



Michael Dertouzos, director, MIT Laboratory for Computer Science

The unfinished revolution

If you think the astonishing wave of change you've been living through has run its course, think again, says this digital guru. The very nature of information technology is about to be redefined.

Michael Dertouzos is an anomaly in today's work world in at least this respect: He's held the same job for more than 25 years. And what a job to hold: Dertouzos is director of the MIT Laboratory for Computer Science, the research facility responsible for some of the world's greatest information technology breakthroughs.

Over the years the lab's scientists have made it possible for multiple users to access networked systems, have produced the advanced math that keeps information secure and even have created the underpinnings of the Internet itself. Dertouzos himself is no mere administrator; he personally has several startup companies and technology patents to his credit, including Computek, a small firm that built the first intelligent termi-

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nals, and the patent for the parallel thermal printer.

What kind of person does it take to stay at the forefront of information technology for a quarter of a century? Dertouzos is quick to demur: "I'm not a futurist, you know." It's an interesting claim from a man whose last book was titled *What Will Be: How the New World of Information Will Shape Our Lives* (HarperSanFrancisco, 1997).

But, Dertouzos explains, "I only forecast things we are actually building." What's more, his experience with the self-avowed futurists writing today—we won't name any names, but the world is crawling with them—is that they, too, simply call the MIT lab and ask what its researchers are working on, and then promptly issue their predictions.

So what is Dertouzos & Co. working on these days? *Outlook* Senior Contributing Editor Julia Kirby got a hint of the future when she visited the scientist in his Cambridge, Massachu-

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setts, lab in April 2000 and not only interviewed Dertouzos but also had a dialogue with the lab's computers.

As a quick introduction to "speech understanding" technology (a generational leap beyond voice recognition), Dertouzos placed a quick phone call to one computer, named Jupiter, to get a weather forecast, and then to another, named Pegasus, to inquire about airline flights. The systems required no special interface or terminology to process these casual inquiries; instead, they responded to questions posed in conversational style ("So how's the weather in Cleveland today?") with immediate, spoken answers. As Dertouzos summed up: "Now that's a humongous difference from what we have today."

Speech understanding is just one of the technologies the lab is developing in an attempt to achieve "human-centric computing." Dertouzos and his colleagues consider today's information systems to be the most rudimentary of tools. For the most part, they say, computers still require us to do the bulk of the work we are using them to accomplish, such as defining the problem in terms the computer can understand, or typing into a keyboard rather than speaking.

To set the course toward technologies that will deliver true utility, the lab has designed its biggest project ever. Funded primarily by the US government to the tune of \$40 million, it is audaciously named Oxygen. Much of the work will be done in a new headquarters—the William H. Gates Building—thanks to a \$20 million gift from Gates's private foundation.

Oxygen's aim is to simultaneously develop and pull together a variety of technologies that will help all of us "do more by doing less" (a favorite Dertouzos phrase). Part of making that

a reality will be the creation of a pervasive worldwide computing system, through which people will be able to link up with other people and with information sources—at work, at home, in the car, walking down the street—using handheld portable devices. Dertouzos took great pleasure in describing how it will all work.

Outlook: For a long time you've been using a term—the "information marketplace"—to describe where the world was headed with information and communications technology. Are we there yet?

Dertouzos: It *has* been a long time. I was saying this 20 years ago! And at that point I was ridiculed. When the book came out [in 1997], there was still a little bit of ridicule. Now there's very little. But really, not much has been achieved as yet; 95 percent remains to be done.

In what sense?

I'm not talking about more people or more equipment. I'm talking about the very nature of this marketplace. Most people think we're already there, and to them I would only say, "You haven't seen anything yet, baby." The information marketplace is still going to change very dramatically.

Some of us were hoping that we might get the chance to catch our breath!

That's what you think because you're in the frying pan, and the oil is sizzling all around you. You think things are changing faster than they ever have. But actually, this movement is not that much faster than the Industrial [Revolution]. It started in the 1950s or '60s, so we're half a century into computing. I looked at where we were half a century into the Industrial Revolution, and it's tracking very closely. By the time we make machines that are truly easy to use

and truly helpful to us, we've got another century to go.

Why will it take so long?

[Computing] still has to penetrate—just like the motor and electricity did—into every single activity, every single office, all the sectors of the GNP. Eventually there will be so much penetration that it will vanish. Just as you don't see any penetration of motors in your life even though you may have 400 of them in your home, and you don't see any penetration of electricity—just light and heat—it will become totally subconscious.

So where are we now?

Right now all of this technology is still in a “wow!” stage and very noticeable. It's going to move from that to business as usual. And when that happens, that's when you'll know we've matured. People will just use these machines and systems without thinking of them. They'll refer to them not as computers or communications or with some obscure acronyms; they'll speak of them in terms of what they do, just like we speak of the refrigerator. But again, that's a long way off. And if I look at where we are now, it's just about where we were 50 years into the Industrial Revolution. So we're not moving that fast.

Where does Oxygen fit in?

Oxygen is precisely aimed at achieving that penetration. And it uses a variety of technologies to achieve that, focusing on automation, speech understanding, information access, collaboration and customization. Most importantly, it's a system that is human-centric: It is trying to be easy to use and to offer true utility. It is trying to come from the lowly levels of today's computer systems up to the lofty levels of the human being.

What do you mean by “human-centric”? Don't systems builders

today strive for user-friendliness and ease of use?

The Web and the Internet don't do anything for you! You do it all. You go there and you squint, you think, you labor with your fingers on the keyboard and get carpal tunnel syndrome. You don't have anything approaching the bulldozer the Industrial Revolution gave us to help with the heavy lifting.

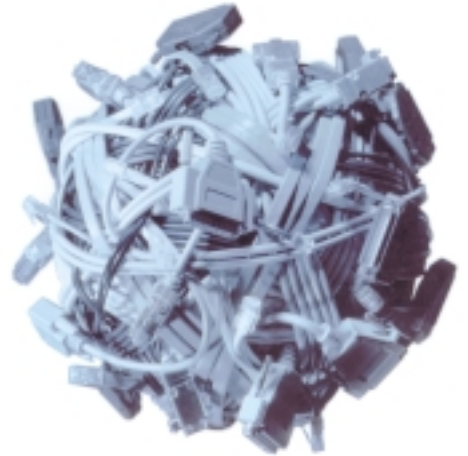
You can't, for example, just say, “Go find the cars that have the greatest rear-seat legroom and the highest horsepower and the lowest cost, and give me the top three.” And there are about 10 different reasons you can't. First of all, [cars] are not organized in any tables you can search, and there is no standard terminology being used.

And Oxygen will remedy that?

[We are using] things we call semantic webs. We'll have ways of relating synonyms to each other so that if General Motors calls it horsepower and Toyota calls it power and BMW calls it *Macht*, and one of them is in watts and another is in HP terms, we can multiply the right things and get the comparison. But that's just one of the problems: getting synonyms to work without forcing everybody to follow a centralized dictionary—which they would never do.

What else is missing?

Automation. Imagine leaving your home and taking your little portable with you but saying to it, “Don't bug me unless it's my husband, my child or my best friend.” Imagine—*bang!*—that becomes an automated procedure, and the Web does it for you. What if I could pick up the phone and say, “Take us to Athens next weekend.” Saying that takes three seconds. If the machine then does all the work, it gives me a 10,000 percent productivity improvement during those few minutes. That's automation, and we don't have it.



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How far away from that are we?
A year and a half to two years from now, you should see one of the first Oxygen systems being put together. You'll be able to sit in your room and say things like, "From now on, block all calls from Michael." Or, "The next article on hypertension that appears on MEDLINE, alert me." You will do it all orally, and then lots of things will start happening in the machine. Automation procedures are being set up, information access techniques are being used. It's doing a lot of work for you.

I've also heard Oxygen described as a "worldwide pervasive computing system." What does that mean?
Right now I have a wireless network in my home, which means I can carry my machine anywhere within 200 feet—I can go out to the pool or whatever—and still have access. The machine is able to sniff out the network and tap into it. In the future, you'll have this as you're traveling. You'll pull out your portable and—let's say you're at Accenture headquarters—your portable will sniff the air and say, "My goodness, there's a high-speed network here—and at half a gigabit per second, I'm going to ride it!" And boy, it's riding that network, so the things that appear on your little screen are instant, they're colorful, it's working gorgeously.

Then you leave your office and someone rings you up as you're heading towards your car. Now the portable sniff-sniffs and finds the so-called campus network, which is extended and connects some of your buildings. Now instead of half a gigabit, it can get maybe 20 megabits per second. (I'm talking [about] the future here—these numbers are about 10 times higher than today.)

Once you enter your car, though, you're back into high speed, because your car has a nice big machine in

the trunk and a big antenna. Maybe you're in France, and later you're out on the streets of Montmartre when the thing rings. Well, guess what—it's geocentelephony. *Whoosh!* It drops all the way down and captures the highest available resource.

You draw a very optimistic picture of the future. Is there anything about the evolution of information and communications technology that's causing you dismay?

It's coincidental you should ask, because just today we held a meeting on developing nations and on what is my biggest, biggest, biggest concern: the rich/poor gap.

Some people like to call it a "digital divide," but it's more fundamental than that. It's the classic rich/poor gap that anyone who reads their history knows about—and it's got the same problems and the same possibilities. And if we let it increase, you know what will happen: blood. And not just in Bangladesh but in Cleveland and Boston and New York, because the ghettos are in the same position as Bangladesh relative to this gap.

The "worldwide" Web is currently just 2 percent of the world, so some modesty behooves us. When we look at what we have, it's the rich folks that are hooked up. And we won't really be able to do more by doing less—which is the objective of this information revolution, just like every other revolution that aspires to be a socioeconomic revolution. We'll never get there if the "we" is 2 percent of the world. We have to make sure that the rest of the world gets interconnected. And that is very difficult. So difficult that you might even say it was approaching the impossible. You ask what worries me—that worries me.

You've commented on occasion about the media's tendency to miss the

really important stories about technology while focusing on froth.

What are they missing now—or focusing too much attention on?

Right now, everybody's hyperventilating about Time Warner and AOL, and everybody's hyperventilating about content. Well, content is important; we all love TV and movies and radio, we all love newspapers and books. But all these things taken together—all the content in the world that is centrally manufactured and distributed—is less than 4 percent of the industrial economy. That's what everybody's hyperventilating about.

Meanwhile, no one's paying any attention to the huge shift we are seeing in collaborative activity and the proffering of human work at a distance. And this is how the growing information marketplace will have an enormous impact on the economy.

Between 50 and 60 percent of the industrial world's economy is in what used to be called white-collar work and what today is called office work. You know what that includes: everything in sight, from health care to government to education to finance to the office side of manufacturing and then to myriad services, business-to-business and business-to-individuals, and so on. It's the office work that makes our economy tick—it's three times as big as manufacturing today.

How will that part of the economy be transformed?

What we'll see is the increasing use of this information marketplace to proffer human work across and within national boundaries. You're going to have, for example, the 50 million Indians who speak, read and write English proffering their work at a fraction of the cost of American labor.

And this is already beginning. For example, Indian M.D.s, who understand

perfectly what the [American] doctor is saying, are already transcribing dictations from American doctors at one-third the cost of American secretaries. The transmission both ways happens electronically, so the doctor can dictate something in his little microphone and two hours later have text.

That is a small example of what you will see in droves, and not just from poor to rich. You'll see it from rich to rich. An American office worker—an insurance adjuster, for example, or a reviewer of mortgage applications—could take off and go to their house in New Hampshire at the lake and from there proffer their services to 20 clients.

Hearing you talk about the hard work ahead, somehow it all sounds like fun.

You called me an optimist, and I am optimistic. I'm very optimistic about human nature because all my study of history leads me to be so. And I think we are doing better; to my thinking we've been progressing well. So why be a pessimist? And anyway, if you're a pessimist, everyone forgets about you. If you're an optimist, you have to deliver. ■

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