

Better Than Nature Made It

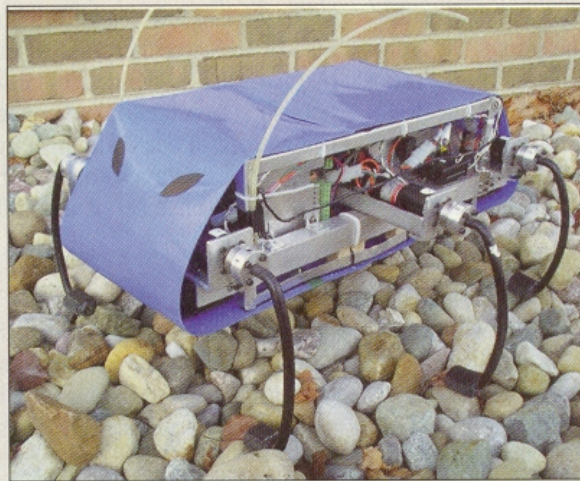
As poets are inclined to point out, the ways in which inspiration can be taken from nature are wondrous, infinite, and varied. In the pursuit of bio-inspired robotics, inspiration doesn't always mean simply copying nature. Instead, many roboticists believe in distilling the fundamental principles at work in organisms and then incorporating those principles in robots, creating a machine that may look nothing like the organisms that inspired it. "We think blind copying is exactly what you don't want to do," says Robert Full, a biologist at the University of California, Berkeley. "You will fail miserably, because nature is way too complex."

Full has studied the locomotion of organisms with two, four, six, eight, and 44 legs—the latter being centipedes—and has concluded that their locomotion is all based on the same basic model, known as a spring-mass system. In effect, they all bounce as they run, like a mass on top of a spring, using alternating sets of legs. "To put it simply," he says, "they act like a pogo stick. And all these legs are bouncing along with the same patterns. The easy way to think about it is that one of your legs works like two legs of a trotting dog or three legs of an insect or four legs of an eight-legged crab and so on."

As to why insects have sprawled postures with their legs on the outside of the body, while humans, dogs, and cats do not, that can be boiled down to a second general principle, says Full. Working with Princeton University mathematician Phil Holmes and others, Full showed that the sprawled posture serves as a self-stabilizing system. As the organism runs along on uneven ground or is buffeted by a predator or a gust of wind, the sprawled legs can absorb the sideways motion and keep the organism's center of mass over its legs where it belongs. "A leg sticking out can act as both springs and shock absorbers," says Full. "Bend it to one side, and it just tosses you back."

Full believes these two observations are general principles of effective locomotion and that any robot that employs them will display the benefits. As supporting evidence, he offers up Robot Hexapod, or RHex. RHex was designed to utilize pogo stick legs and sprawled posture to get by in the world, no matter how rough the terrain. Built by a collaboration of researchers led by engineers Dan Koditschek of the University of Michigan, Ann Arbor, and Martin Buehler of McGill University in Montreal, RHex is roughly the size of a shoe box and weighs 7 kilograms. It has a six-legged sprawled posture and C-shaped

plastic legs that provide the necessary springiness and self-stabilization. The legs are mounted on hip joints that rotate a full 360 degrees, taking the legs around with them. RHex doesn't look much like an insect until you see it walking across rough terrain, which it does effortlessly, with neither eyes to see nor nerves to feel, at a speed of a meter a second.



Roughing it. RHex can travel swiftly over uneven ground.

"It's the fastest running legged platform I know of," says Alan Rudolph, who manages the controlled biological and biomimetic systems program at the Defense Advanced Research Projects Agency. "And it's pretty simple but quite stable." Or as Full puts it, "RHex demonstrates the point that you don't need to copy things to make a better robot."

—G.T.