
HIGH-TECH HUMANIST



It was Stevie Wonder who wanted one. He had been a loyal user of Ray Kurzweil's reading machine, an extraordinary device that looks like a photocopier but reads books out loud to the blind. He invited Ray out to his house in Los Angeles one day and told him that, much as he enjoyed the reading machine, what he would *really* like was a keyboard synthesizer that would reproduce the sounds of a piano, as well as those of every other instrument in the orchestra. Of course, no such machine existed. No one had ever even come close to duplicating electronically the unique sound of a piano, let alone that of other instruments. But that didn't faze technology's wunderkind Ray Kurzweil. With the quiet understatement befitting a man who has accomplished everything he has ever attempted, he replied softly, "I think I can do that."

And exactly a year after he embarked on the project, Ray produced, in June 1983, a working model of the Kurzweil 250, a digital synthesizer that does indeed reproduce with uncanny accuracy the sound of a \$25,000 Steinway grand piano, from the reverberant bass up through the plinking treble, with all of a grand's lingering richness. It looks like a snappier version of the usual electric keyboard, done in a glossy black that has one thinking "grand piano" even before the first note sounds. The keys are designed to reproduce a Steinway's action. Yet at the press of a button one can bring forth from the same keys a string quartet, a trumpet blast, a choral group, even a drum set, or any of one hundred instruments, plus a variety of other sounds the musician can enter into the computer himself.

RAY KURZWEIL'S COMPUTERS EXPLORE THE WORLD OF THE SENSES

BY JOHN SEDGWICK
PHOTOGRAPHS BY BENNO FRIEDMAN

Says Larry Bodony, one of the engineers of the 250, "We didn't figure we had done our job until you could close your eyes when you heard the sound and see the instrument." And you can. In fact, as commentators have noted, a player's chief reaction is trying to figure out where Ray has hidden all those instruments. Testing out the 250 at a major music convention last June, Robert Moog, the inventor of one of the first and most famous electronic synthesizers, acclaimed its "complete

realism" and "complete accuracy of control." Since then, Lyle Mays, keyboard player for the Pat Metheny jazz group, has tried it out. "I'm *really* excited," he exclaims. "It allows me to play on the keyboard anything from piano to strings to drums. It's fantastic! I can think orchestrally while playing the keyboard. I've never gotten such a powerful feeling from an instrument."

Judgments on these matters are notoriously subjective, of course. Classically

trained musicians may detect, however faintly, the timbre of a synthesizer. But the original customer is very pleased. Stevie Wonder played the Kurzweil for two hours this fall and was only sorry that it hadn't been available in time to use on his latest record album.

In his unassuming way, the thirty-six-year-old Ray Kurzweil is inventing the future, not just in musical instruments, but in equipment for the handicapped, in office systems, and in other fields he is

The realistic sounds of the Kurzweil 250, left, are a musician's dream come true. The inventor, below, composing at a different keyboard.



RAY'S TIME IS HIS COMPANY'S CHIEF RESOURCE.

only beginning to ponder. This isn't the future as seen in *Star Wars* or *2001*, a sci-fi vision that is so arresting because it is so disconnected from everything we have ever known. Rather, it is a future that, while just as dazzling as the amazing Kurzweil 250, stems directly from the needs of the present. His is a future that sells.

Abe Zarem, a onetime group leader in the Manhattan Project and former head of Xerox Development Corporation, a Xerox subsidiary, calls Kurzweil "extremely gifted, a genius." Then, in a tone that makes clear this is the supreme accolade, "He's just good." Zarem reaches back with unabashed grandiloquence to the classic inventors to describe him. "Ray has the inventive spirit of Firestone, the mastery of details of Edison, and the daring of Marconi."

Kurzweil is not content merely to invent new gadgets. He wants to develop and market them as well, and in this he is

taking the role of inventor into new territory. "You can't just spring a new machine on the world," he says. "You have to make sure it addresses a problem that people need solved. And it has to be easy to use. It's one thing to develop a machine that can sound like a piano. It's another to make one that musicians can operate without being computer technicians." Vincent Fulmer, a senior administrator at Kurzweil's alma mater, the Massachusetts Institute of Technology, has observed graduates of the school for thirty years. He puts Kurzweil in a class with Intel's Robert Noyce and Kenneth Olsen, the founder of Digital, as "one of the top ten young entrepreneurial geniuses" to emerge from the school in the last three decades, precisely for his combination of technical innovativeness and awareness of the demands of the market.

A quick study, Kurzweil has picked up other talents as well. He is said to be the fastest typist in his company, the best pro-

grammer; and there is the lurking suspicion in the minds of all his associates that he could do their jobs better than they. By branching out so widely from invention into marketing, Kurzweil has already had to master such new fields as corporate law, SEC regulations, bookkeeping, finance, and distribution. He writes promotional literature—"An important part of creating a company is defining what you're trying to do," he says. And he keeps his own appointment book, recognizing that his time is quite likely the company's most valuable resource.

We meet in his cramped office at Kurzweil Speech Systems, the company he has formed to develop his latest product, a voice-activated typewriter. Located in Waltham, the building also houses Kurzweil Music Systems, responsible for the 250. Kurzweil's own office is mostly a work station, with room for only a few personal touches, such as the wall full of framed citations for his reading machine (from the likes of Ronald Reagan, Governor Michael Dukakis of Massachusetts, and the American Library Association), art by Joan Miró, and a telescope pointed out the window toward the marsh outside—trained, I imagine, on the future.

Short, chubby, and tousle haired, Kurzweil looks oddly like a more compact version of John McEnroe, a neighbor from his hometown in Queens, New York. His businesslike manner and a certain weariness about his eyes make him seem older than he is. Indeed, the only vestiges of youth are a powerfully concentrated energy, a taste for fashionable Italian clothes, and a playful sense of humor that is put quickly in evidence when he hands me a recent production: a sheaf of poetry written by his computer in the style of various modern poets, including William Carlos Williams, T. S. Eliot, and Raymond C. Kurzweil. The cybernetic Eliot begins:

*Blessed sister, holy mother, spirit of
high sentence, but asserted by long fingers,*

*Asleep . . . tired . . . or throwing
off a dusk through narrow streets
And the cool of trivial things*

*In the unread vision in the golden
god,*

*Whose flute is not it, after tea and the
mind over the voice*

Because I mean!

Kurzweil taught this machine the phonetic rules of reading much as one would teach a child.



As I look it over, his face lights up with a look of what I come to recognize as Kurzweilian delight: his eyes wrinkle, his mouth curls into a grin. But the expression is gone as soon as I see it. It's like a light on a computer panel, registering the inner workings but not indulging them. "Some of the poems are interesting," he says, casually, and leaves it at that.

His interest in computerized poetry aside, Ray has many of the trappings of a normal life. He is happily married to a psychologist specializing in reading disabilities. He is devoted to his four-year-old son, Ethan (who has thoughtfully printed out the word DADDY in Dymotape on his father's battered briefcase). He plays classical piano but enjoys the Rolling Stones and watches MTV. He works out on an exercise bicycle and concentrates on his job. Nevertheless, he is not exactly a normal person. Geniuses never are.

Aaron Kleiner, a friend from MIT who is now his business associate, recalls that Ray was known as "The Phantom" because he was always off doing his own projects. One was a computer program to match students with colleges, which he



The electronics whiz makes the hop from Boston's "Silicon Valley," Route 128, to New York.

sold to Harcourt Brace Jovanovich for \$100,000 plus royalties his junior year. He seemed never to bother to study. It used to irritate Aaron the way Ray would ignore the lectures all semester, then borrow Aaron's course books for an hour or two

before the final exam and waltz off with an A.

Yet what appears to be breeziness is in fact an iron will to accomplish his objectives in the most efficient way possible. In business, once he has determined his

DEFINING A PROBLEM

THE CHALLENGE OF DEVELOPING THE KURZWEIL 250

We were asked to create a computerized keyboard instrument whose sound, when you pressed a button labeled PIANO, would be indistinguishable from a top-of-the-line acoustic grand piano. Similarly, if you pressed OBOE, DRUM SET, HUMAN VOICE, VIOLIN, or VIOLIN SECTION, it should not be possible to tell (without looking) if someone is playing a "real" oboe, et cetera, or playing from the keyboard.

Just what is the problem? Let's stay with a piano. Functionally, it is a collection of keys that have a distinctive, snappy feel when pressed, at which time they initiate "piano" sounds. Each sound depends on three factors: the key being struck, the force or velocity of the strike, and the state of the foot pedals.

The key determines pitch. The effect of force is associated with volume, but also with the character of the sound. Any tone results from the interaction of hundreds of vibrating strings, a soundboard, and other components—a composite of constituent sounds, each of

which has a rapidly varying sound spectrum. The sum of these sounds is called the "time-varying timbre" of a single piano note. There is such a time-varying timbre for every one of over 200 different loudness levels for every one of the eighty-eight keys.

Finding by hand these thousands of different sounds that a piano can create would not be feasible. We used, instead, "pattern recognition" techniques to analyze them automatically. (This process brings true artificial intelligence into play.) We recorded the actual instrument at many different pitches and levels of volume. Our automatic-analysis program pinpointed the salient patterns to create what we call a "contoured-sound model." This computer model of the piano is stored in our instrument's computer memory. When the keyboardist plays the keyboard, the built-in computer and other specialized hardware and software re-create in real time the original sounds.

In a similar manner we created con-

toured models for all the other featured sounds. The analysis program has been built into the instrument, so users can sample their own sounds (their own voice, a creaking door) and create their own contoured-sound models to initiate from the keyboard. Other capabilities, such as a twelve-track sequencer to allow simultaneous playback of the parts of a multiple composition (a Beethoven symphony, a rock number), now become relatively straightforward.

One last complication is the feel of the keys. In an acoustic grand piano, each key is attached to its own "action" mechanism, consisting of some ninety parts. We built analysis equipment to plot the mechanical displacement of a number of acoustic-piano actions to see exactly what happens during each millisecond of a typical strike. Then we designed a special action to duplicate the displacements we had observed.

How successful have we been? The results sound good to us, but we are not the final judges. —Raymond Kurzweil



Many blind users of the reading machine say they have come to think of its voice as Ray's.

course of action, he won't let anything stand in his way. It's just not in the plan. "I'm really very confident," he admits. "I honestly feel that the chance of my products not working out is very small." To others, though, such confidence sometimes seems more like blind faith. As Aaron Kleiner says, "When the glass is half-empty, Ray doesn't just call it half-full. He says it's all full, because he's sure we're going to fill it."

His confidence was put to the test during the development of his reading machine in the midseventies. Venture-capital funds were drying up so badly for untested companies like Kurzweil's that, as Kleiner recalls, "we were living on half a shoestring. Everybody in the company was eating eggs." When they were finally ready to issue a private offering to raise some desperately needed cash, they had no money to pay the telephone bill and keep the phone lines open so that investors could reach them. Ray went down to the pawnshop to hock some tape recorders. There, he encountered a woman with a dog, which suddenly leaped out at him, fangs bared, and ripped his trousers. Ray ran back to the office elated because the

woman had promised fifty dollars to pay for the damage. "Put it into the cash flow!" he exulted. "We've got fifty bucks."

It is because of such dedication, he says, that he always puts his name on his machines, though he has been criticized for doing so. "The name says that I'm strongly committed to anything I do," he explains. "I don't want to walk away from anything."

The name *Kurzweil* seemed to go with computers from the start. Although Ray is the son of a conductor for the Bell Symphony and an artist, he had decided by the age of five that he would be a scientist. "I used to invent things," he says. "Different types of boats, some spring-loaded devices, a special puppet theater with moving scenery. I had a scientific fantasy life. But I guess it grew more rooted in reality as I grew older." He encountered his first computer at age twelve, and it was love at first sight. That same year, he held, precociously, a summer job with New York's Institute for Developmental Studies analyzing test variants for a psychological project. One day he was asked to deliver some results to

the project's computer center. "The computer sort of intrigued me," says Kurzweil, "so I picked up some manuals." By the time the summer was out, he had devised a program to perform the work being done so laboriously by several rooms full of people, including himself, at the institute. The program was later distributed nationally by IBM.

Two years later Kurzweil went on to devise a program that would compose original music in the style of a variety of old masters. "The computer would analyze different melodies from the composer that I fed in," he explains, "make certain mathematical structures of the notes, and then generate music that would have the same relationships." Kurzweil says that when he applied this technique to Mozart, the compositions resembled less the master than "one of his third-rate students." Still, it wasn't bad for a computer, and his experiments with music won him seven national science awards.

Although Kurzweil didn't think of his efforts in these terms then, he was working in a field of artificial intelligence called pattern recognition. Essentially, it is the ability to discern the common denominator, or pattern, in a variety of different versions of the same thing. While the function may seem merely playful in the case of determining the Mozartean essence of Mozart, it is a critical element in the development of the next generation of computers, the ones that go beyond computing into actual reasoning.

And that is what has gone into the Kurzweil Reading Machine. Kurzweil became interested in developing such a device and got to work on it in earnest in 1974. Before it can read print out loud, the machine must recognize essential patterns: what, for example, makes an *a* an *a* in any type style? Kurzweil notes that Norbert Wiener's classic text *Cybernetics*, published the year Kurzweil was born, in 1948, alluded "fancifully" to a reading machine. "It's been one of those goals that's been out there, a 'someday' kind of thing," he says.

Pleased as Kurzweil must be to have solved one of the classic problems of the computer age, he professes greater pride that the machine is actually useful. On this score he must be gratified that the machine has been hailed as the greatest advance for the blind since Braille. Announced in 1976, the machine has still not been duplicated, although such corporate giants as IBM have tried.

In a later application of the relevant technology, he has come up with the Kurzweil Data Entry Machine to "read"

TODAY'S COMPUTERS ARE JUST "TIRELESS IDIOTS SAVANTS."

text into a computer for building corporate and government data bases and speeding up the transition from manuscript to print in publishing. And now he is working on an even bigger breakthrough, with his voice-activated typewriter (VAT). State-of-the-art models today have a tiny vocabulary and work with only one user, for whom they have been specifically trained, but Kurzweil is developing his VAT to work with any speaker, at a rate of 150 words a minute and with a vocabulary of 20,000 words for any one person.

It is his most ambitious project to date. To help him reach his goal, Kurzweil has lured eighteen specialists from fields ranging from linguistics and statistics to signal processing and psychoacoustics. The scale of the venture has caused Kurzweil to recast his role from his MIT days, when he assumed he could do everything himself. "The model of the mad inventor in the basement may still work occasionally," he says, "but I think that, increasingly, really worthwhile projects require complex interdisciplinary efforts. The individual is still very important in the concept and leadership and in providing a driving force. But no one can do it alone anymore."

Kurzweil's products augur a new era in the computer age. Despite the tremendous changes in society computers have already brought about, Kurzweil points out, they really don't do very much. "They're just tireless idiots savants. They are good for very simple calculations and record keeping and file management. But they have no true artificial intelligence. Computers are clearly superior to people in certain things, like remembering extremely accurately vast data bases of knowledge and doing things very quickly, and doing them over and over. But they've been very inflexible, and they lack even rudimentary intelligence. If you can combine low levels of intelligence like pattern or speech recognition with some basic understanding of the nature of the information the computer is dealing with, you have something very powerful."

Kurzweil is often called a visionary; his ability to see far beyond the present is one of the qualities that have attracted such

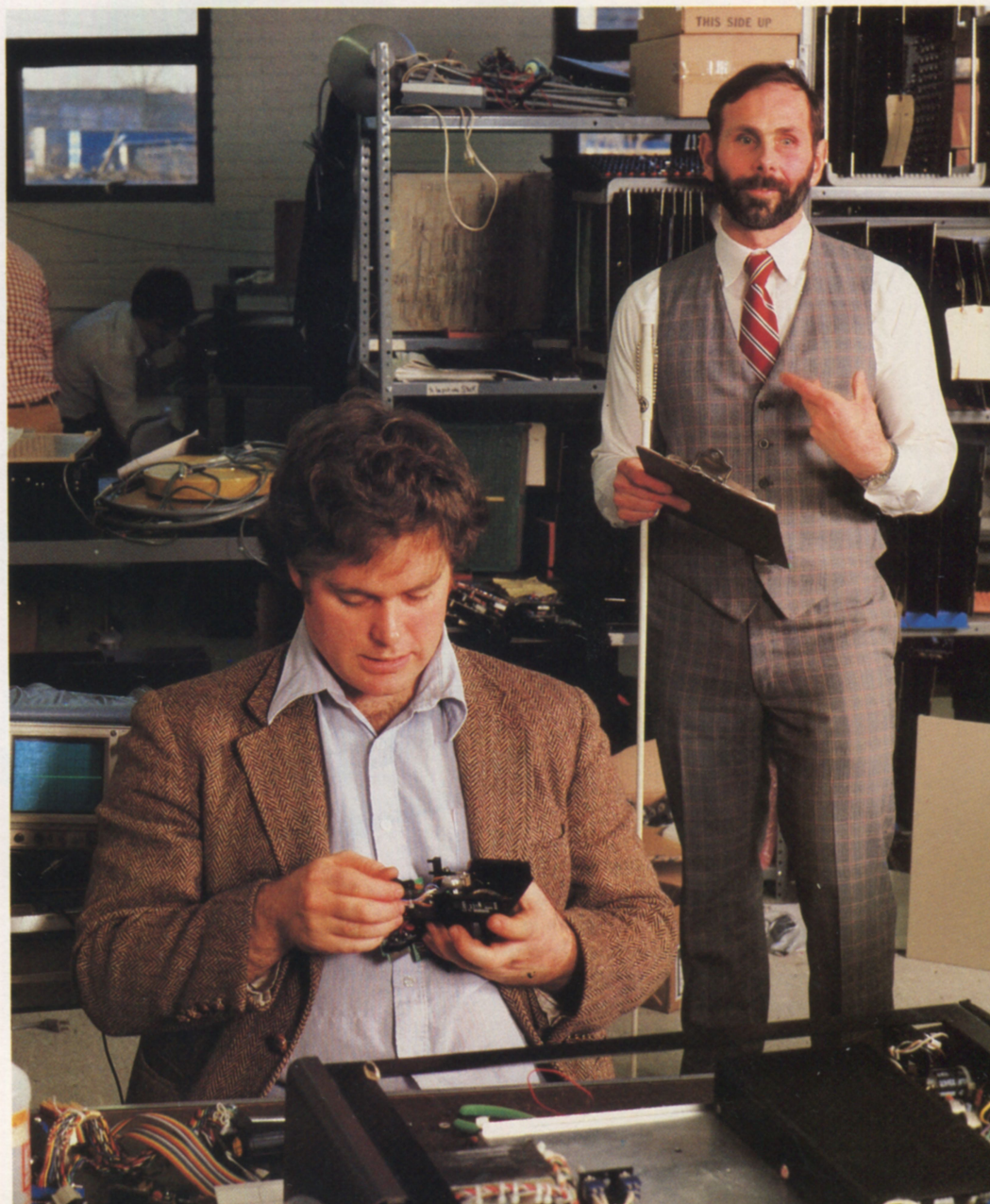
talent to his cause. He has a vision now. "In three or four years," he says, "you'll have a new member at business meetings, whom you'll be able to talk to in normal speech and ask questions like 'How did our sales compare in the western region to those of our three best competitors?' The computerized system would understand the words and the nature of the question and have the answer for you either verbally or for display on a chart on a screen. What would have been a two-week research project would be available instantly."

Then, as he says, he "goes further out," to twenty or thirty years. There he sees domestic robots doing your cooking and

housecleaning. Your car would drive itself—you'd just tell it where you want to go. And instead of phone calls, a telecommunications network would beam out your three-dimensional image. "We could sit together like this, except you'd be seeing a three-dimensional holographic image of me. You could visit people that way. You just couldn't touch them. Then you wouldn't have to get together with people for anything except to make love."

There's that childlike smile again. But the light flashes only for an instant and then blinks out. Kurzweil is back to business once more, thinking about how to market his vision. □

David Ticchi, standing amid technicians, is a manager in reading-machine sales, and a user.



John Sedgwick is the author of Rich Kids, a forthcoming book on inherited wealth.