Do It Yourself, Robot

If machines are to emerge from the factory and enter our homes, they'll need to learn to be self-reliant.

BY FRED GUTERL

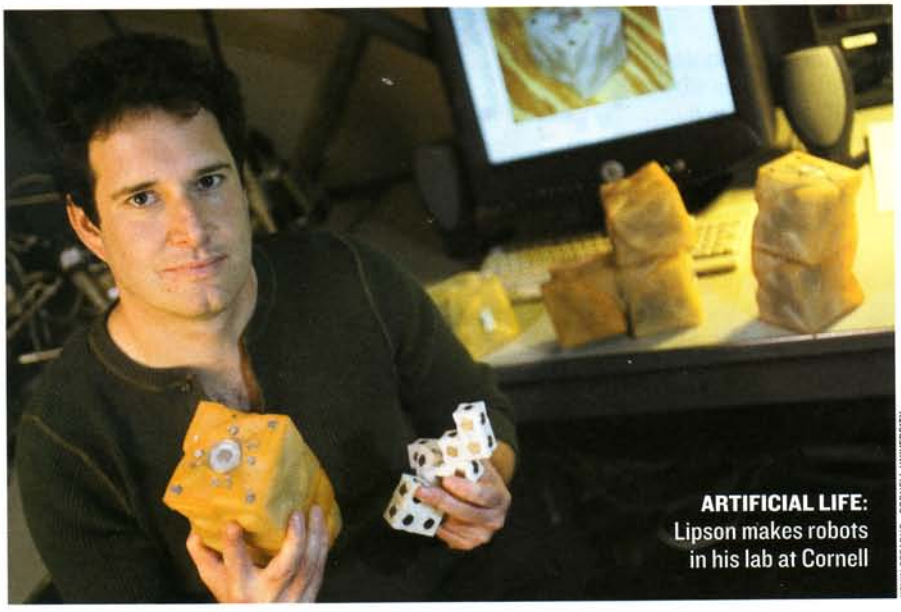
CHRISTMAS DAY 2003 WAS A gloomy time at the National Space Center in Leicester, England. Scientists waited all day for a signal from the European Space Agency's Beagle 2, announcing its successful landing on Mars, but no signal ever came. Beagle 2's failure remains a mystery, but it was never a surprise. A robot ship millions of kilometers from home stands a decent chance of encountering the unexpected. And robots aren't good at handling what their makers can't foresee.

The inability of robots to adapt is a symptom of their growing complexity—the more we want them to do, the harder it is to build them for every contingency. This limitation is the biggest obstacle to making robots more useful around the house, attached to the human body, in our cities and streets. Almost all commercial robots now work in tightly regulated environments such as the factory floor, where objects are always where they're supposed to be, and people are nowhere near. Scientists want to change all that. In last week's issue of the journal Nature, roboticist Hod Lipson and his colleagues at Cornell University report that they've taken a big step closer to endowing robots with adaptability. Lipson's lab built a four-legged robot that teaches itself to walk. When something happens—when Lipson, say, decides to saw off a leg—the robot simply teaches itself to get by with a stump.

Lipson's robot started life with a kernel of programming and then "evolved" its own kind of self-consciousness. The robot makes dozens of copies of its software code, introducing a random mutation each time, and then tests each version to see how effective it is. The robot's programming sends signals to its motors and sees what happens. The beauty of this approach is that the robot can always reprogram itself when circumstances change. When a leg goes missing, the machine stumbles at first. Then it runs a few "experiments," twitching a leg here and there. Then it settles down to "think," sometimes for hours, "evolving" new code, which includes a revised model of its own body.

This kind of self-learning and self-awareness are more fundamental to robotics than merely making machines that can operate when they're damaged. It's also a labor-saving device for roboticists, who are being called upon to make increasingly complex devices. "This is the key to making robots for increasingly sophisticated systems," says Lipson. "People can handmake robots that are very realistic, but they're nowhere near as clever in terms of how they can manipulate things." Scientists are working on prosthetic robotic limbs that adapt to their users, rather than forcing people to learn how to use them. These machines would be extremely complex, custom products. Laboriously programming one for each patient would be impractical. Better to let the software sort things out for itself.

The logical extension of this approach is to build robots that can build themselves, not just mentally, but physically. (If robots can invent their own software, why not hardware, too?) Lipson's lab has built machines that can extrude plastic into parts and etch their own electrical circuitry. They can't yet fully assemble their own progeny, but Lipson and others are working on it.) He and colleague Jordan Pollack have written in Nature about creating artificial life by giving robots "full autonomy" over their own design and fabrication. "Biological life is in control of its own means of reproduction," they wrote. "Only then can we expect synthetic creatures to sustain their own evolution." In this sense evolution means robots building themselves to fit a task, not evolving over many generations. But there's still more than a bit of Frankenstein to the idea. ■

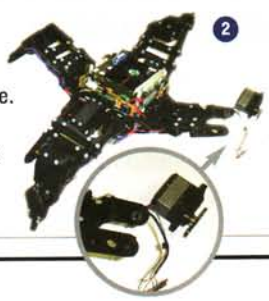


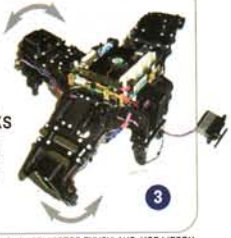
ARTIFICIAL LIFE: Lipson makes robots in his lab at Cornell

KEVIN STEARNS—CORNELL UNIVERSITY

ROBOT, HEAL THYSELF

1 Unlike typical robots that move only according to software made for them by an engineer, a resilient robot keeps track of its actions, interprets them and then builds its own software. 2 An accident like this broken leg means game over for other robots. But here, the robot first identifies the damage and then generates many new programs. 3 It then tests each one and picks out the version that will best let it move without using the broken leg.





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