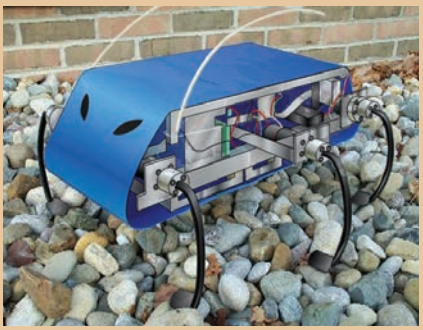
Crawls, Creeps, Swims, or Flies
ROBOTS GO WILD!

by Peg Lopata

Wouldn't it be great if a robot could fly like a bird, crawl up a wall like a spider, or swim like a fish? Scientists and engineers have long sought to mimic the efficiency of plants and animals. For example, Velcro's inventor, George de Mestral, got his idea for the innovative fastener by carefully examining cockleburs, and the Wright brothers copied birds' wings for their airplanes. The science of mimicking animals and the natural world is called *biomimetics,* from *biomimesis*, which means "to mimic life." Robots that mimic animals are just as fascinating as the critters they copy.



TOP: An exterminator wouldn't want to remove this helpful roach called RHex. That's not the case for the common pest on which its design was based (bottom).

COCKROACHES TO THE RESCUE

RHex, which stands for robot hexapod, mimics the movement of the world's least liked animals — cockroaches. *Hexapod* means that it has six legs. RHex was developed about ten years ago, and you can buy one today for about $10,000. The smallest hexapod robot is a lot bigger than a cockroach, about 14 x 12 x 3 inches. Though it can move on its own, usually it's directed by someone using a joystick to control speed and direction.

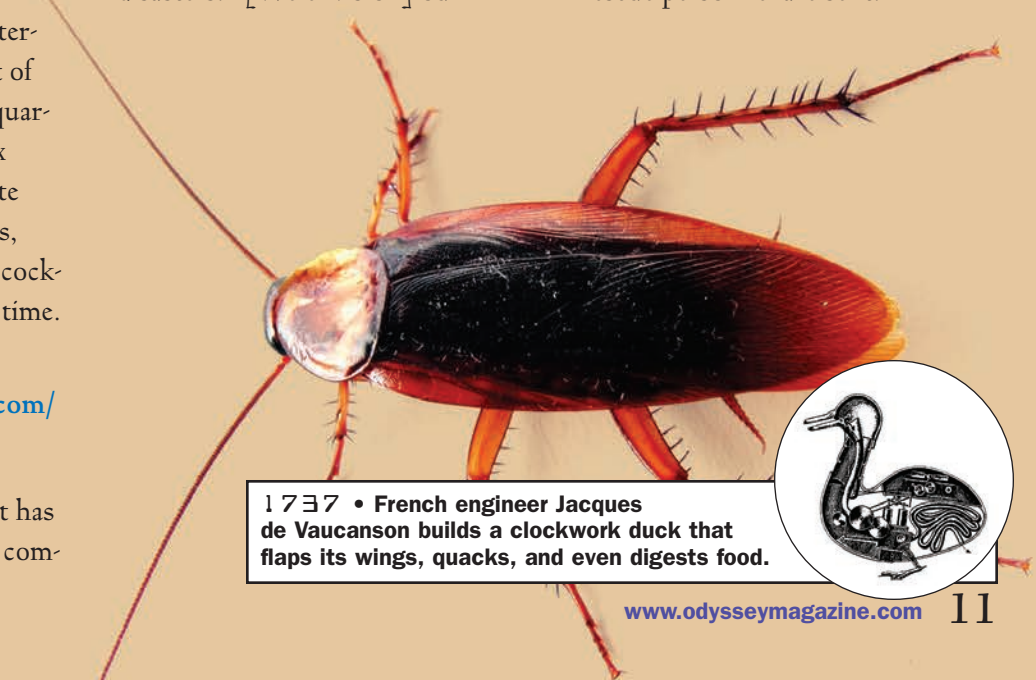
RHex can run over rugged terrain with the power from a set of batteries for about two and a quarter miles. It moves at about six miles per hour and can navigate slopes of more than 45 degrees, swim, and climb stairs. Like a cockroach, it moves three legs at a time. See these robots move at:

www.sandboxinnovations.com/index.php?leaf=16.

RHex moves so well because it has a camera that acts as an eye, a computer that acts as a brain, motors to function like muscles and legs, and sensors to feel obstacles and determine which way is up and down. There's even a hexapod robot that can dance. Check it out at:

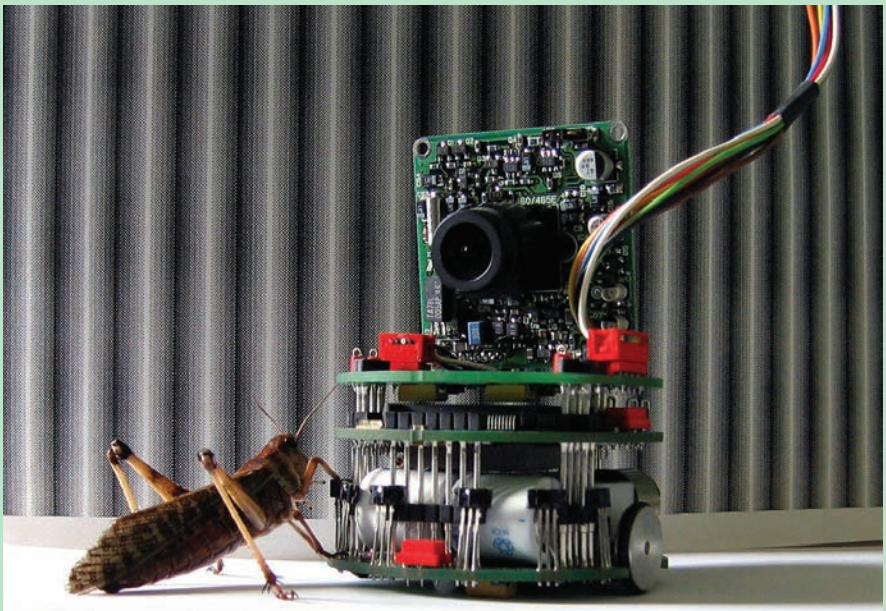
kodlab.seas.upenn.edu/~ese112/index.php?leaf=2.

This type of robot could help *first responders*, emergency personnel who are first on the scene of major disasters. "[We envision] our robot, RespondBot, will be the first tool sent into a ground zero," says Dr. Haldun Komsuoglu, robotics researcher at University of Pennsylvania and co-founder and CEO of Sandbox Innovations, Inc. "It will reach the problem area quickly and send back crucial visual inspection and chemical, biological, and radiological readings for the first responders to assess the situation before rescue personnel are sent."



1737 • **French engineer Jacques de Vaucanson builds a clockwork duck that flaps its wings, quacks, and even digests food.**

LOOKS LIKE A LOCUST



Who says you're faster?

The optic lobe, located in the locust's brain, is common in fish and birds, and will someday be common in robots, too.

Imagine you're riding along on your bicycle, when suddenly it blares — like a fire alarm going off. Up ahead you see why. There's a fallen tree in the road. Whew! Lucky your onboard collision sensor saw that! Just a pie-in-the-sky idea? Not if you understand how locusts see. Right now, scientists and engineers are developing robots with visual system sensors that could help us avoid collisions just as well as locusts do.

A locust's visual system is called a lobula giant movement detector (LGMD). It's actually a large neuron in the locust's *optic lobe*, which makes the insect very skillful at avoiding collisions. Dr. Claire Rind, a researcher at Newcastle University in the United Kingdom who builds artificial visual systems, discovered how the LGMD works. She strapped locusts in specially designed "chairs" for a most unusual ride, during which they were bombarded with video of scenes from the movie *Star Wars*. Probes had been placed under each locust's skin, which enabled the researchers to learn how the locusts avoided collisions with objects in the movie scenes. Rind concluded the LGMD gives the locusts warning of an impending collision, triggering escape behavior when a large object approaches.

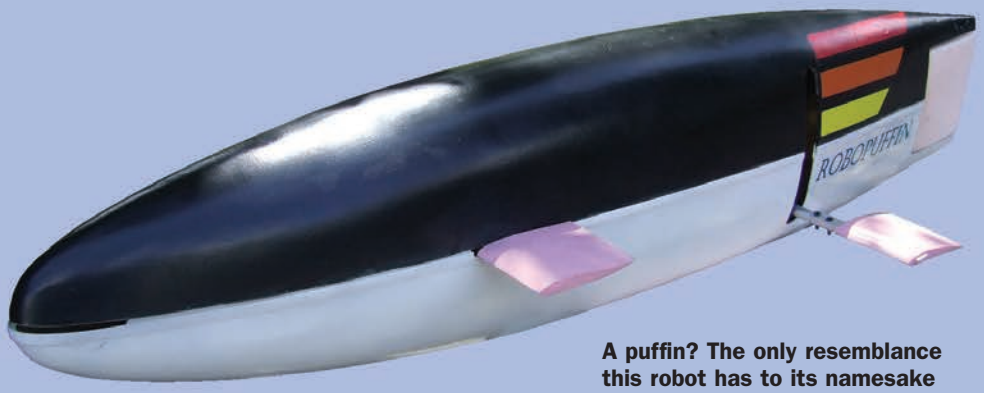
Not only is the locust's visual system great at avoiding collisions, but engineers are intrigued that all the neural circuitry for it is extremely small. Many animal-inspired robots copy a specific animal's abilities, but not its size. That's because the machines needed to make the robot function like the animal can't be made as small as the animal parts being copied. But in the world of robot development, striving for smaller parts is often part of building a better robot. If your bike's onboard collision visual system were as big as your bike, for example, it wouldn't be useful. But what about if it were as small as a pea? A robot with a tiny visual system as effective as a locust's would be very useful.

Check out robots with locust visual systems at:

www.k-team.com.

Optic lobe — Part of the brain containing visual centers

RoboPuffin is another animal-inspired robot. It copies the movement of (surprise, surprise!) *puffins*, seabirds with vertically flattened bills. When operational, RoboPuffin will swim in an area of water, patrolling and recording oceanographic information. Although the robot is designed to be ***autonomous,*** at this early stage in its development it can't do much of anything. "At the moment, we'd be happy just to see it go forward!" says Dr. William Megill, a biomimetics specialist at the University of Bath in the United Kingdom.



A puffin? The only resemblance this robot has to its namesake is its little purple fins.

To design RoboPuffin, the researchers first carefully examined how puffins move under water. Puffins' short wings make them superb underwater swimmers. To fly or swim, a puffin tips its wings forward so that the trailing wing edges are above the leading edges. In water, verses in air, the puffin can tip its wings even farther forward to propel itself more horizontally. On the upstroke, the bird folds its wings in against its body, reducing ***drag*** as it moves through the water. Then the bird flaps its wings, lifting its entire body upward and forward.

RoboPuffin will replicate this maneuver, but it will be able to lift itself on *both* the upstroke and downstroke. Of course a robot puffin doesn't look much like the real bird. Its wings are made of a material that's hard like plastic, but flexible like rubber. It will have computers, a webcam, ***sonar,*** an artificial nose to detect chemicals underwater, and a compass. It will even be able to tell when its battery is running low and head for the dock for a recharge!

Megill would like to see RoboPuffin put to work mapping out the distribution of salmon in the fjords of western British Columbia. "It would finally begin to address the question of 'where do little salmon go when they leave the river?'— something really basic that we still don't understand," he says hopefully. The information would enable researchers to properly manage the salmon species so it could become plentiful again.

There's no limit to the possibilities of biomimetic robots because the animal world is endlessly diverse and scientists' and engineers' imaginations are limitless. In the not-so-distant future, *you* may even be helped by robots that swim like fish, crawl like bugs, or fly like birds.

Peg Lopata is associate editor of *FACES* magazine and a frequent contributor to *ODYSSEY*.

Puffin pals show their stuff!

1868 • American inventor Zadroc P. Dederick builds "Steam Man," which can pull a cart.

Autonomous — Independent; not controlled by outside forces

Drag — The retarding force exerted on a moving body by water or air

Sonar — A system using transmitted and reflected underwater sound waves to locate submerged objects