

DOZENS OF HACKS AND HOW-TOS FOR YOUR GEAR **Premiere Issue!**

Make:

technology on your time



181
pages of
D.I.Y.
technology

*How to Make a
Magnetic Stripe
Card Reader*

*Backyard
Monorails
XM Radio
Hacks
iPod Tricks
Blogging
Made Simple*

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PHOTOGRAPHY
NOW WITH
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O'REILLY

Make:

technology on your time™

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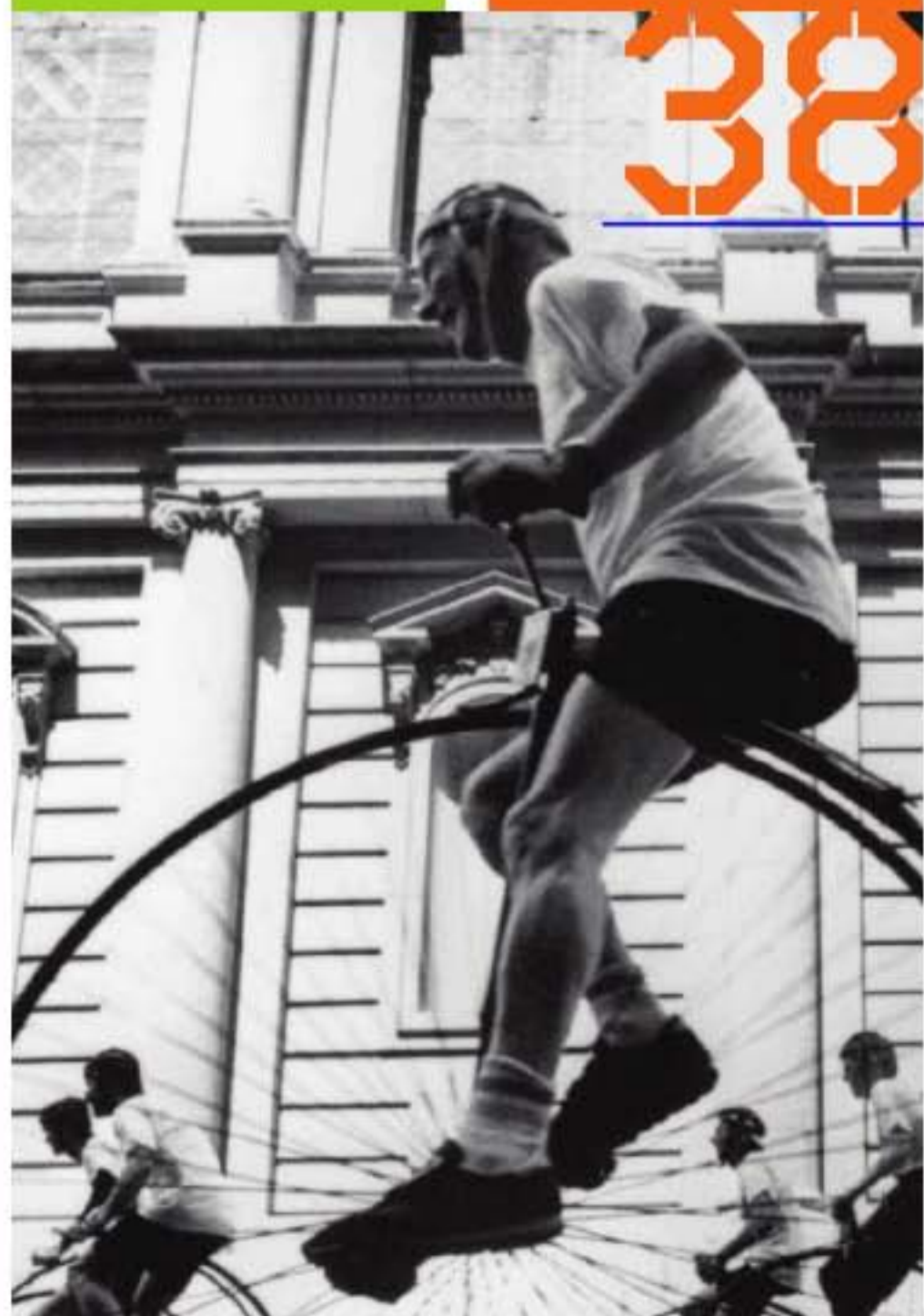


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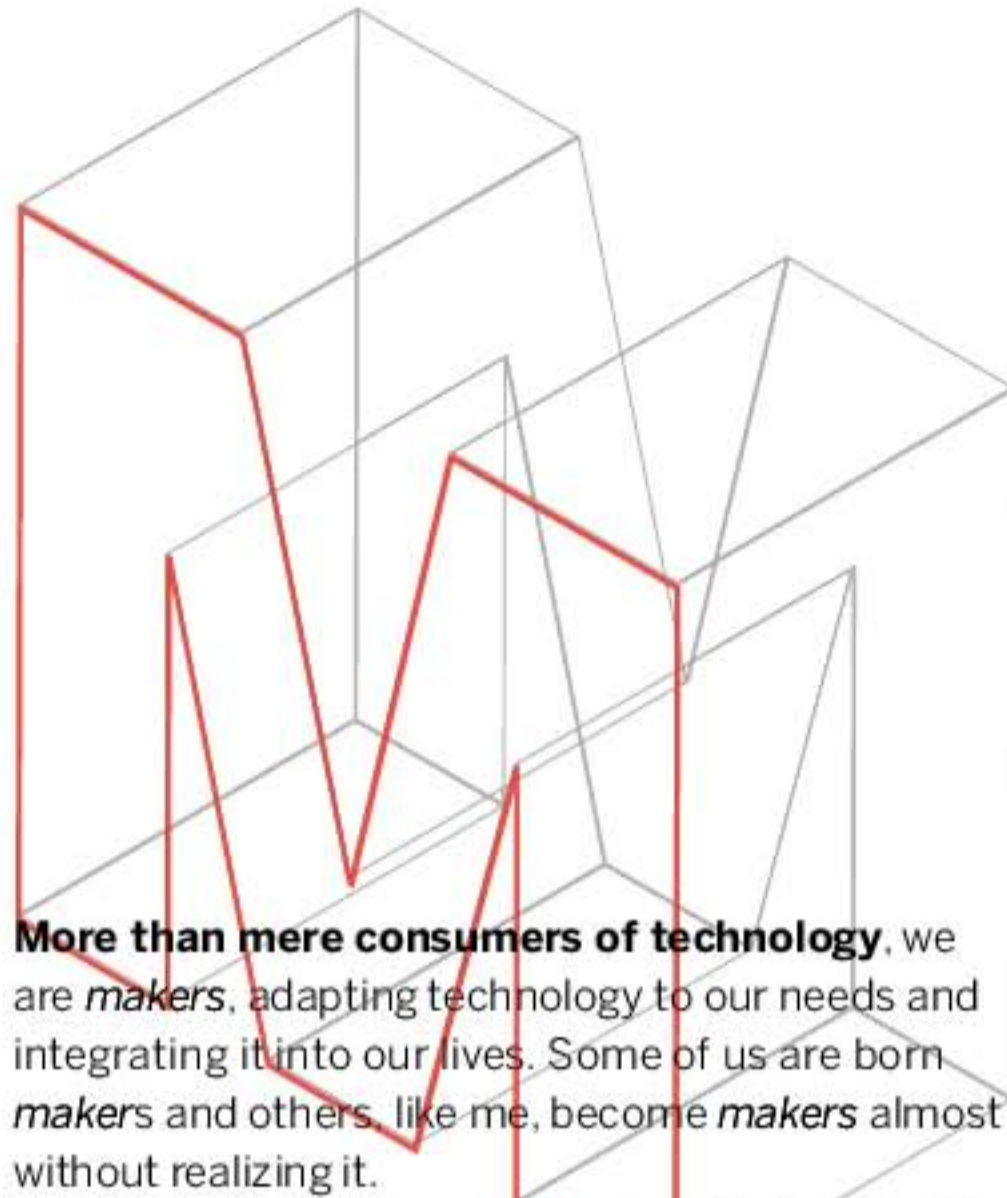
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The Making of **Make:**



More than mere consumers of technology, we are *makers*, adapting technology to our needs and integrating it into our lives. Some of us are born *makers* and others, like me, become *makers* almost without realizing it.

Maybe it started when I burned my first music CD, ripping individual songs from packaged CDs and assembling my own playlist. This was unthinkable just five years ago, and now it's how we make our own music — much to the chagrin of the recording music industry.

Maybe it started when I got Wi-Fi working, not just for myself but for my whole family. Suddenly, the computer wasn't locked down to a desk and wired to an outlet. It was free to roam, like a cell-phone, and I began finding new places such as coffee houses that I could call home, or at least home-office.

Maybe it started when I brought my digital camera and laptop on vacation and found that my slideshow was ready before the vacation was even over.

I'm sure that most of us share these experiences, and many others that demonstrate the impact of new technologies in our lives. Think of how many devices each of us interacts with on a regular basis today. And that's only the beginning. Neil Gershenfeld of MIT's Center for Bits and Atoms, who is featured in this issue, writes in his book *When Things Start to Think* that "personal computing has not gone far enough; it lets us shape our digital environment but not our physical environment." In other words, technology that allows us to create complex things will soon become as affordable as the technology we use to create and manage data. We are just beginning

to see the impact of technology in our personal lives. So much is possible.

MAKE is a new magazine dedicated to showing how to make technology work for you. At the core of the magazine are projects that show you how to use technology in interesting and practical ways. A MAKE project is rewarding and fun as an experience, and it produces something you can share with your friends and family. Becoming a *maker* is a lot like learning how to become a better cook — you can follow or improvise upon the work of experts.

In the process of developing MAKE, I have met all kinds of expert *makers* who were excited to contribute their ideas and their favorite projects. There are some I'd call *extreme makers* who bring highly specialized skills and experience working with both new and old technology. They specialize in the unexpected and go beyond what you or I would ever consider practical. We can learn a lot by following what they do, and I'm happy that MAKE provides a showcase for their work.

I hope you enjoy getting to know the experts as well as meeting other *makers* like yourself. We expect that our website will become a place to share your experiences building the projects in the magazine, as well as a home for projects that you develop. I look forward to meeting you there.

Let me know what you think of MAKE and how you use technology to make your own life better. You can contact me at dale@oreilly.com.

Dale Dougherty is the editor and publisher of MAKE and the publisher of O'Reilly Network (www.oreillynet.com).

It's ironic that in an industry
so concerned with memory,
how quickly we forget.

Luckily we have a place to remind us. The Computer History Museum is dedicated to exploring the computing revolution and its impact on the human experience. It is home to the largest collection of computing-related artifacts in the entire world. The collection includes hardware, software, photos, films and video, documents and many one-of-a-kind and rare objects. The Museum's many programs include a popular speaker series featuring luminaries and their personal stories, commemorative celebrations and oral histories that are sure to jog your memory. The Computer History Museum. *Where Computing History Lives*



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Please note: Technology, the laws, and limitations imposed by manufacturers and content owners, are constantly changing. Thus, some of the projects described may not work, may be inconsistent with current laws or user agreements, or may damage or adversely affect some equipment.

Your safety is your own responsibility, including proper use of equipment and safety gear, and determining whether you have adequate skill and experience. Power tools, electricity and other resources used for these projects are dangerous, unless used properly and with adequate precautions, including safety gear. Some illustrative photos do not depict safety precautions or equipment, in order to show the project steps more clearly. These projects are not intended for use by children.

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NEW LEAF PAPER

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Contributors



Joe Grand ("Soldering & Desoldering") describes himself as "anal, goofy, high-strung, and obsessed with work." He grew up in Boston and has been involved in electronics since he was 7 years old. "Hardware hacking is, to me, a perfect example of 'anti-establishment'. Make a product do something it

was never intended to do, add a personal touch, and make it your own. Not just buying a product and using it as is (which is what The Man wants you to do!)." Besides working on secret projects involving video games, toys, and consumer electronics for his company, Grand Idea Studio, Inc., Joe lives in San Diego where he runs, swims, cycles, and plays the drums.



Andrew "Bunnie" Huang ("Glowstick A Go-Go") simply put, is an engineer. The Cardiff by the Sea, Calif., resident says he's somewhat of a hacker because he likes to explore complex systems and understand them at a deep level. "I've always liked the smell of new electronics. I think it is like the smell of a new

adventure. Every time I get a new piece of hardware, I like to look inside and learn everything I can from visual inspection."

Blaming his father for his hacker sensibilities, Bunnie says, "He would never let me touch electronic parts because they contained harmful compounds like lead. That just made me more curious about the subject." Bunnie now spends his time designing nanophotonic integrated circuits for a startup company, Luxtera. He's also a big fan of electronic music, both from a DJ and dance perspective.



Billy Hoffman ("Magnetic Stripe Reader") says he is too curious for his own good. "I like to take things apart, see how they work, see their shortcomings, and try to make them better."

Living in Atlanta gives him plenty of time to pursue outdoor activities as well

as seek input from his friends about possible technological advances he's working on. Some of Billy's current projects include a self-destructing hard drive, some radio frequency ID stuff, blogging technology, and spyware-cracking software. He's graduating this spring from the Georgia Institute of Technology with a computer science degree — anyone hiring?



As an illustrator who straddles the worlds of art and science, **Nik Schulz** ("Kite Aerial Photography," "\$14 Video Camera Stabilizer," and "5-in-1 Network Cable") loves to make things and has always appreciated well-drawn instructions. Working on the illustration for the Kite Aerial Photography project

was inspirational to him. "I remember thinking how amazingly thorough and well-presented Charles Benton's reference work was. The rig itself was also a triumph. He had created a product that reflected truly exceptional standards of design, function, and aesthetics, out of materials as humble as rubber bands and popsicle sticks."

The San Francisco resident continued, "It reinforced the idea that good design doesn't have to be expensive and that, in fact, the best design makes the most use out of the fewest resources. To have the opportunity to help illuminate these really clever projects for others is really enjoyable for me."



Photographer **Emily Nathan** ("Welcome to the Fab Lab" and "Kite Aerial Photography") became interested in photography because her dad had an Olympus OM-10 camera and a subscription to *National Geographic*. "I became obsessed early on with the *The New York Times Magazine* and with

pictures my dad had taken in vegetable markets in Israel." Attending art camps and taking shop class while growing up gave her a fondness for scientists and makers of all kinds. She herself has taken apart her fair share of calculators. Emily lives with her husband in San Francisco in a 100-year-old Victorian apartment when she's not surfing, shooting photos, or traveling, all of which she's been known to do at relatively the same time.

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YAK SHAVING

Stuck in the middle of a stack of stuff you're supposed to do? Sharpen your wool clippers. By Danny O'Brien and Merlin Mann

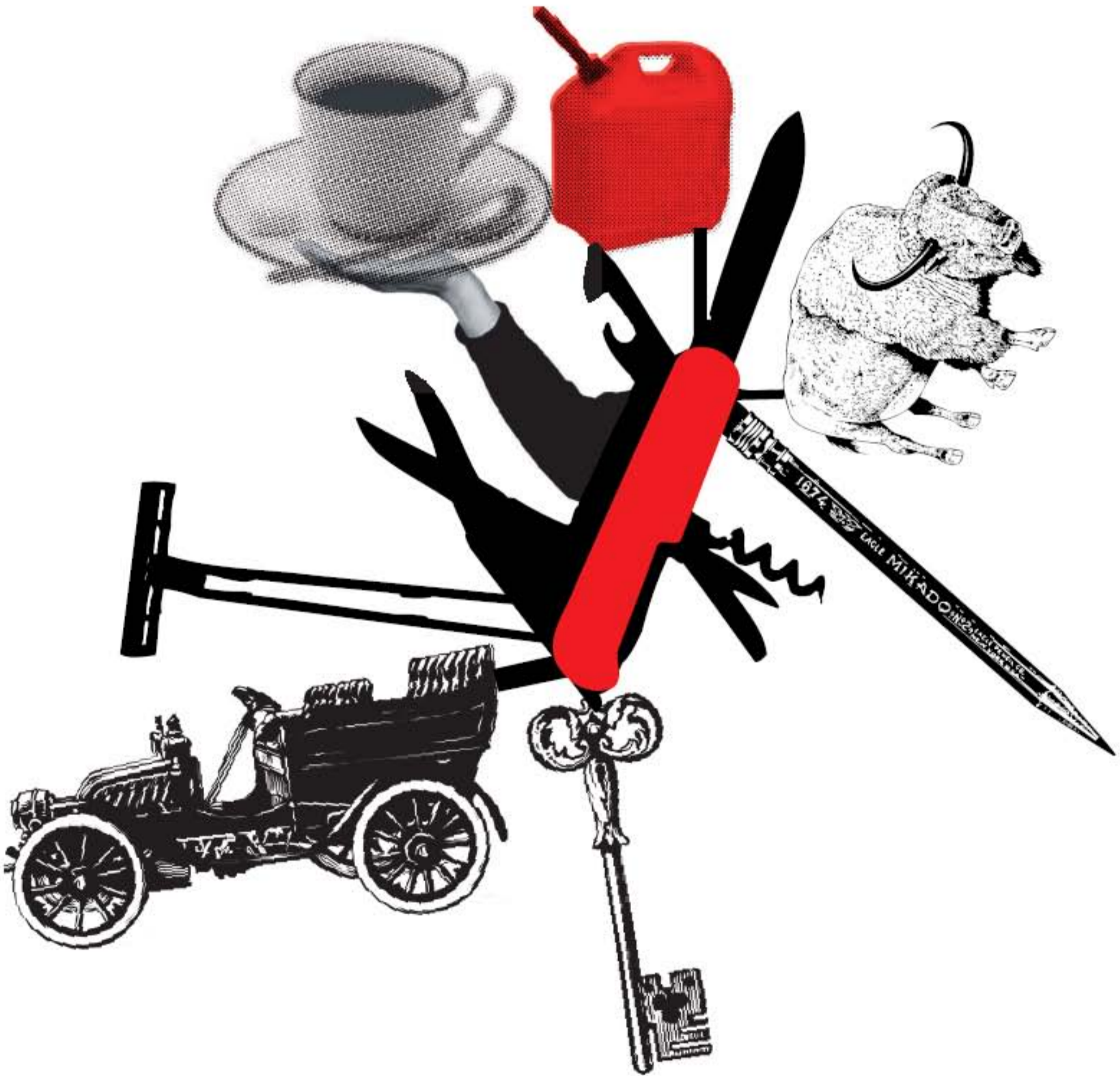


Illustration by Dennis Pasco

WE AT LIFE HACKS LABS HAVE

dedicated our careers to understanding how geeks hack their own lives to become super-productive monsters of speed and acuity. This has, unfortunately, led many people to assume that we are in some way super-organized ourselves.

Oh, as if. Nothing could be further from the truth. It's sort of like confusing the territory with the map, or the glamorous fashion supermodel with the creepy guys hanging out at the stage door, taking notes on everything she does.

We are those creepy guys (metaphorically, at least). We're trying to get our own lives sorted, and that's why we spend all our time staring at and standing disturbingly close to the effective geeks. It's hard work, and the longer you work at it, the harder it appears to be.

Take writing this article. Looks like a perfectly constrained job, doesn't it? Write a few words, paste them into an email, and send it to whatever home-made, clanking machine made of string, cornstarch, and organic squid ink the MAKE staff uses to construct the magazine. It turns out, however, that the time and effort expended between writing that first word and just reaching this paragraph has, by our estimates, been almost infinite.

It has required, among other duties, a careful cost-benefit analysis of whether to write it using Microsoft Word or a text editor using DocBook Lite XML; the meticulous examination of four Wikipedia articles (including re-editing two of them); the compromise coding of a plaintext-to-RTF conversion utility; several great pizzas; and a two-hour Googling distraction into exactly how one might make machines out of string and cornstarch.

About the only thing we didn't do was A) get the piece in on time, and B) shave a yak.

Well, that's only partly true. Actually, all of this was yak shaving. Yak shaving is the technical term* for when you find yourself eight levels deep — and possibly in a recursive loop — in a stack of jobs.

You start out deciding to tidy your room, and you realize in order to do that you'll need some more trash bags, so you need to go to the shops, which will involve you getting out the car, but the car needs gas, so you'll need to go to the gas station first, which means that you should probably find your gas discount card, which involves finding your keys, which are in this room somewhere...

What can we do? Our anti-yak-shaving research is still ongoing (current estimates indicate between

five minutes and 50 years before we have it licked). But we've got some guesses as to why hackers hit the problem more than others.

The problem is problems. We like solving puzzles. And, if we were honest, we'd admit that some of us like solving puzzles a bit more than we like solved puzzles. And, thanks to our upbringing in the infinitely tinkerable world of computers, we subconsciously believe that any problem is a puzzle to be fixed. When you have a Swiss Army knife of a mind, everything looks like it should be dismantled.

Other people — you know, people who actually get things done — don't have this problem. Much of the world, to them, is locked up, nailed to the floor, not something they can do much about. They navigate around mountains, rather than invent a new sort of crampon.

"Some of us like solving puzzles a bit more than we like solved puzzles."

Super-efficient hackers, we think, do something slightly different. They learn when to say no to the temptation of endless fiddling.

We're trying to get to that state ourselves. And, like anyone attempting to fix some busted code, the first step is sticking in a few breakpoints.

So, here's the Life Hack we're giving you: have a notepad (real or computer), and whenever you find yourself spawning a new sub-task, stop, record your task-switch, and note why you're doing it. The act of writing itself may give you pause: is this problem-solving really necessary? If it really is an essential task, you'll at least have a reminder of what you set out to achieve — and what that job was that you're supposed to be returning to.

Solving the world's problems is something good hackers achieve, often as a side effect. But you don't have to spend all your time lost in your own life's subroutines — even if that's where the best fun is to be had.

*Don't believe us? Check the Jargon File:

www.catb.org/~esr/jargon/html/Y/yak-shaving.html

Learn how to shave your yak more efficiently at Danny O'Brien's lifelife.com and Merlin Mann's 43folders.com.

A linear accelerator for studying high-energy physics costs around \$5 billion. But you can make one for about 30 bucks with four strong magnets, a wooden ruler, some plastic tape, and nine steel balls.

This easy project demonstrates the transfer of kinetic energy from one object to another. More importantly, it also shoots a steel ball really fast at the target of your choice. When each ball strikes the magnet in front of it, its kinetic energy is transferred to the next ball down the line. By the time the fourth ball shoots off the ruler, it possesses almost four times the energy of the first ball, which means it's moving faster, too. (The speed increase is proportional to the square root of the increase in kinetic energy.) This project takes just a few minutes to build once you have the parts, which can be ordered from scitoys.com.

1 GET



One 12" wooden ruler with a groove running through it



Four gold-plated neodymium-iron-boron magnets



Nine 5/8" diameter nickel-plated steel balls

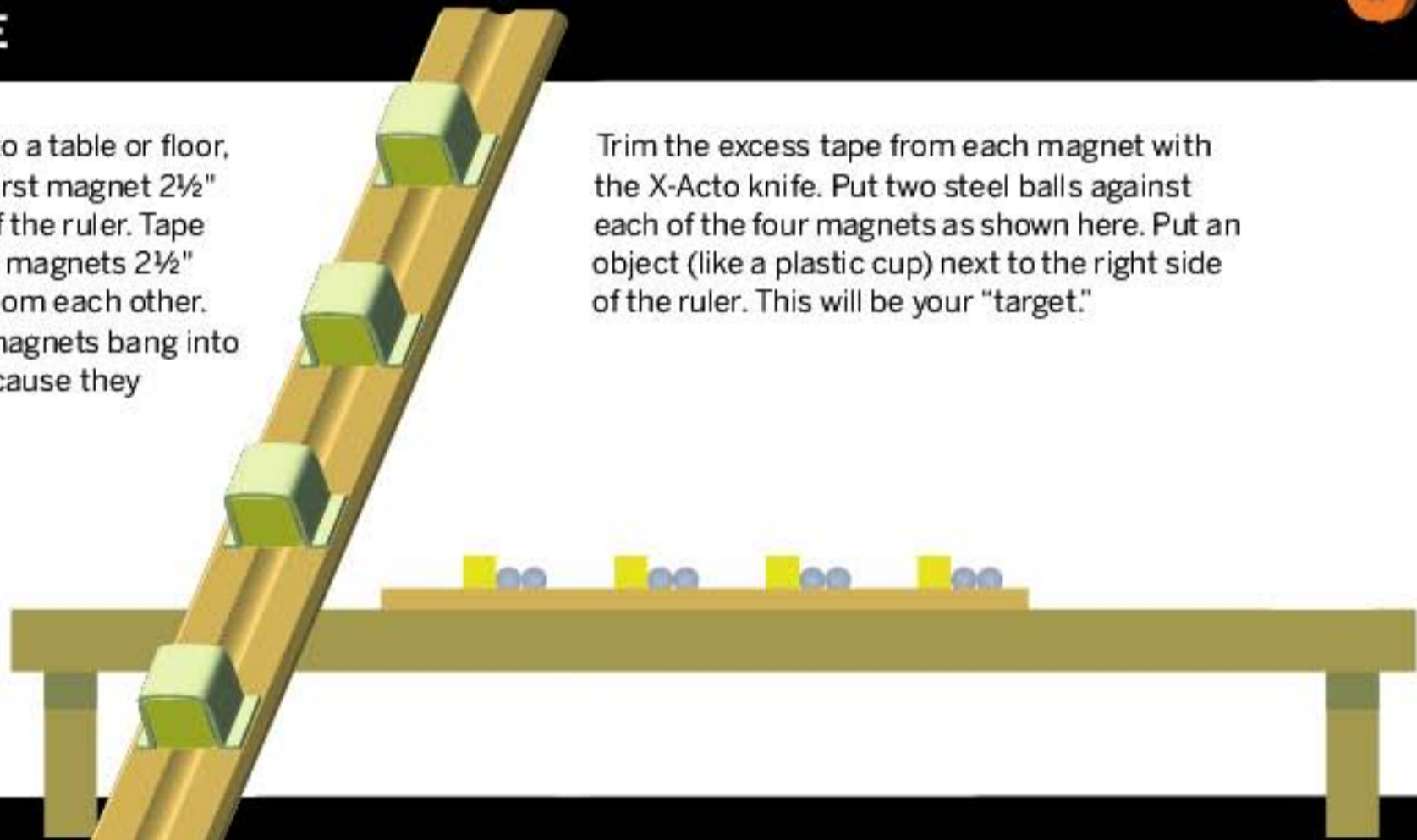


Scotch tape and an X-Acto knife

2 MAKE

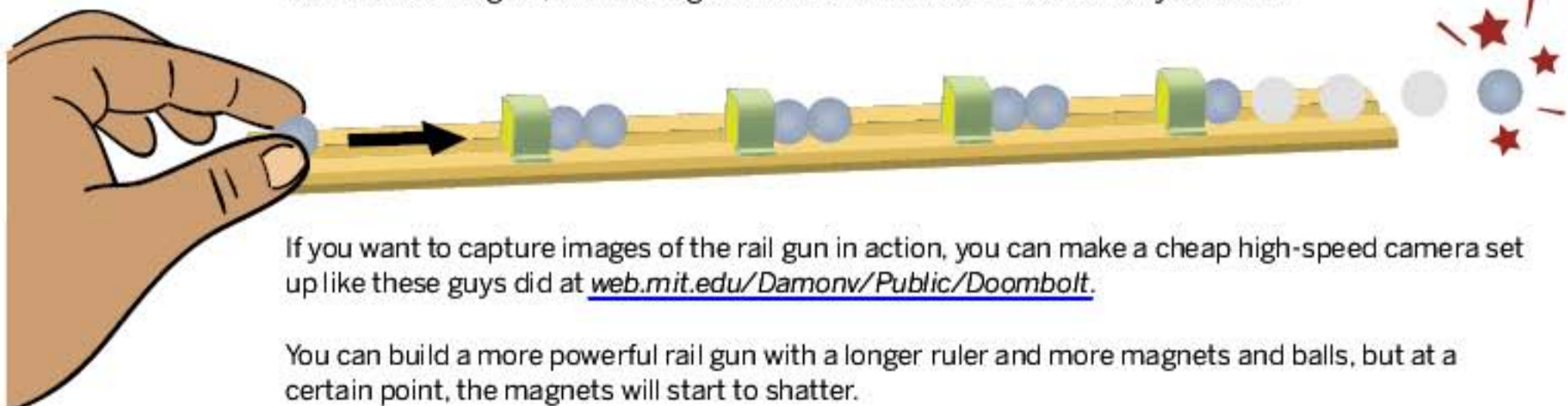
Tape the ruler to a table or floor, then tape the first magnet 2½" from the end of the ruler. Tape the other three magnets 2½" inches apart from each other. (Don't let the magnets bang into each other because they shatter easily).

Trim the excess tape from each magnet with the X-Acto knife. Put two steel balls against each of the four magnets as shown here. Put an object (like a plastic cup) next to the right side of the ruler. This will be your "target."



3 USE

Place a ball on the groove as shown. You might need to give it a gentle nudge. Once the ball hits the first magnet, the ensuing chain reaction will move too fast for you to see.



If you want to capture images of the rail gun in action, you can make a cheap high-speed camera set up like these guys did at web.mit.edu/Damonv/Public/Doombolt.

You can build a more powerful rail gun with a longer ruler and more magnets and balls, but at a certain point, the magnets will start to shatter.

NEWS FROM THE FUTURE

WILLIAM GIBSON ONCE SAID, "The future is here. It's just not evenly distributed yet." His words match up perfectly with my experience.

Time after time, I've watched people who are comfortable pushing the boundaries of technology — researchers and the kind of people who are called "hackers" in the computer world — show us something that looks like a clever trick, only to see it blossom years later into a whole new industry.

I've built my business — one of the largest and most successful computer book publishers in the world — by watching these people, whom I affectionately call "alpha geeks," and helping the technologies they pioneer find roots in the wider world.

So, for example, when Wi-Fi was first released as a local area network (LAN) technology, we saw hackers climbing on rooftops, placing homebrewed antennas to beam their office networks down to the local coffee shop. And we knew immediately that wireless networking was going to become much more ubiquitous than its corporate backers imagined.

This column celebrates news tidbits that, to me, hint at the shape of the future. I won't draw any conclusions; I'll just share some of the news headlines that are hitting the O'Reilly Radar. Make of them what you will.

You may notice that patterns begin to emerge: ubiquitous wireless networking, ubiquitous digital image recording, the surveillance society, robots in our midst, what Freeman Dyson calls "the domestication of biotechnology," automobiles and buildings as computers ripe for hacking....

Visit makezine.com for references to these items. In future columns, I'll drill down into some of this "news from the future."

If you are reading this magazine, you're probably one of those people who is shaping the future that's already here, so tell me what's on your radar. Send email to tim@oreilly.com.

Tim O'Reilly (tim.oreilly.com) is the founder and CEO of O'Reilly Media.

JAPANESE ROBOTS TO CARRY HUMANS

IMPLANTED RFID TAGS TO REPLACE CASH

INTERNET-CONTROLLED ROBOT TO BROWSE LIBRARY STACKS

MAN FLIES UNPOWERED ACROSS ENGLISH CHANNEL USING CARBON-FIBER WING STRAPPED TO HIS BACK

HOME DNA SEQUENCING KIT GOES ON SALE

WIRELESS STREET LAMPS FOR TRAFFIC MONITORING

GENETICALLY MODIFIED FLOWER DETECTS LANDMINES

ROBOT "DOG" LEARNS TO EAT "GOOD-TASTING" BLOCKS

GENE THERAPY CREATES SUPER-STRONG RATS

JAPANESE SCIENTIST INVENTS "MAGNETIC WOOD" TO BLOCK CELL PHONE SIGNALS

DIGITAL "GHOSTS" TO GUIDE STUDENTS AT COPENHAGEN UNIVERSITY

WIRELESS ACCESS POINT BUILT INTO LIGHT FIXTURE

ISRAEL DEVELOPING MICRODRONE SPY PLANES

HP EXPERIMENTS WITH "ALWAYS-ON" CAMERA

BRITISH GOVERNMENT LOBBYING FOR REMOTE CONTROL OVER AUTO ELECTRONICS TO STOP FLEEING CARS

ROBOTIC CONES CAN BE AUTOMATICALLY MOVED AROUND ON HIGHWAY

"SENSECAM" NECKLACE TAKES 2,000 IMAGES A DAY

U.S. WILL USE ROBOTS TO PATROL WATER SUPPLY

FLASH-MOB GANG WARFARE

SENSOR-ENABLED SHOE DYNAMICALLY RECONFIGURES ITSELF BASED ON CHANGING CONDITIONS



Monomania

No rational person denies that monorails are the greatest mode of urban transit ever. So **Kim Pedersen** built one in his backyard, making it the greatest backyard ever. The Niles Monorail, named for his family's Fremont, California neighborhood, treats riders to a looping, open-air journey between trees, across the back fence, above the pool, and alongside the house before making a hairpin turn over the driveway and returning to Kitchen View Station for disembarking.

The monorail's graceful track is supported by 4-inch square wooden pylons that range from five to eight feet in height, each anchored in two feet of concrete. Plain 4x8-inch beams comprise the straight sections, while curves are made from strips of $\frac{3}{8}$ -inch plywood that soaked in the pool before being bent and laminated together. The kid-size, 2-car trains run off of a 6-inch drive-wheel powered by twin motorcycle batteries and a 1-horsepower Badsey scooter motor, controlled by a 4-speed Winland WMC120 controller. One 6-hour charge,

and the monorail has enough juice to make casual runs all day long. The wood-framed cars have a painted sheet-metal exterior. A headlight in front, bellows (made of duct-tape material), and detailing inspired by Seattle's Alweg monorail complete the streamlined look.

Fifty-two-year-old Pedersen, who also founded a monorail enthusiast and advocacy group that boasts over 3,800 members in 73 countries, admits that he has a one-track mind — but now he and his kids can ride a monorail whenever they want.

—Paul Spinrad

» The Niles Monorail: monorails.org/tMspages/Niles.html

Top: The monorail took five years to make. The track runs 299 feet, 9 inches, and is supported by 36 pylons. Public transportation officials, take note: the total cost of materials for the project, including train, track, and hardware, was \$4,070.07, or about \$13.58 per foot. Pedersen points out that a mile-long track would run just under \$72,000.



Middle: Pedersen working on the track in August 1997. After experimenting with different methods and materials to make curved sections of track, Pedersen settled on using laminated plywood, which he soaked in the family swimming pool to make it easier to shape. He says it was difficult to maintain the curved shape when he drilled the sections together.



Bottom: An early concept drawing from 1988. Pedersen started sketching plans for a backyard monorail in 1969 when he was a junior in high school. His father nixed the idea, though, so he had to wait until he had his own house to build one. He started construction on the monorail in 1996.

