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Robot Design  
 By David Talbot

**Jorden Pollack**

Robot builders make a convincing case that in 2001, robots are where personal computers were in 1980—poised to break into the marketplace as common corporate tools and ubiquitous consumer products performing life's tedious chores. One big obstacle remains: It is expensive to design and make robots smart enough to adapt readily to different tasks and physical environments, the way human beings do.



Photography by John Goodman

That's the reason why robotics have, so far, found a commercial niche only in simple and highly repetitive jobs, such as working on an automotive assembly line, or mass-producing identical items, such as toys. The challenge for builders of robots is to build more complexity into them without the huge investment of custom-tailoring each robot for a different task.

One promising approach is to fully automate the design and manufacture of robotics by deploying computers to conceive, test and even build the configurations of each robotic system: in short, to use robots to build robots. Last year, in a cramped lab at Brandeis University in Waltham, Mass., Jordan Pollack demonstrated how this automated robotic design and manufacturing might work.

Pollack, an associate professor of computer science, together with postdoc Hod Lipson, directed a computer to design a moving creature using a limited set of simple parts: plastic rods, ball joints, small motors and a "brain" (neural network). The computer—using an algorithm inspired by biological evolution—"evolved" hundreds of generations of potential designs, killing off the sluggish and refining the strong. Eventually, several of the fastest and fittest came to life, manufactured in a rapid-prototyping machine. Pollack and Lipson snapped on the motors, and the creatures moved.

"I think the important point of our coevolutionary design and automated



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manufacturing for robotics is to get small-quantity production to be economical," Pollack says. He predicts that the evolutionary approach to robot building could lead to the first cheap industrial robots in five to 10 years. "If we are successful, we could see an industry within a decade which makes low-quantity custom machinery worth more than it costs to make."

For now, Pollack's "automated" process still takes plenty of human intervention and money: Pollack and his colleague wrote the computer program and spent \$50,000 on the human-built fabricating device. Still, the team's advance, reported last August in the journal *Nature*, garnered wide publicity. "The importance is symbolic," says Hans Moravec, principal research scientist at the Robotics Institute at Carnegie Mellon University in Pittsburgh. "You have systems that develop robots out of thin air, not by humans. In the future, there will be real robots designed that way."

Pollack's design and manufacturing methods have plenty of competition. Academic and industrial labs around the world are busy building new generations of robots. Within this decade, experts predict a steady evolution in commercial utility robots: robots that can clean floors and pick up things. "There will be a mass market for robots," suggests George Bekey, founder of the robotics lab at the University of Southern California in Los Angeles. "This next decade will be the decade of the robot."

Before robots reach out into the everyday world of business and the household, though, they will need their own version of Moore's Law: becoming dramatically more affordable and powerful over time. In spite of intriguing experiments such as Pollack's, designing even relatively simple robots is a painstaking task. In Japan, for example, Honda has spent over 14 years building a humanoid robot able to walk, open a door and navigate stairs.

A walk around Pollack's lab suggests, perhaps, a better way to design robots. On a workbench sits one example of his computer-designed and computer-buildable machines; it moves eerily like an inchworm. Pollack trims excess plastic from a newly fabricated plastic-rod machine, oblivious to the shavings collecting on his shirt and around his chair. In a few years Pollack may well evolve a cheap robot able to sweep those shavings off the floor.

### Others in Robot Design

Organization	Project
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iRobot (Somerville, Mass.)	Household communications robot
Humanoid Interaction Lab (Tsukuba, Japan)	Interactions between humanoid robots and humans
MIT Artificial Intelligence Lab (Cambridge, Mass.)	Machine learning, robot legs, faces
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David Talbot is a senior editor at *Technology Review*.

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