



Doughnut R&D

Gasoline-powered monowheel

MAKER	Kerry McLean	COST	\$10,000
OCCUPATION	Metal fabricator, machinist	TIME	200 hours
LOCATION	Wall Lake, Michigan	MORE	kerrymclean.com

Kerry McLean insists his single-wheeled vehicle drives “like an airplane.” Sounds like a proud craftsman’s conceit until he finally explains what a monowheel is like to ride. “It’s three-dimensional like flying,” says the Wall Lake, Mich., metal fabricator and machinist. “You shift your body to steer it. Your pitch changes when you brake or accelerate. You may be hauling ass, but you feel like you’re floating.”

Only a handful of people have made monowheels in the last century. They’re really more for fun, though you can register them with the DMV and buzz your neighborhood, and they apparently do well at parades. McLean has made all kinds of wheels, including a 225-horsepower racing hog (pictured). For \$10,000 each, the monomaniac will build a spunky 15-horsepower monowheel for private sale. It’s labor intensive; each of the eight wheels he’s sold has taken about a month to complete.

To make the giant wheel, McLean starts with a thick aluminum tube bent into a 6-foot series of spirals, like a huge spring. A metal shop does the initial work of bending the tube and is careful not to crimp the inside edges, but the spirals aren’t perfectly round at first. In his detached workshop in front of his house, McLean cuts pieces off the aluminum tube until he has a single circle with flush ends, and then he clamps the tube to a giant steel slab. “I gasket this thing down in there, bump it around, heat it, stress relieve it, and weld in place balance lugs. I work on it until I get it flat and round,” he says. McLean connects the ends of the circle together by welding an aluminum lug into the center. (To compensate for the lug, he welds a scrap piece of equal weight to the opposite side.)

The rubber tread for this new wheel originates as several new motorcycle tires, which McLean cuts up and sticks to the gargantuan new rim with special primers, adhesives, and more than 200 hand-applied buttoncap screws. He modifies a brand-new Briggs & Stratton 5-horsepower engine to crank out 15 horsepower and suspends it inside the frame by soft urethane mounts connected to steel rollers. The frame and outside wheel then glide along the rollers with a gentle suspension.

Oh, there’s one extra step: McLean pours molten lead in empty spaces under the engine. The counterweight prevents gerbiling — monocyclists’ argot for accelerating too quickly and sending the driver into a loop-de-loop around the inside of the monowheel.

When McLean is between larger projects, he can’t seem to keep his hands off items around the house. A few years ago, he scooped out the innards of his 6-year-old’s pink Barbie Jeep, inserted a 5-horsepower motor and chromoly frame, and retroed the body back on (top speed: 35 mph). In his living room, he’s modified a vintage Kranich & Bach grand piano with “drag slicks, Corvette header pipes, tachometer gauges, and a ’32 grille with a blower.” He describes it while playing a short blues shuffle over the telephone.

McLean is charming, albeit a little intense. He built his first monowheel in 1970 and has been obsessively perfecting the design ever since. “I don’t feel like anyone has seen it through,” he says, affirming a strong dislike for scavenged parts. “They’re using some hokey old engine and they think that’s good enough. They’re limiting themselves. You hear the words ‘trial and error.’ That’s just some hillbilly stuff. Broomsticks and baling wire. I’m doing R&D.”



Waterbug

Dual-prop pedal-powered canoe

MAKER	Erhardt Wowerat	COST	\$700
OCCUPATION	Electrical engineer	TIME	80 hours
LOCATION	Milwaukee, Wisconsin	MORE	bikeforest.com/homebuild1.php

Somewhere in a basement in Milwaukee, a man has created a souped-up canoe that promises to run circles around wimpy paddleboats and swan boats. His invention uses dual propellers for speed and steering, a power train that sits high in shallow water, and most importantly, a system of cycle gears and derailleurs for varied speeds. "Bikes were once one-speed," says Erhardt Wowerat, 36. "Why can't we improve pedal-powered boats, too?"

His first try was not quite seaworthy. Wowerat made an unorthodox propeller out of wood that was supposed to jet water out the back through a heavy wooden channel. Unfortunately, this electrical engineer for a construction company was soon frustrated by the limit of his mechanical skills. "It didn't work at all," he says. "I didn't sink, but I wasn't going anywhere either."

For the Mark II version, Wowerat switched to aluminum, now his medium of choice. (He played with Legos as a kid, and working with aluminum reminds him of those days.) He cut the 1/8-inch gauge pieces using a table saw fitted with a carbide blade. Through trial and error, he learned how to weld it, putting a small fitting on the bottom of his aluminum canoe to bolt the apparatus on. He cannibalized parts from a Trek 1000 bike for sprockets, derailleurs, and a front crank set. He bought a machinist's miter gear to transfer the crankshaft's force 90 degrees to the propellers whirring out back. And the extravagant seat? "It's a tractor chair," notes Wowerat. "It has detachable armrests and adjusts forward and back. I saw it in the store and just said, 'That's the one I want.'"

Aside from a few run-ins with lake weeds, the rig works well (alas, his wife has yet to take it for a spin).

Wowerat can't wait to tackle the next version. The son of German immigrants, he spent nearly every day of his youth boating around Lake Winnebago in Michigan. He's been taking night classes at Milwaukee School of Engineering to get his master's and improve his mechanical engineering skills. He recently bought AutoCAD software for his computer and hopes to test canoe designs before getting bogged down in a local lake again. His next version will be more modular, a Lego-like add-on to any canoe. Just think: one day you too could turn your gentle little boat into a killer watercraft.



Fried (above, right) works the jammer on an “unsuspecting” cellphone user. The device works by employing a high-frequency oscillator circuit (left) to blanket the immediate area with junk signal.

Radio Free Boston

Cellphone jammer

MAKER	Limor Fried	COST	\$50
OCCUPATION	Freelance engineer and artist	TIME	4 months
LOCATION	Boston, Massachusetts	MORE	ladyada.net

“It happens to me all the time,” explains twentysomething Limor Fried, a recent master’s degree grad from MIT. “You’re stuck on a bus from Boston to New York and the person next to you talks on their cellphone for three hours ... well, it certainly feels like three hours.” Fried started itching for a mass-transit solution, and soon built a pocket-sized device that could squelch phones up to 6 feet away at the push of a button.

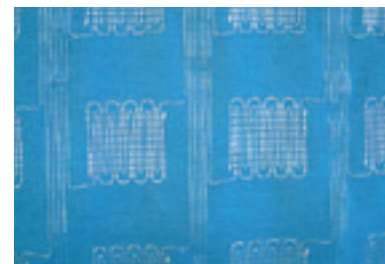
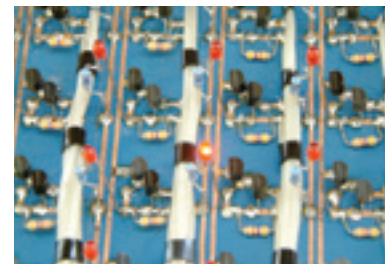
Part of a demo for her master’s thesis, the jammer uses a method called “denial of service” to overwhelm the phone’s radio band with a high-power burst of junk signal. To create it, Fried bought two voltage-controlled oscillator circuits to create a radio carrier frequency. She designed a tuning circuit using op-amps and simple components. The tuner leads the VCO through all the frequencies, generated to sweep across common analog and digital cellphone radio bands from 800MHz to 1.9GHz. Store-bought amplification stages increase the size of the jamming space, and in a later version, an RP-SMA PCB edge-launch antenna allowed her to attach a variety of antennas. Unfortunately, because cellphone bands vary so widely, you have to guess which type of phone you’re trying to disrupt and swap antennas appropriately. But in the end it worked with most phones. And with two AA batteries, the device can jam periodically for a few hours. Fried’s grade on her thesis: A.

Though she’d like to make improvements, Fried has already moved on to her next project. She lives in South Boston with a couple of roommates and a cat named Mosfet. (“Yeah, I know, that’s pretty bad,” she admits.) Her electronics workshop is a door on sawhorses, on which she and a roommate make open-source

synthesizer kits they sell over the internet, with sales of over 100 units at \$300 apiece.

Fried grew up in both the U.S. and Israel. She credits her big sister with planting the tinkering bug. “She’d be like, ‘Hey, look, 50 oil cans on the side of the road!’” Fried recalls. “She’d wash them out and make them into boxes for everyone in our family.”

Despite the glee of creating a jammer, Fried doesn’t exactly recommended the project to other makers. “If you want one, just buy it,” she says. “They’re illegal, but they’re out there.” (According to the FCC, it’s forbidden to block licensed radio communication, though describing the device for a school project probably won’t get Fried into trouble.) She worked so hard to create the device for the paper that some of the joy went out of it. “I tried it and it works, but I never got to the revenge stage.”



MacCary (left) at home with her loom. The conductive fibers she weaves lead to 36 amplifier circuits (top), which illuminate LEDs depending on where you touch the fabric. Her finished artwork is called *Dialectric: Connection* (above).

Shocking Duds

Hand-woven electric cloth

MAKER	Laura MacCary and Lawrence MacCary	COST	\$1,500–\$5,000
OCCUPATION	Artist, retired engineer	TIME	60–100 hours
LOCATION	Seattle, Washington	MORE	maccary.com

She wasn't exactly spinning straw into gold, but close. In 1997, Laura MacCary began loading professional audiotape instead of thread into her 150-pound wooden floor loom after she discovered miles and miles of the stuff in a nearby dumpster. MacCary, an advanced weaver and former network administrator, started to prepare it on the loom (which she keeps in her apartment) by loading the warp threads into the loom and keeping them under tension for weaving.

"The dumpster belonged to a company that sold Muzak," says MacCary, 38, recalling a lunchtime excursion she made near her former job at Aldus. "I used to check it all the time before they put a lock on it, and that day I found all this tape from a reel-to-reel machine. It was shiny on one side. I wondered if I could weave something that would act as a potentiometer." MacCary promptly brought it home and created a 5-by-5-foot audiotape blanket in a shimmering crisscross pattern, connecting the end strands to an oscillator circuit. She hoped it would produce strange sounds.

"I kept blowing transistors," she says. "But I did know one person who could figure it out." MacCary mailed off the whole business to her father, Lawrence MacCary, 80, a sculptor and longtime tinkerer. Lawrence created a new circuit around a 555 chip that would regulate the voltage and create an audio signal for the speakers. Now you can vary the tone it creates when you touch it in various places. It was a cool piece of interactivity, and the start of a collaboration in electronic cloth.

In mid-2005, MacCary and her dad developed a more mature example of the work, in a series she calls *Dialectric*. Instead of making sound, the piece illuminates 36 red LEDs according to where you place your hand.

The winter before, MacCary had received her master's in fine art, and she'd been showing the piece and several others in various museums and galleries. The new piece consists of wool-polyester blended thread, which MacCary wove together with tinned copper wired in a zigzag pattern. She and her father then collaborated to solder together 36 Darlington amplifiers to correspond to each pair of wires in the piece.

"You're basically using your body to short out the circuit to light the LED," says MacCary. "But it's tough getting something to conduct because people are generally really big resistors." The sensitivity of the cloth is so high that the display sometimes flickers in humid weather.

MacCary wasn't always so handy with the soldering iron. Though her father, a former geologist for the government, was constantly building high-voltage devices, she didn't get to spend a lot of time with him. Her parents were divorced by the time she was in high school. Still, she witnessed plenty of the finished projects — Tesla coils, Van de Graaff machines, and Marx generators. "My early experience was getting shocked a lot. He once built a Cockroff-Walton Voltage Multiplier — it's got a lot of capacitors that discharge into it. When you reach the top capacitor, the current is tremendous. It's the sort of thing that would punch a hole in your head if you came too close."

During a recent interactive art exhibit, a local newspaper characterized those in the show as "basement tinkerers" rather than as artists. Several participants took exception, but MacCary says she was pleased. "I don't have a problem with being associated with basement tinkerers. I grew up in that world."