-handed, and the computer, which was programmed to look at the strokes in the writing, couldn't interpret the very different strokes in my left-handed penmanship. Getting a computer to recognize handwriting is as difficult as getting one to recognize speech. But even though the challenges have proved greater than I believed they were at first, I remain confident that we can find a solution and that the ultimate market for pen-based computers will be huge. In the future lots of people will be taking

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handwritten notes on computer tablets rather than paper.

Whether you give a command by voice, in writing, or by pointing, you probably won't stand for being confused or frustrated or for having your time wasted. The interactive network's software will have to make it almost infallibly easy to find information, to navigate, even when users don't know exactly what they're looking for.

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