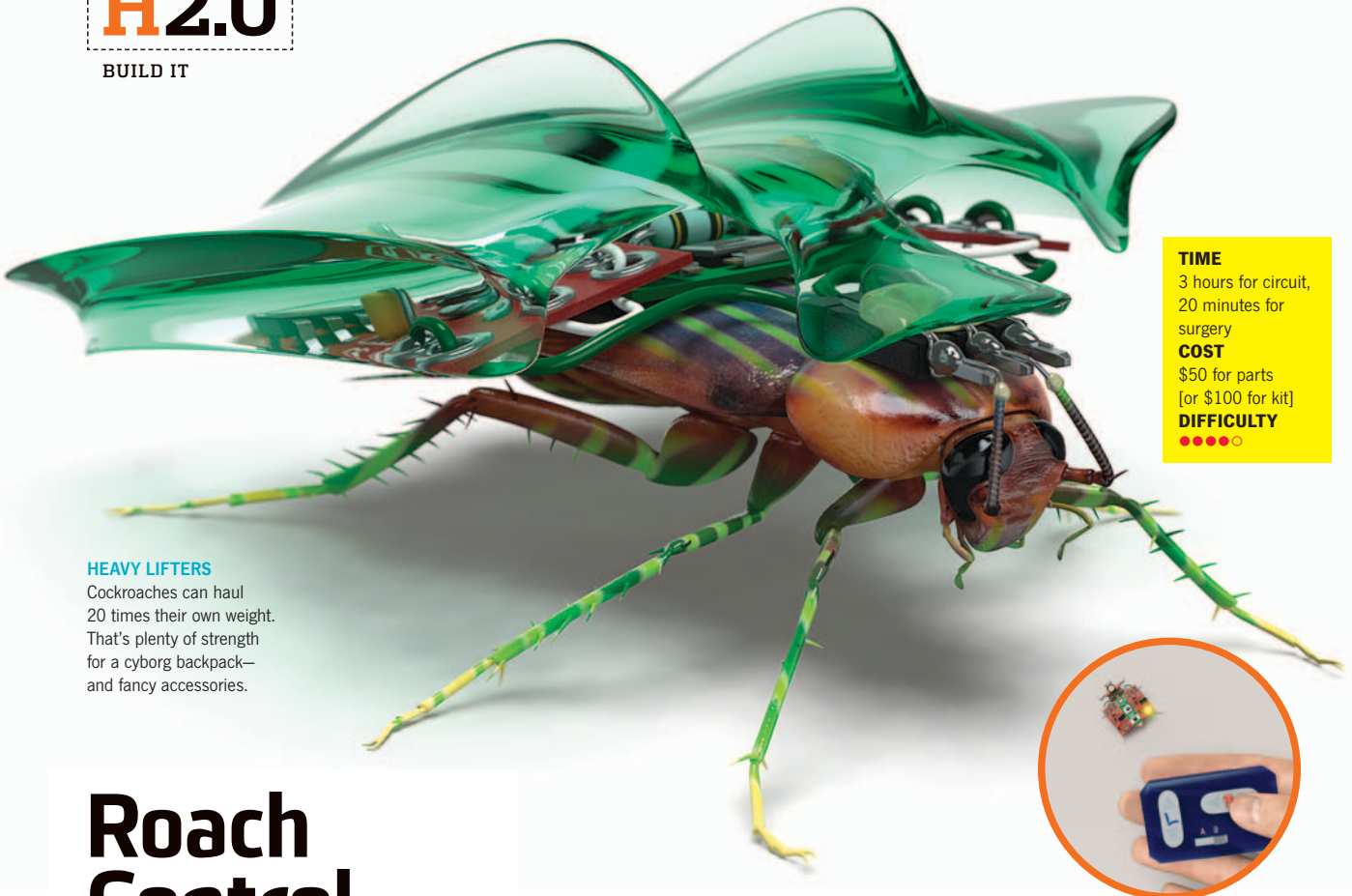


# H2.0

BUILD IT

**50 BODY LENGTHS PER SECOND** Top scuttling speed of the American cockroach, one of the fastest-known invertebrates on Earth



#### TIME

3 hours for circuit, 20 minutes for surgery

#### COST

\$50 for parts [or \$100 for kit]

#### DIFFICULTY



#### HEAVY LIFTERS

Cockroaches can haul 20 times their own weight. That's plenty of strength for a cyborg backpack—and fancy accessories.

## Roach Control

An insect cyborg that scurries at your command

If **cockroaches** send you scrambling, use neuroscience to reverse the human-insect power balance. Carefully electrifying the nerves in a roach's antennae makes the insect think it has met an obstacle—a sensation that can be manipulated to steer it. The trick could turn roaches into handy tools. Alper Bozkurt, an engineer at North Carolina State University, envisions a network of cyborg roaches assisting in search and rescue. Neuroscientists Greg Gage and Tim Marzullo, meanwhile, think hacking insects could inspire kids to research and improve electronic interfaces with the human nervous system. Gage and Marzullo developed a \$100 RoboRoach kit that includes all the tech required for insect neurosurgery. But you can follow these steps to assemble a similar kit—and command your own troop of six-legged cyborgs—on the cheap.

STORY BY **Amanda Schupak**

ILLUSTRATIONS BY **Graham Murdoch**

#### THE ROBO

The RoboRoach kit contains a circuit board and controller, but you can hack the essential parts from a remote-controlled Hexbug toy.

#### CIRCUIT BOARD

Remove the Hexbug's circuit board. The toy's infrared remote control can start and stop current to the roach's antennae from afar.

#### TIMER CHIP

Electricity needs to flow at 55 pulses per second to mimic the chatter of roach neurons (and hijack the insect's senses). Computer chips called 555 timers can get the job done. Detach each motor on the Hexbug circuit board and solder on a timer.

#### CAPACITOR

To provide a clean, steady flow of electricity to the timer, add a capacitor to its output pin.

#### BATTERY

Replace the Hexbug's two batteries with a single 12-millimeter, 3-volt lithium-ion battery.

#### ELECTRODE CONNECTORS

Snip a pair of three-electrode segments from a header. Wire one set to the circuit board and solder a 1-inch strand of 41-gauge silver wire to each electrode on the other. The latter set will be superglued to the roach's head as an electrode connector for the circuit board.



#### THE ROACH

Pet stores typically sell false death's head cockroaches as reptile food. These big-and-slow roaches make great cyborgs, but pick an adult to avoid disrupting its maturation process (yes, roaches can enjoy their post-cyborg lives in lettuce-lined terrariums).

#### ICE BATH

Dunk the roach in ice water for a few minutes to anesthetize it. Dry the back of its head and sand off some of the wax. Superglue the electrode connector in place.

#### WIRING

Poke the left silver wire about 1 millimeter into the roach's thorax, under a wing just behind its head, and secure it with superglue. Cut each antenna to expose a neuron-lined tube. Insert the middle wire 1 millimeter into the left tube, and the right wire into the right tube. Superglue both wires into place.



#### CONNECT AND COMMAND

Hot-glue the circuit board onto the roach's back and plug it into the head connector. After the roach wakes up, press the remote's left button to urge it right, and the right button to move it left. The cyborg will ignore commands after a few minutes. Peel off the circuit board and clip all wires to ensure a long retirement.