

You, Robot

He says humans will download their minds into computers one day. With a new robotics firm, Hans Moravec begins the journey from warehouse drones to *robo sapiens* By CHIP WALTER

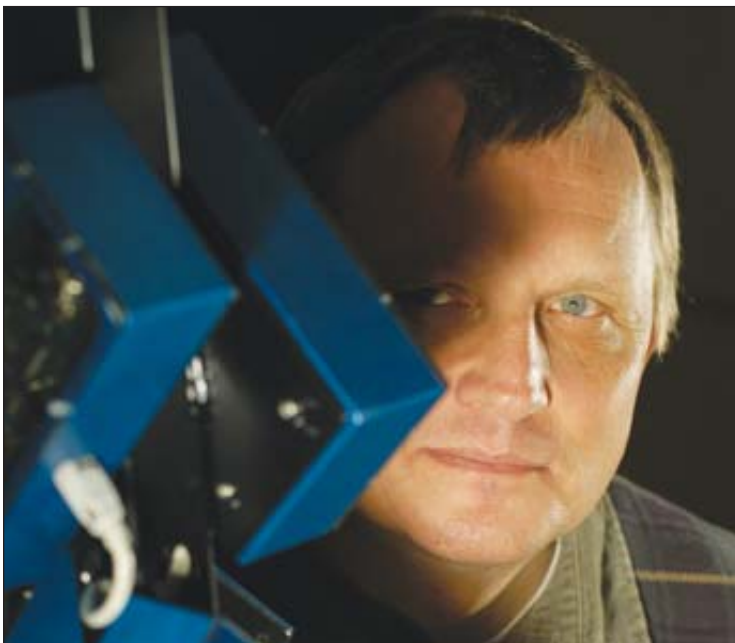
When word got around that Hans Moravec had founded an honest-to-goodness robotics firm, more than a few eyebrows were raised. Wasn't this the same Carnegie Mellon University scientist who had predicted that we would someday routinely download our minds into robots? And that exponential advances in computing power would cause the human race to invent itself out of a job as robots supplanted us as the planet's most

adept and adaptive species? Somehow, creating a company seemed ... uncharacteristically pragmatic.

But Moravec doesn't see it that way. He says he didn't start Seegrid Corporation because he was backing off his predictions. He founded the company because he was planning to help fulfill them. "It was time," he says, slowly rubbing his hand across his bristle-short hair. "The computing power is here."

The 56-year-old Moravec should know. Born in Kautzen, Austria, and raised in Montreal, he has been pushing the envelope on robotics theory and experimentation for the past 35 years, first as the graduate student at Stanford University who created the "Stanford Cart," the first mobile robot capable of seeing and autonomously navigating the world around it (albeit very slowly), and later as a central force in Carnegie Mellon's vaunted Robotics Institute. His iconoclastic theories and inventive work in machine vision have both shocked his colleagues and jump-started research; Seegrid is just the next logical step.

Moravec pulls an image up onto one of the two massive monitors that sit side by side on his desk, like great unblinking eyes. It's six o'clock in the evening, but an inveterate night owl, he's just starting his "day." "I have been drawing these graphs for years about what will be possible," he comments. His mouse roams along dots and images that plot and compare the processing power of old top-of-the-line computers with their biological equivalents. There is the ENIAC, for example, that in 1946 possessed the processing capacity of a bacterium and then a 1990 model IBM PS/2 90 that once harnessed the digital horsepower of a worm. Only recently have desktop computers arrived that can deliver the raw processing muscle of a spider or a guppy (about one billion instructions per second). "At guppy-level intelligence," he explains, "I thought we could manage 3-D mapping and create a robot that could get around pretty well without any special preparation of its environment."



HANS MORAVEC: A FUTURE OF ROBOTS

- **Constructed his first robot at age 10 out of tin cans, batteries, a motor and lights; as a child, deeply affected by science fiction, especially the writings of A. E. van Vogt and Arthur C. Clarke.**
- **Predicts that by 2040 faster processing will enable robots to become self-aware and experience emotions.**
- **Why a robotics industry is necessary for real advances: "I've seen robotics research at universities, and it's pretty interesting, but it's primarily a lot of one-shot projects."**

But no one was creating that robot, so in the late 1990s Moravec says he began to grow “very antsy” about getting one built. In 1998 he wrote an ambitious grant proposal that outlined software for a robotic vision system. The Defense Advanced Research Projects Agency quickly funded the proposal, and three and a half years and \$970,000 later, with PCs just reaching guppy smarts, a working demonstration was complete.

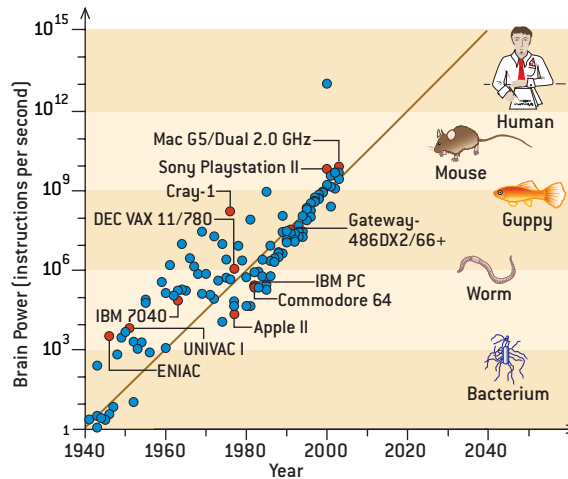
“It proved the principle,” Moravec says. “We really could map with stereo vision, if we did things just right.” But doing things

just right required more than prototype software. Robotic evolution, he adds, “has to be driven forward by a lot of trial and error, and the only way to get enough is if you have an industry where one company is trying to outdo another.” To help things along, he and Pittsburgh physician and entrepreneur Scott Friedman founded Seegrid in 2003. Their focus: the unglamorous but potentially huge “product handling” market.

Industrial robots already flourish in tightly constrained environments such as assembly lines. Where they fail is in locations loaded with unpredictability. So Seegrid concentrated on creating vision systems that enable simple machines to move supplies around warehouses without any human direction.

Not exactly the stuff of science fiction, Moravec agrees, and a long way from superintelligent robots, but he says you have to start somewhere. Nearly everything sold has to be warehoused at some point, and at some point it also has to be rerouted and shipped. Right now human workers move millions of tons of supplies and products using dollies, pallet jacks and forklifts. Seegrid’s first prototype devices automate that work, turning wheeled carts into seeing-eye machines that can be loaded and then walked through various routes to teach them how to navigate on their own. The technology is built on Moravec’s bedrock belief that if robots are going to succeed, the world cannot be adapted to them; they have to adapt to the world, just like the rest of us.

Other approaches can guide robots, but they typically rely on costly, precision hardware such as laser range finders or on extravagant arrangements that prewire and preprogram the machines to move through controlled spaces. Seegrid’s system uses off-the-shelf CCD cameras and simple sonar and infrared sensors. Although these components gather imprecise information, the software compensates. It statistically compares the gathered data to develop a clean, accurate 3-D map. “If the



RAW COMPUTING MUSCLE, as exemplified by a plot of 120 top machines of their time since 1940, is today on par with the brain of a guppy. It may reach the human equivalent around 2040.

same information keeps coming up, then the program decides that it’s probably really there,” Moravec explains. The robot then knows to stop or roll around it. This approach is how you might make your way through a dark room with a flashlight, in which you slowly build up a mental picture of what is around.

Creating warehouse drones as a first step toward the startling robotic world Moravec foresees might seem an unlikely concession to reality. But those who know Moravec say it is no surprise: he is an unusual mix of whimsy, wild vision and rigorous

pragmatism. He has been known to be so lost in thought during his daily walks to his office that he bumps into mailboxes, yet none of that eccentricity has tarnished his reputation as a first-rate engineer and programmer.

“Some of Hans’s ideas are pretty outrageous,” admits Raj Reddy, who as director of the Robotics Institute brought Moravec to Carnegie Mellon in 1980, “but his work has always been very practical.” Seegrid co-founder Friedman says it is exactly Moravec’s vision and dogged persistence that separates him from the pack: “He’s a genius, *and* he works hard.”

The same themes run through his view of the future of robotics. Evolution moves in tiny steps, Moravec notes, but accomplishes amazing things. Machine evolution will do the same as it incrementally nudges robots from their clumsy beginnings to the heights of human-level intelligence and mobility. “We don’t need a lot of Einsteins to do this; we need a lot of engineers working diligently to make little improvements and then test them out in the marketplace,” Moravec insists. And that, he says, will ultimately lead to robots becoming vastly more intelligent and adaptable than we are.

That seems to leave us only one destination: the endangered species list. “Something like 99 percent of all species go extinct,” Moravec observes. Why, he asks, should we be any different? Not that he sees us being destroyed by what he calls our “mind children” exactly. “It’s not going to be like *Terminator*,” he reassures. But children do often exceed the accomplishments of their parents. And in our evolutionary dotage, he is sure they will take good care of us, as parents’ children often do. “They will create the perfect welfare state,” he says.

At least, we hope so. ■

Chip Walter is working on his third science book, Six Traits (That Make Us Human).