

MOTOWN REVIVAL
OUR SIX-PART PLAN TO
RENEW DETROIT **P. 54**

TESLA S
WE TEST THE
BEST EV **P. 37**

TAILGATING
GREAT GRILLING
GEAR **P. 21**

**MAKE YOUR
YARD
AWESOME**
12 UPGRADES IN
ONE WEEKEND—
REALLY! **P. 74**

Popular Mechanics

10.12

PopularMechanics.com • Volume 189, No. 10

STEALTH

New Threats, New Tech

Inside the Secret Battle
To Protect U.S.
Planes and Pilots

P. 68

After 16 years and
\$400 billion in development,
the F-35 Lightning II
faces growing risks.

DIY

Build a Woodshed
Protect Your Digital Data
Cordless-Drill
Test & More!

P. 79

Since 1902

THE ENVIRONMENTALLY CONSCIOUS CAR THAT GOES ALL THE WAY TO THE ENVIRONMENT.

A gas-free commute is great. But sometimes you want to get out of the city and actually see some of that environment. With the Chevrolet Volt, you can drive 35 miles gas-free and tailpipe-emissions-free, and up to 375 miles with a full charge and a full tank of gas! It's electric when you want it, gas when you need it. Learn more at chevy.com/volt. It's more car than electric.



¹ EPA-estimated 35-mile range based on 94 MPGe (electric); 340-mile range based on 35 MPG city/40 highway (gas). Actual range varies with conditions. Available to order at participating dealers.

2012 Chevrolet Volt. Chevy Runs Deep





PopularMechanics

IGNITION

10.12

Will Brick, shop manager of TechShop Detroit, is helping to lead the city to a bright future.

INSIDE

IGNITION

Letters, Complaints, Events 01

TECH WATCH

News, Trends, Breakthroughs 11

UPGRADE

Gear, Tools, Gadgets 21

AUTO INTEL

Test Drives, Car Tech,
Hot Rides 37

COLUMNS

Jay Leno's Garage Aircraft-
engine-powered autos 50

FEATURES

Detroit 2025 From cutting-edge urban planning to a DIY business boom, here's our plan to get the Motor City firing on all cylinders once again. BY BILL MORRIS 54

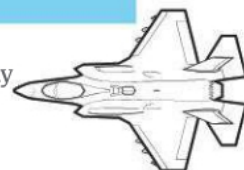
The Stealth War New radar and missile technology can target planes once thought to be undetectable—even America's most advanced stealth aircraft are at risk.

BY JOE PAPPALARDO 68

48 Hours, 12 Easy Upgrades Take on this home-improvement marathon. Revamp your home—and your stature in the neighborhood—over a single weekend. BY THE EDITORS 74

ON THE COVER

Set to enter service in 2016, the F-35 is America's latest stealth warplane. Although reported to be more easily detected by enemy radar compared with past stealth aircraft, what the Lightning II lacks in invisibility, it compensates with its electronic warfare package, capable of jamming radar and incoming missiles.



PHOTOGRAPH THIS PAGE BY SARAH SHATZ

PopularMechanics

W
weekend

26 Pages of DIY

80. **Tech**

How to protect your digital data.

Early Adopter Halloween

DIY: Squishy Circuits.

Digital Clinic Record TV on your computer.92. **Home**

Build this simple shed to keep your firewood neat and dry.

Tool Test Brushless-motor drill and impact drivers.**Home Clinic** The right steps to take to fix a problematic chimney.100. **Science**

See life from a new perspective with a DIY iPad microscope.

102. **Auto**

Save your back and ditch the jack; install an auto lift in your garage.

Car Clinic How to diagnose and replace a busted wheel bearing.112. **Adventure**

Rig up a slackline and hone your balance.



Randy Bolen, here in Victoria, British Columbia, loves our gadget coverage: "You always show cool tech toys that I want."

What You Said

(ABOUT OUR AUGUST ISSUE AND MORE)

We read all of your comments, tweets, and handwritten letters. And sometimes we even respond with our own handwritten letters.

CURATED BY
ALYSON SHEPPARD



PM's Larry Webster, now the editor-in-chief of our brother publication *Road & Track*, wrote about how some carmakers are funneling manufactured engine sounds into the cabin to enhance driver experience ("Making Noise," August). Dan Gassaway of Mebane, N.C., thought the auto industry should take it even further. "I walk or ride my bike whenever I can," he writes. "But the newer fuel-efficient hybrids (ahem, Prius) have a tendency to sneak up on pedestrians like me who cannot hear them. A little more noise than the current stealth silence may give people a heads-up that a motor vehicle is approaching." ● Brad Kramer of Mandan, N.D., disagreed with our advice to wait until the last minute to season a steak ("DIY Adventure," August). "Salt may indeed pull a bit of water from the meat, but it's fat that makes meat moist, not water," he writes. "That story did make me hungry for a nice thick steak, though, so if you'll excuse me, I'll be seasoning mine right now and cooking it in about 6 hours."

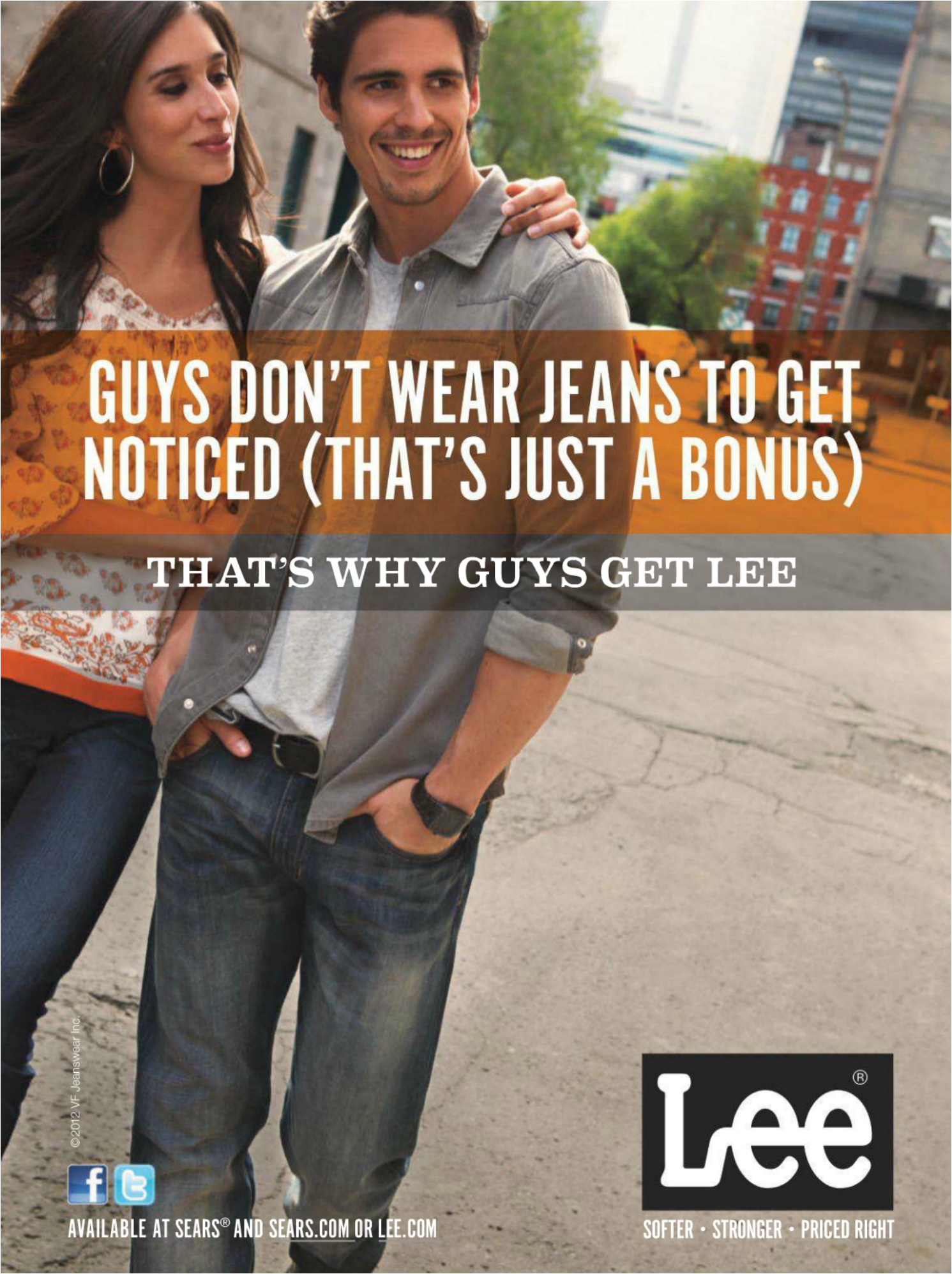
IGNITION

COMPLAINTS
DEPARTMENT

?#@*%!



Guys like me who work with our hands and brains don't like "green." I am responsible and respect my home and environment, but "green" isn't science—it's control. There is no place for that kind of stuff in this type of magazine. **BRUCE KALASHIAN, PORT ORANGE, FL**



**GUYS DON'T WEAR JEANS TO GET
NOTICED (THAT'S JUST A BONUS)**

THAT'S WHY GUYS GET LEE

©2012 VF Jeanswear Inc.



AVAILABLE AT SEARS® AND SEARS.COM OR LEE.COM



SOFTER • STRONGER • PRICED RIGHT

And now some notes from our adoring Twitter followers:

- I think I win the Biggest Giant Nerd award—cozied up with my copy of POPULAR MECHANICS on a Friday night. Yeah, baby. — @QUARKUM
- Reading @PopMech has provided me with lots of useful information, yet again. New adventure location, countless car repair tips. — @RVATITO
- Stories like “How to build a backyard bike track” are the reason my wife hates @PopMech. — @VEXAPE
- The front covers of @PopMech are getting crazier every month! — @WHEATLN2

TALK TO US

✉ email popularmechanics@hearst.com
 ✉ snail mail 300 West 57th St., New York, NY 10019
 📄 subscribe subscribe.popularmechanics.com

IGNITION



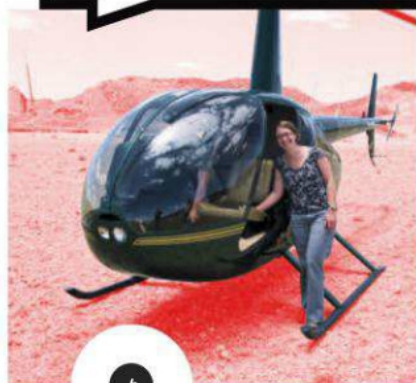
WHAT YOU SAID

- (a) Associate auto editor Andrew Del-Colle takes flight lessons in a single-prop over Long Island, N.Y. You know, just for fun.
- (b) Contributing editor Kalee Thompson grabs a helo ride to report on a new rare-earth mine in Mountain Pass, Calif.
- (c) Special projects photo assistant Katrina Zook gets a lesson in slacklining from pro Josh Greenwood in Clintondale, N.Y., between shots for DIY Adventure [page 112].
- (d) Senior tech editor Glenn Derene test drives Tesla's long-awaited electric luxury sedan, the 2013 Model S [Auto Intel, page 37].



What We're Up To

(PM NEWS & EVENTS & STAFFERS ON THE SCENE)



b



a

We're really busy in October

OCT. 4
PM Breakthrough Awards

OCT. 21-27
National Chemistry Week

OCT. 30
Assassin's Creed III released

TBA
First commercial resupply mission to the International Space Station (SpaceX)



d



INTRODUCING ZzzQuil™ SLEEP-AID.
BECAUSE SLEEP IS A BEAUTIFUL THING.™

The non-habit forming
sleep-aid from the
makers of NyQuil®.
It's not for colds.
It's not for pain.
It's just for sleeping soundly,
so you can wake refreshed.

Use as directed for occasional sleeplessness. Read each label.
Keep out of reach of children.

© Procter & Gamble, Inc., 2012.



PopularMechanics

JAMES B. MEIGS

EDITOR-IN-CHIEF, EDITORIAL DIRECTOR,
MEN'S ENTHUSIAST GROUP

EXECUTIVE EDITOR **David Dunbar**
DESIGN DIRECTOR **Michael Lawton**
DEPUTY EDITOR **Jerry Beilinson**
MANAGING EDITOR **Michael S. Cain**

Editorial

SENIOR EDITOR, HOME **Roy Berendsohn**
SENIOR EDITOR, TECHNOLOGY **Glenn Derene**
SENIOR EDITOR, NEWS **Joe Pappalardo**
ASSOCIATE EDITOR **Erin McCarthy**
ASSOCIATE EDITOR, AUTOMOTIVE **Ben Wojdyla**
ASSOCIATE EDITOR, AUTOMOTIVE **Andrew Del-Colle**
ASSISTANT EDITOR, TECHNOLOGY **Rachel Z. Arndt**
COPY CHIEF **Robin Tribble**
RESEARCH DIRECTOR **David Cohen**
ASSOCIATE EDITOR, RESEARCH **Alyson Sheppard**
ASSISTANT TO THE EDITOR-IN-CHIEF **Theresa Breen**
WEST COAST EDITOR **Ben Stewart**
SPECIAL PROJECTS EDITOR **Joe Bargmann**

Art

SENIOR ART DIRECTOR **Peter Herbert**
ASSOCIATE ART DIRECTORS **Mike Ley, R. Scott Wells**
INTERACTIVE DESIGNER/ILLUSTRATOR
Anthony Verducci

Photography

DIRECTOR OF PHOTOGRAPHY **Alyson Torrisi**
SENIOR ASSOCIATE PHOTO EDITOR **Michele Ervin**

Editorial Board of Advisers

Buzz Aldrin (APOLLO 11 ASTRONAUT)
Shawn Carlson (SOCIETY FOR AMATEUR SCIENTISTS)
David E. Cole (CENTER FOR AUTOMOTIVE RESEARCH)
Saul Griffith (OTHERLAB)
Thomas D. Jones (NASA ASTRONAUT)
Dr. Ken Kamler (MICROSURGEON)
Gavin A. Schmidt (NASA GODDARD INSTITUTE
FOR SPACE STUDIES)
Amy B. Smith (MIT)
Daniel H. Wilson (ROBOTICIST)
Wm. A. Wulf (NATIONAL ACADEMY OF ENGINEERING)

Senior Correspondents

Davin Coburn, Alex Hutchinson, Erik Sofge,
Logan Ward, Jeff Wise
PYROTECHNICS & BALLISTICS EDITOR
William Gurstelle
MYTHBUSTING EDITORS
Jamie Hyneman, Adam Savage
GARAGE PROPRIETOR **Jay Leno**
RESIDENT CONTRARIAN **Glenn Harlan Reynolds**

Production

ASSISTANT MANAGING EDITOR **Natalie Neusch**

Imaging

DIGITAL IMAGING SPECIALIST **Steve Fusco**

PopularMechanics.com

ONLINE DIRECTOR **Angela Diegel**
ONLINE EDITOR **Andrew Moseman**
ONLINE PRODUCER **Carl Davis**

Popular Mechanics Interactive

ART DIRECTOR, MOBILE PLATFORMS **John Walker**
DEPUTY MANAGING EDITOR, MOBILE PLATFORMS
Ed Manning
DEVELOPERS **Alexander Karpedinis, Johnny Tablada**
PRODUCERS **Spencer Lloyd, Jeff Zinn**

Contributing Editors

Andrew English, John Galvin, Jim Gorman,
Chris Grundy, Carl Hoffman, John Pearley Huffman,
Dan Koepfel, Fred Mackerodt, Joe Oldham,
Barbara S. Peterson, Elizabeth Svoboda,
Kalee Thompson, Joseph Truini, James Vlahos,
Basem Wasef, Kevin A. Wilson, Barry Winfield

Contributing Photographers & Illustrators

Chris Buck, Jamie Chung, Christopher Griffith,
Dennis Kleiman, Martin Laksman, Mark Mahaney,
Axel de Roy, Dan Saelinger, Sarah Shatz,
Vladimir Shelest, Art Streiber, Dan Winters

Special Projects Team

Jon M. Chang, Michael Frank, Heather Lockwood
Hughes, Julie Knetzer, Miriam Kramer, Keziah
Makoundou, Paula Rackow, Chris Raymond, Greg
Robertson, Michael Roselli, Steve Rousseau, Janet
Stafford, Katrina Zook

Employee of the Month

Joe Pappalardo had a busy summer. From riding shotgun with French Foreign Legion soldiers through Guianan jungles to cheering the Mars Science Lab landing with NASA engineers in California, he's PM's man on the ground when bullets or rockets fly.



BILL CONGDON

PUBLISHER & CHIEF REVENUE OFFICER

ASSOCIATE PUBLISHER **Jane Wladar** GENERAL MANAGER **Bruce Mitnick**

Integrated Marketing

EXECUTIVE MARKETING DIRECTOR **Mike Kresch**
ASSOCIATE PUBLISHER/MARKETING **Zvia Herrmann**
MARKETING DIRECTOR **Barbara Serino**
CREATIVE DIRECTOR **Glen Fuenmayor**
SENIOR MARKETING MANAGERS **Deanna Ambrosio, Bonnie Harris**
MARKETING MANAGERS **Chad Meany, Amanda Luginbill**

Administration

ADVERTISING SERVICES DIRECTOR **Regina Wall**
ADVERTISING COORDINATOR **Anna Chelak**

Digital

ADVERTISING DIRECTOR **Matthias Wolf**
ACCOUNT MANAGER **Allison Cawley**

Production

GROUP PRODUCTION DIRECTOR **Karen Otto**
GROUP PRODUCTION MANAGER **Jackie Beck**
ASSOCIATE PRODUCTION MANAGER **Karen Nazario**

Circulation

CONSUMER MARKETING DIRECTOR **William Carter**

Advertising Sales Offices

NEW YORK
EAST COAST SALES MANAGER **Ray Rienecker** 212/649-2876
ACCOUNT AND APPS MANAGER **Cameron Albergo** 212/649-2901
ACCOUNT MANAGER **Matthew Schwagerl** 212/649-2902
ACCOUNT MANAGER **Samantha Rady** 212/649-2867
ASSISTANT **Amanda Marandola** 212/649-2898

LOS ANGELES

CALIFORNIA SALES MANAGER **Anne Rethmeyer** 310/664-2921
ACCOUNT MANAGER **Amy Suprenant** 310/664-2921
INTEGRATION ASSOCIATE **Michelle Nelson** 310/664-2922

CHICAGO

MIDWEST DIRECTOR **Richard Bisbee** 312/251-5312
MIDWEST DIRECTOR **Spencer J. Huffman** 312/984-5191
ACCOUNT MANAGER **Rikka Runyon** 312/251-5355
ASSISTANT **Yvonne Villareal** 312/984-5196

DETROIT

REGIONAL DIRECTOR **Melissa Homant** 248/614-6066
ASSISTANT **Toni Starrs** 248/614-6011
HEARST MAGAZINES SALES, LLC

DALLAS

Patty Rudolph 972/533-8665 PR 4.0 MEDIA

SPECIAL SECTION SALES

Beth Boyle 914/461-3269 SPECIAL ADITIONS

DIRECT RESPONSE ADVERTISING

SALES MANAGER **Brad Gettelfinger** 212/649-4204
ACCOUNT MANAGER **John Stankewitz** 212/649-4201

CLASSIFIED ADVERTISING REPRESENTATIVE

Kathleen Gleason 888/473-0788; FAX: 708/352-4094 KLASSMARK

SENIOR VICE PRESIDENT & PUBLISHING DIRECTOR, MEN'S GROUP **Jack Essig**

PUBLISHED BY THE
HEARST CORPORATION

Frank A. Bennack, Jr.
EXECUTIVE VICE CHAIRMAN
& CHIEF EXECUTIVE OFFICER

Steven R. Swartz
CHIEF OPERATING OFFICER



HEARST MAGAZINES DIVISION

David Carey
PRESIDENT

Gilbert C. Maurer
PUBLISHING
CONSULTANT

Michael Clinton
PRESIDENT, MARKETING
& PUBLISHING
DIRECTOR

Mark F. Miller
PUBLISHING
CONSULTANT

John P. Loughlin
EXECUTIVE VICE
PRESIDENT & GENERAL
MANAGER

Ellen Levine
EDITORIAL DIRECTOR



THE KID WANTS TO KNOW

Are you a kid with a question? Ask us!
Email popularmechanics@hearst.com.



**"Can atoms
get so hot that
they vibrate
faster than
the speed of
light?"**

**Zimri L., 11,
Monson, ME**

While nothing can travel faster than the speed of light, matter can still get infinitely hot, says Csaba Csaki, professor of physics at Cornell University. "Since there is no limit on how much energy a particle can have, there is no limit on how hot matter can get," he says. The energy of an atom is proportional to the square of its velocity, but the rules change once you approach the speed of light, he explains. A particle accelerated to 0.99999999 times the speed of light has twice the energy of one at 0.99999996. — STEVE ROUSSEAU



TEFLON

CHROMIUM

DIAMOND-LIKE CARBON

NIOBIUM

4 STRENGTHENING LAYERS

MACH3

**LASTS 2X LONGER
THAN A DISPOSABLE***

Gillette

*VS. GILLETTE® 2-BLADED DISPOSABLES, COMPARING AVERAGE
NUMBER OF SHAVES REPORTED BY CONSUMERS IN A 2010 NATIONAL SURVEY.

THE BEST A MAN CAN GET™

PopularMechanics.com

AUTOMOTIVE SCIENCE TECHNOLOGY HOME HOW-TO CENTRAL VIDEO

Mobil 1
Extended
Performance

Keep your engine running like new with Mobil 1 Extended Performance Synthetic Motor Oil. Its advanced fully synthetic formulation is proven to protect your engine for up to 15,000 miles between oil changes.

Mobil 1
Get the full story at mobil1.us

CIGARETTES

STAND UP FOR WHAT
YOU BELIEVE IN, AND
VOTE
NOVEMBER 6



NaturalAmericanSpirit.com
Website Restricted to 21+

SURGEON GENERAL'S
WARNING: Smoking Causes
Lung Cancer, Heart Disease,
Emphysema, And May
Complicate Pregnancy.

No additives in our
tobacco does **NOT** mean
a safer cigarette.

© SFNTC 4 2012

ON THE WEB

This month at PopMech.com, keep your car alive as it creeps past 200,000 miles, build a shed to store all the junk that's cluttering your garage, see wild custom vans, and read these great stories:

UNDER THE SEA

You kick off your shoes, lie back on the fluffy hotel-room bed . . . and a school of fish zooms by overhead. This is no dream. It's one of the growing number of underwater hotels providing stunning views of ocean depths. And hotels are not the only example of marvelous undersea engineering.

popularmechanics.com/underwater



BOXY BUT BEAUTIFUL

We live in an era of curvilinear cars. But the 1980s and early '90s were the heyday of angular autos such as the Volvo 240 and the original BMW M3, as well as classic off-roaders like the Jeep Cherokee and Chevy Blazer. These boxes rock.

popularmechanics.com/boxycars

SCI-FI GETS REAL

The robotic exoskeletons defense contractors are building today might not be as sexy as Iron Man's high-tech suit, but they represent one place where science-fiction gadgetry is becoming reality. Check out the rest:

popularmechanics.com/scifigadgets

IGNITION



FOLLOW POPMECH

For plenty more from our editors, follow Popular Mechanics on:

Twitter [@PopMech](https://twitter.com/PopMech)

Facebook facebook.com/popularmechanics

Tumblr popmech.tumblr.com

**Pop
Mech**
USED CAR
CHECKLIST

LET THE POPMECH EXPERTS GUIDE YOU
THROUGH AN INSPECTION OF A USED CAR.
AVAILABLE FOR THE IPHONE. DOWNLOAD FOR FREE TODAY.

Presented by Mobil 1™

ENTER FOR YOUR CHANCE TO

WIN A 2013
FORD MUSTANG
CUSTOMIZED

BY JUSTIN PAWLAK
& VAUGHN GITTIN JR.



SCAN THIS QR TO ENTER!

FALKEN
TIRE
WE GET YOU GOING™

NO PURCHASE NECESSARY. A PURCHASE WILL NOT INCREASE YOUR CHANCES OF WINNING.
Must be legal resident of the 50 United States (D.C.) 18 years or older as of the start date. Sweepstakes
ends 10/15/12. For entry and official rules with complete eligibility, prize descriptions, odds disclosure and
other details, visit www.Facebook.com/FalkenTire. Sponsored by Falken Tire, Corp. **Void where prohibited.**
Actual Mustang may vary. The promotional pictures and description of the sweepstakes prize are merely
descriptive and generally representative of the mustang sweepstakes prize.

Visit us at falkentire.com

GoPro®
Be a **HERO.**



Actual GoPro video, captured from camera mounted on weather balloon. Watch more on the GoPro Network at gopro.com.

World's Most Versatile Camera

Wear it. Mount it. Love it.



HD HERO2
2X MORE POWERFUL
MSRP: \$299.99

11MP Professional Sensor
2X Sharper Glass Lens
2X Faster Image Processor
1080p | 960p | 720p | WVGA
Full 170° | Medium 127° | Narrow 90° FOV
120 | 60 | 48 | 30 Frames Per Second
11MP Ten Photo Burst / Second
Wi-Fi BacPac™ + Wi-Fi Remote Compatible

gopro.com

FEATURED EXPANSION ACCESSORIES



Wi-Fi Combo Kit
(Wi-Fi BacPac + Wi-Fi Remote)



LCD BacPac™



Battery BacPac™



3D HERO® System



Chest Mount
Harness



HD HERO
Wrist Housing



Head Strap Mount



Suction Cup
Mount



Handlebar Seatpost
Mount



Vented Helmet
Strap

Tech WATCH

NEWS

TRENDS

BREAKTHROUGHS

1

A glimpse inside one of the particle detectors that rewrote physics.

"The discovery tells us that nature is simpler than most theorists expected."

— NEIL TUROK, HEAD OF CANADA'S PERIMETER INSTITUTE FOR THEORETICAL PHYSICS



BREAKTHROUGH

The Hunt Is Over

Physicists were thrilled when two teams at the Large Hadron Collider in Switzerland found the elusive Higgs boson particle. Everyone else was a little confused. Higgs is the final missing piece of the Standard Model of particle physics; it explains why matter weighs something rather than nothing. Take away the Higgs, says Sally Dawson, a theoretical physicist at Brookhaven National Laboratory, and "the predictions aren't just a little wrong, they're infinitely wrong." Here are three more reasons to be excited. — ALEX HUTCHINSON

1 GROUCHO MARX

Physicists worry about what they call the Groucho Marx effect—that any universe simple enough to be understood is too simple to produce a mind capable of understanding it. The



➔ discovery of the Higgs boson right where physicists were looking for it is a great sign that the universe isn't too complicated for us to understand after all. "It's a new clue to the big bang," says Neil Turok, director of Canada's Perimeter Institute for Theoretical Physics. "It gives us hope that we can really describe what was going on at that time."

2 IMPERFECT PREDICTIONS

What's most exciting for young physicists isn't what the predictions got right—it's what they got wrong. Early indications suggest that the Higgs boson isn't behaving quite as predicted when it decays into other particles at the end of its ultrashort lifetime. So far, it's decaying into photons more often than expected and into other particles less often. One possible explanation: The Higgs itself is a composite particle made of smaller particles, a prospect that could help to explain the mysterious dark matter that permeates the universe.

3 TECHNOLOGIES TBD

Even Peter Higgs, the 83-year-old physicist who helped predict the new particle in the 1960s, was stumped when asked about the new discovery's practical applications. "I have no idea," he admitted. That doesn't mean there won't be any, Brookhaven physicist Howard Gordon says: "When Einstein proposed relativity, no one thought of its application to GPS." Higgs's discovery sheds light on the energy stored in the fabric of space—and gives us a chance to harness it.



TECH WATCH

ALTERNATIVE ENERGY

Green Crude

A

lgae has been used to make fuel in laboratories, but its low yield and high cost haven't made it profitable on an industrial scale. San Diego-based Sapphire Energy has built a 300-acre integrated algal biorefinery in New Mexico to prove the concept can pay. The facility will be finished courtesy of a \$144 million influx from investors. It's expected to produce about 1.5 million gallons of crude by 2014 for about \$85 a barrel.

— ALEX HUTCHINSON

HOW IT WORKS
The algae created by Sapphire produces an oil that is molecularly similar to light sweet crude. This oil can be processed in existing refineries to make gasoline, diesel, and jet fuel.



Tomato Tech

BREEDERS, SCIENTISTS, AND ENGINEERS ADAPT THE FRUIT—IT'S NO VEGETABLE—TO THE 21ST CENTURY.

BY STEVE ROUSSEAU

BREEDING STOCK

In May an international team of scientists announced it had sequenced the tomato's 35,000 genes. The knowledge could lead to larger yields, disease resistance, and great flavor. In a recent study researchers at the University of Florida identified key traits of a superior-tasting tomato, such as high levels of sugar and aroma-producing chemicals known as volatiles.

BORN TASTY

Industrially bred tomatoes do not have the flavor of heirlooms; now we know why. University of California, Davis, and Cornell researchers pinpointed a genetic link to the mass-ripened tomato's blandness. The ripening mutation bred into the fruit disables a gene responsible for chloroplast production. Fewer chloroplasts means less sugar and thus the bland taste, says Ann Powell of UC Davis.

SMOOTH DELIVERY

MIT researchers have developed LiquiGlide, a coating that causes ketchup to effortlessly slide free from its glass prison. Crafted from edible materials, the coating contains a lubricant for the ketchup to slip on. To keep it from leaching into the condiment, a finely grooved surface is placed underneath the coating; the ridges work like pores in a sponge, holding the lubricant in place.

A close-up photograph of a hand holding a paintbrush, applying a thick coat of yellow paint over a piece of white tape that has been applied to a wall. The brush has dark bristles and a silver ferrule. The tape is partially covered by the paint, and the wall surface is visible in the background.

THE ONLY
SHORTCUT
YOU'LL TAKE IS
TO THE JOB.

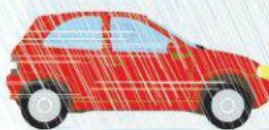
You know the difference between getting the job done and doing the job the best it can be done. It's why you demand reliability, precision, and superior results. Shurtape demands the same. So you can give every job the exceptional effort that it deserves. For more information, go to www.shurtape.com.

© 2012 Shurtape Technologies, LLC

Shurtape®
TRUE TO YOUR WORK™

NEWS BRIEF / Beaming Between Raindrops

ILLUSTRATION BY ANGIE WANG



Flick on your high beams in a storm and all you see is a wall of rain or snow. Researchers at Carnegie Mellon have a solution: smart headlights that use a camera to monitor the position of drops, then adjust a collection of light beams to shine between them. The prototype can adjust to the position of raindrops within 13 milliseconds, and at city driving speeds it can avoid up to 80 percent of visible rain in a heavy storm. — A.H.

TECH WATCH

FORENSIC SCIENCE

Wild CSI

Forensic investigators use any information they can to solve crimes, including the clues generated by birds, plants, and insects interacting with human corpses. Increasingly, specialists in natural-science fields are adapting their research to better support police. It's grim, necessary work that helps to identify corpses, determine if foul play was involved, and catch criminals. Here are some new postmortem science studies that bring more certainty to crime scenes. — SARAH FECHT



Vulture Variability

Scavenging by vultures can make it extremely difficult for forensic scientists to estimate time of death. One study found that it took 37 days for a flock of vultures to discover a human corpse that had been laid out in an experimental enclosure but only 5 hours to strip the body down to a pile of bones. Researchers are using GPS to discern patterns in the way vultures scatter remains.



Bug Spray

Insect repellents can keep bugs off a body—even after death. New research shows that when pig carcasses are doused with DEET, they attract fewer bugs and decompose more slowly, which could cause forensic entomologists to underestimate a person's time of death by several days.



Green Grave Markers

Digging a grave may alter nearby plants, says a new study. Although the presence of a buried body doesn't appear to affect which types of plants grow above a grave, upturned soil favors plants that are good at colonizing disturbed areas. These clues might be useful in the search for buried bodies.



The Nose Knows

Cadaver-sniffing dogs are often trained using pig remains, but a new study reveals that the volatile organic compounds (aka odors) produced by decaying pigs are significantly different from the odors of decaying human bodies. Decomposed chicken carcasses were actually a closer match to humans. The findings could help scientists devise more effective training aids for the dogs.



NEWS BRIEF /

Firetrap

Modern houses favor open, airy living spaces instead of compartmentalized rooms. That means that interior house fires burn faster and hotter than they used to, reaching flash-over—the point at which contents start bursting into flame simultaneously—more quickly. To test new techniques for fighting this type of fire, the New York City Fire Department in collaboration with the National Institute of Standards and Technology set fire to 20 abandoned townhouses, formerly Coast Guard barracks, on Governors Island. One of the key goals: Investigate different ways of ventilating a burning building, since kicking open a door can sometimes blow in enough oxygen to trigger flash-over. Each townhouse was outfitted with 100 sensors to monitor temperature, heat flow, and gas levels, and the results will be used to suggest changes to firefighting tactics and building codes.

— ALEX HUTCHINSON

1&1 MY WEBSITE

BUILDING A BUSINESS WEBSITE IS EASY.

Choose from fully customizable professional layouts, text, and images that compliment your auto repair business. Everything you need for a successful web presence is included – social media integration and more!

SELECT

Your Business Type



CUSTOMIZE

Your Website With Text Pictures & More



YOU'RE ONLINE!

No software installation or web design experience required.

NEW FEATURES

- SEO Spotlight*
- Web Apps

No waiting, no worrying and no extra costs. All you need is an internet connection. Professionally written content and graphic elements created just for mechanics and auto repair businesses are included with your website package and can be customized or changed online at any time.



1&1 MY WEBSITE
TRY IT FOR
FREE!

30 day free trial, then just \$9.99 per month*

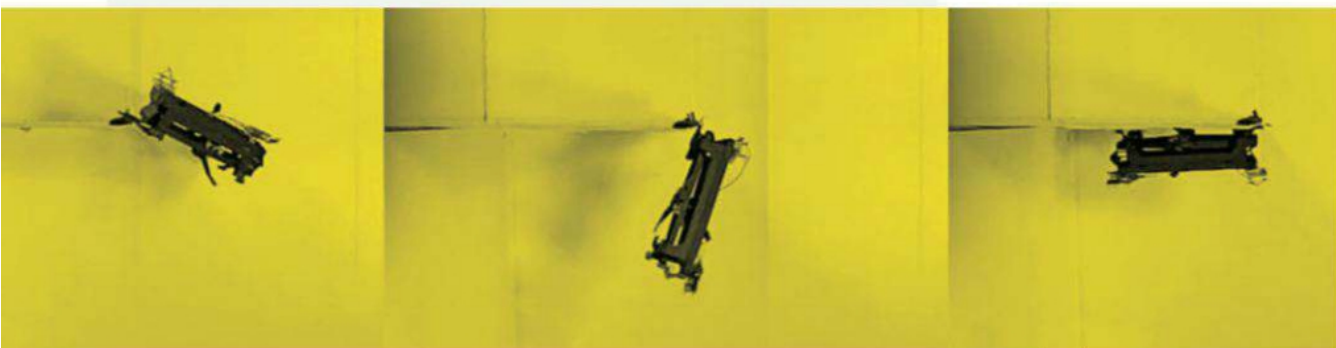
Includes a **FREE .COM** domain with Private Registration.

1&1



www.1and1.com/popmechanics
1-877-461-2631

*12 month minimum contract term applies after 30 day free trial. SEO Spotlight feature available with select packages only. Visit www.1and1.com for billing information and full promotional offer details. 1&1 and the 1&1 logo are trademarks of 1&1 Internet AG, all other trademarks are the property of their respective owners. © 2012 1&1 Internet, Inc. All rights reserved.



▲ ROBOT



▲ GECKO

BIOLOGICAL INSPIRATION

Escape Artists

To survive while being chased by predators, gecko lizards leap off ledges at top speed—then use their rear feet as grappling hooks to catch themselves before they fall. The wily animals then swing to the underside of the ledge, disappearing from a predator's view. University of California, Berkeley, biomechanics and computing experts analyzed the maneuver in order to train a six-legged robot to do the same. The ultimate goal is to produce small search-and-rescue robots that can match the agility of lizards over broken terrain to reach victims quickly. The researchers fit the robot's rear legs with Velcro for grip. — ALEX HUTCHINSON

TECH WATCH



Lying Eyes: Debunked

THE EYES MAY BE WINDOWS TO THE SOUL, BUT THEY DO NOT OFFER A RELIABLE VIEW OF WHO IS TELLING THE TRUTH.

Shifty-eyed liars always give themselves away: They look to the left when they're telling the truth but look to the right when they're fibbing. At least that's what proponents of neuro-linguistic programming teach in investigator-training courses. But the claim doesn't stand up to scrutiny, according to a series of studies by psychologists in the U.K. and Canada. In addition to lab studies with volunteers, the researchers analyzed 52 news videos of people pleading for the safe return of a missing relative. In half of the videos, later evidence revealed that the speakers actually had been lying—but eye-movement analyses showed no differences between the liars and the truth tellers. — A.H.

NEWS BRIEF / Pluto's New Moon

S

Scientists analyzing images from the Hubble Space Telescope have discovered another moon circling the dwarf planet Pluto. Named P5, the fifth moon is 6 to 15 miles in diameter. The find adds evidence to the theory that Pluto's moons were formed during a collision with another Kuiper Belt object. Scientists will get a better look at Pluto during a July 2015 flyby of NASA's New Horizons spacecraft.

— JOE PAPPALARDO

**THE NAME YOUR PRICE TOOL CAN
HELP YOU SEIZE CONTROL OF YOUR
BUDGET AND MAYBE EVEN...
THE WORLD!**

Mwahahaha



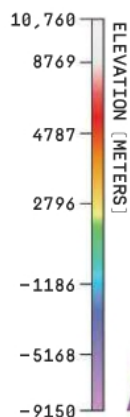
**IF YOU ASK ME, YOU SHOULD GET
A SAY IN WHAT YOU PAY.**

That's why we created the Name Your Price® Tool. We show you a range of options, and you pick the coverage that fits your budget. Putting you in control. Now that's Progressive.



1.800.PROGRESSIVE | PROGRESSIVE.COM

©2012 Progressive Casualty Ins. Co. & affiliates. Price and coverage match limited by state law. 12D000444.WD (07/12)



A

Visitor's Guide to ...

THE MOON

pollo astronauts reached the moon 43 years ago, but we know little about our nearest celestial neighbor. "The moon is a way of recording what has happened since the formation of the solar system," says John Keller, deputy project scientist for NASA's Lunar Reconnaissance Orbiter (LRO) mission, which has been examining the moon since 2009. Whether you're a lunar colonist or a tourist, here's what you won't want to miss. — SARAH FECHT



NATURAL WONDER

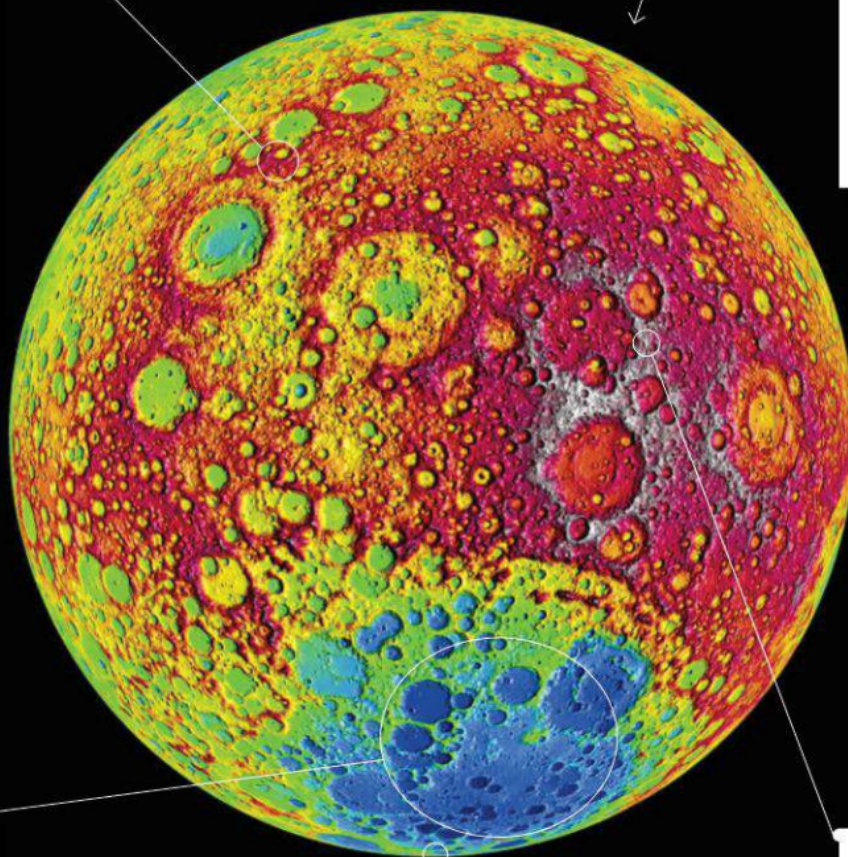
The Compton-Belkovich volcanic region is isolated from the majority of lunar hotspots, which are on the near side. It is forcing scientists to rethink lunar volcanism. The moon has a molten core but, oddly, no active volcanoes. Using X-ray analyses of melted moon rocks, researchers found that some of the magma is too dense to spew from the surface.



MASS TRANSIT

The moon used to spin faster, but Earth's gravity slowed its rotation. Since the moon's mass is not evenly distributed, it was destined to stop with one side constantly facing Earth, according to a new study.

< FAR SIDE >



HISTORIC ARTIFACT

Swaths of the surface—including an area near the south pole—are highly magnetized. New research suggests that the anomaly is a relic from a skidding asteroid that left behind iron-rich rock.



WHAT TO WEAR

The Shackleton crater at the lunar south pole hasn't seen sunlight in 2 billion years. Keller says craters can reach temperatures below minus 400 F. "Those are really the coldest temperatures that have been measured in the solar system," he says. "Water and other volatiles could potentially be held there for hundreds of millions of years."



OUTDOOR RECREATION

The highest point on the moon is 35,000 feet. That's 6000 feet taller than Mt. Everest. But the slopes are gentler than Everest's, making for an easier hike.



SEE HOW IT WORKS AT
WRANGLER.COM/USHAPE

Wrangler®



FIVE STAR

Premium Denim

Real. Comfortable. Jeans.



HISTORIC LANDMARKS

NASA's LRO has collected detailed images of the Apollo landing sites. "The Apollo astronauts brought back samples, and these images help us to pinpoint exactly where those samples came from," Keller says. Apollo-era moon rocks are still producing science. Many scientists believe that the moon was created after Earth collided with a Mars-size object. But this year, a chemical analysis showed that Earth is the moon's sole parent. Exactly how our planet "gave birth" to the moon is still a mystery.

NOTHING BEATS WRANGLER

COMFORT

OTHER JEANS

{ V-PATTERN PINCHES }



Wrangler

{ U-SHAPE PROVIDES MORE ROOM }

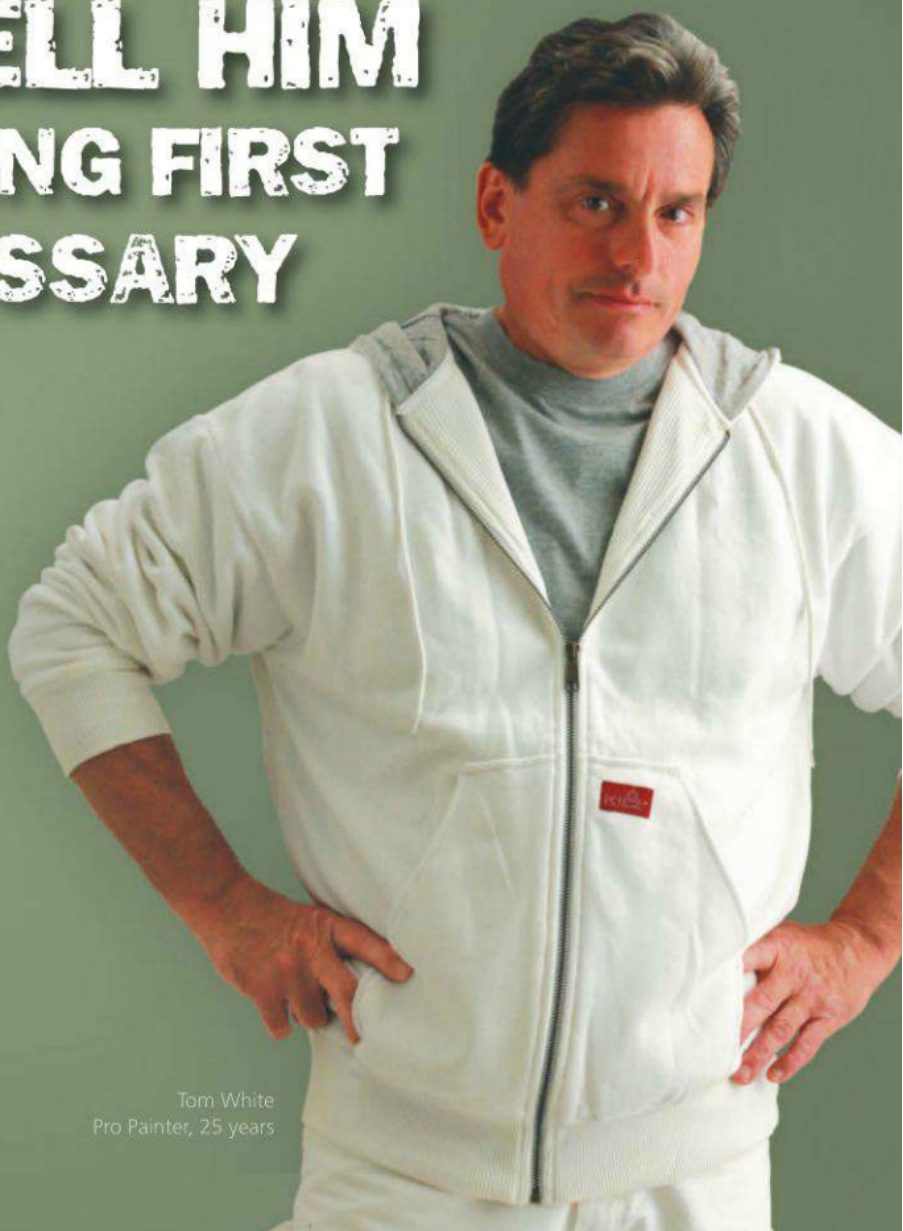
VS



Available at
Walmart

DON'T TELL HIM THAT PRIMING FIRST ISN'T NECESSARY ANYMORE.®

Pros do it right.
Pros start with
KILZ® primer.



Tom White
Pro Painter, 25 years



Your home is the biggest investment you'll ever make. So it deserves the best solutions for its toughest challenges. For covering stains or bold colors, pro painters understand that a separate coat of primer followed by a quality topcoat provides the best results possible... and often at a lower cost than two coats of paint. Pros know that starting with a precoat of KILZ® primer is the secret to solid coverage and a durable finish. KILZ primer... the problem solver that your home deserves.



www.kilz.com



GEAR

TOOLS

GADGETS

Upgrade



Woolrich
503 Field
Coat,
\$199

Coleman
54-Quart Steel
Belted Cooler,
\$110

Get Your Tailgate On

At some indeterminate but inspired moment in recent years, tailgating changed from a simple pregame communal activity into a national movement. Whether you're grilling in the chilly fall air on the University of Michigan golf course in Ann Arbor or baking on the blacktop at Arizona State University's Sun Devil Stadium (water misters are set up there to keep fans cool), the same tips apply. Dave Lamm of TailgatingIdeas.com recommends prepping your grub the day before the game and placing uncooked food and drinks in separate coolers. Afterward, he says, clean up and dispose of trash fast. Leaving a mess can lead to time restrictions and other rules that cut against this movement's grain. — JOHN BRANDON

Tailgate Targets: Dave Lamm of TailgatingIdeas.com says to put Talladega Superspeedway in Lincoln, Ala., and Lambeau Field in Green Bay, Wis., on your bucket list. Talladega lets the party get rolling days before the event. "The Talladega infield is like Mardi Gras for Nascar tailgaters," Lamm says. The crowd at Lambeau fights the cold with camaraderie, even braving subzero temperatures. Lamm says the clever Cheeseheads prevent their beer from freezing by drinking faster.



Charcoal grills are great for the backyard, but for the ultimate tailgating experience rely on the Party Hub instead. It has a griddle to cook breakfast, a grill for your meats and kebabs, and a deep fryer for, you know, frying stuff. Four folding legs support the 26-inch cooking surface. Started by an electric pulse igniter, the propane grill's infrared-ceramic burner cooks 50 percent faster than charcoal. Better pack some extra grub. You'll draw a crowd.

BLACKTOP 360 PARTY HUB GRILL- FRYER, \$250



STANLEY CARBONATED DRINK BOTTLE, \$20

With its insulating plastic and neoprene sleeve, this 32-ounce bottle is designed to keep your soda or beer chilled and fizzy for over 3 hours. We forgive you for emptying it faster than that.

MSR ALPINE DELUXE KITCHEN SET, \$55

Forget the hassle of gathering disparate BBQ utensils. This kit fits in a 6 x 9-inch pouch and weighs less than 2 pounds. The spatula, spoon, and grater fold up; the towel is super-absorbent; and the set has much more, including a corkscrew, salt and pepper shakers, and squeeze bottles.



ION TAILGATER AM/FM, \$160

Unless your buddy really knows how to play, don't tell him that the Tailgater doubles as a guitar amp. Could be awkward. Otherwise you can just use it as intended: to pump out iPhone- or iPod-stored rock anthems with 50 watts of power or to tune in your favorite sports-radio station, be it AM or FM.

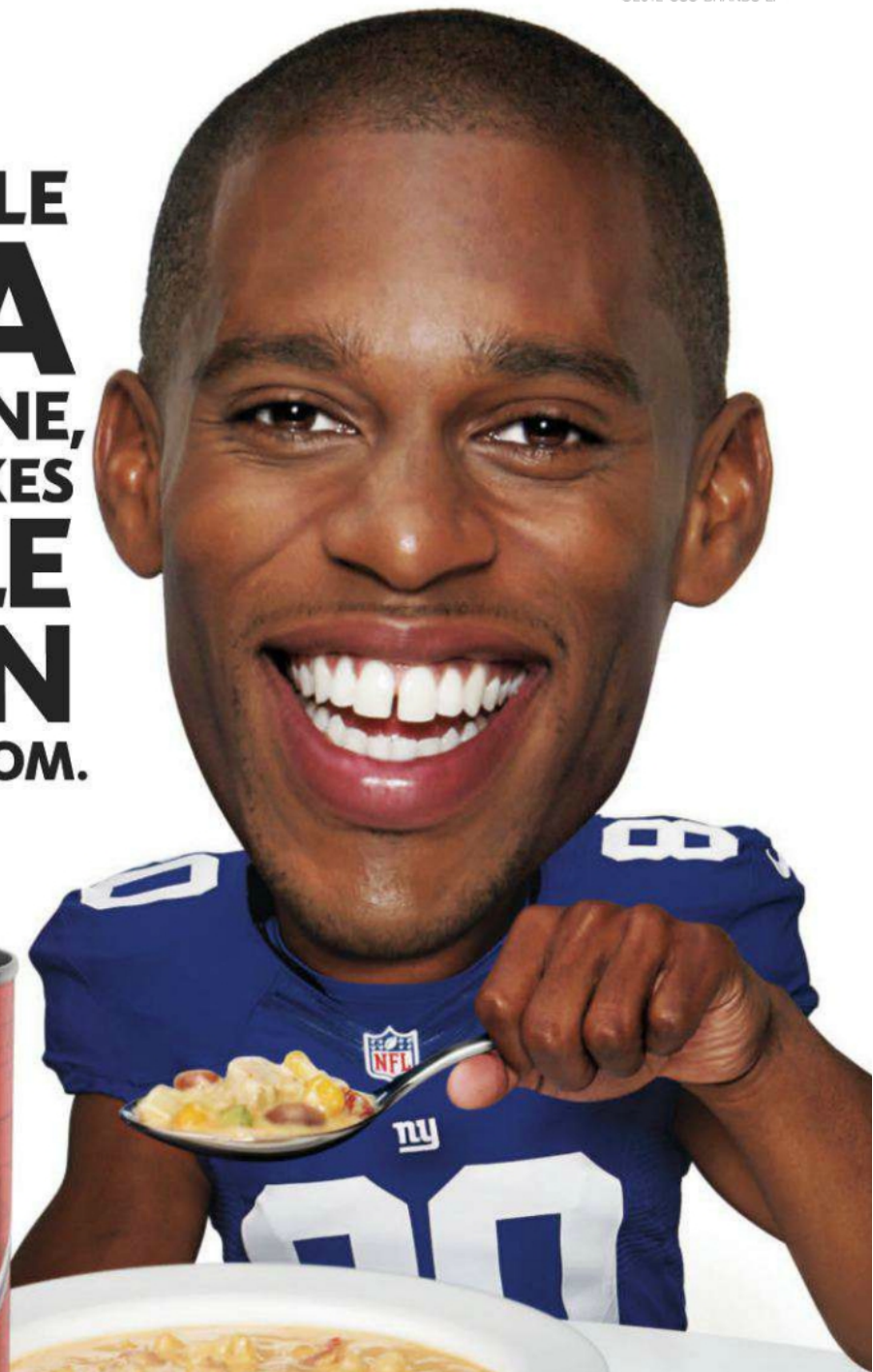
DON'T BE AN IDIOT

PLAY IT COOL WITH YOUR COALS

The sooner you pack up the tailgate party, the sooner you can get to the game. But don't just spill hot coals on the asphalt. They leave a smoldering pothole and could even torch your vehicle. Instead, pack heavy-duty foil, a gallon jug of water, and a noncombustible container, such as a stainless-steel bucket. Line the bucket with the foil, dump in the coals, and heavily douse them with water. When you return, dispose of the coals in a parking-lot Dumpster. — STEVE ROUSSEAU



AFTER A LITTLE
SALSA
IN THE END ZONE,
VICTOR CRUZ LIKES
**CHIPOTLE
CHICKEN**
IN THE LOCKER ROOM.



Big pieces of chicken and veggies
to feed an NFL size hunger.

IT FILLS YOU UP RIGHT.®



OFFICIAL SOUP SPONSOR OF THE NFL

Snap a photo of this page and text it to qn2a@agm.tw and get a special video of James Denton and friends turning the big Q into an A.

QN2A.ORG

INTRODUCING THE QN2A PROJECT

ANSWER CANCER WITH BETTER QUESTIONS

Dr. Shayma Kazmi
Medical Oncologist



Sara Faccio
Survivor



James Denton
Stand Up To Cancer
Celebrity Ambassador



With cancer, having questions doesn't make you weaker. It makes you stronger. The more you ask, the more you know, and the more you can stand up to cancer. So we've created QN2A.org, a powerful new online resource of all the Big Questions that can help both patients and caregivers after a cancer diagnosis. Discussing these questions

with your healthcare professional can help you collectively arrive at the treatment plan that's best for you—turning those questions into answers. And while you're at QN2A.org, help us grow the list by sharing the questions that helped you the most. Together we can find the right answers. Without question.

James Denton, Stand Up To Cancer ambassador, has helped family members navigate their cancer treatment. Stand Up To Cancer is a program of the Entertainment Industry Foundation (EIF), a 501(c)(3) charitable organization.



Winning the fight against cancer, everyday.



INTUIT® PAYROLL

Intuit® Payroll allows small businesses to pay employees and file tax forms in minutes, with just a few clicks. Just enter employee hours and Intuit Payroll automatically calculates everything else. And, there's even live expert support. No wonder more small businesses rely on Intuit Payroll than any other payroll provider. Learn more and get a 30-day free trial at payroll.com.

intuit. Payroll

Visit www.payroll.com for more information.

FROGTAPE® BRAND PAINTER'S TAPE

FrogTape® is the only painter's tape treated with PaintBlock® Technology. PaintBlock is a super-absorbent polymer which reacts with latex paint and instantly gels to form a micro-barrier that seals the edges of the tape, preventing paint bleed. The result: Very sharp paint lines and less time spent on touch-ups!



Visit www.frogtape.com for more information.

KRYLON®

Krylon® is the aerosol brand DIYers trust for quality, color and innovation. With hundreds of products that let you tackle household projects with confidence and creativity, from Krylon Indoor/Outdoor paint to Krylon Fusion™ Paint for Plastic. Plus the newest innovation: Krylon Rust Protector™ paint, with proven performance that dries in as little as 8 minutes instead of 2 hours like the leading rust competitor. It's the rust protection the world has been waiting for. Krylon. Make it Yours™.



Visit www.krylon.com for more information.

A CLEAN SWEEP FOR PENNZOIL®

Pennzoil Platinum® synthetic motor oil keeps pistons up to 8% cleaner than Mobil 1; up to 17% cleaner than Valvoline® SynPower®; and up to 20% cleaner than Castrol® EDGE® with SYNTEC®.

LONG LOVE CARS. Not Just Oil, Pennzoil®.

*Based on ASTM Sequence IIIG piston deposit test using SAE 5W-30. ©2012 SOPUS Products. All rights reserved.



Visit www.pennzoil.com for more information.

RADIOSHACK IS EXPANDING ONLINE



RadioShack.

RadioShack asked for your help in selecting the technical products missing from our stores. The response was overwhelming! With your advice, we've expanded our tech product line by thousands of items on RadioShack.com. Check out what we now carry online, or you can order within our stores. We're here to help.

Visit www.RadioShack.com/Tech for more information.

GEAR UP/Birding

During the fall migration, species you might not otherwise see will be flying through your backyard, so it's a great time to start birding. **BY JENNIFER BOGO**



UPGRADE

L.L. BEAN WAXED COTTON CONTINENTAL FIELD BAG, \$85

Eschew modern materials for this rugged bag, which stows bins, guides, food, and water. It's made of moisture-resistant waxed cotton, first used in sails in the 1850s.



IBIRD APP, FREE

Apps have turned smartphones into handy birding tools too. IBird for Apple and Android lets you look up birds by plugging in their shape and color; tap the speaker to hear a species' song.



NIKON MONARCH 5 10x42 BINOCULARS, \$300

An essential: good binoculars. These are slim and comfortable to hold, and in our test magnolia warblers and scarlet tanagers popped against the landscape.



THE SIBLEY FIELD GUIDE TO BIRDS, \$20

This guide (for the Eastern or Western U.S.) is indispensable to most birders. Expert tip: Wait to crack open the book until you've studied a bird carefully and it flies away.



CARHARTT KETCHIKAN JACKET, \$180

This waterproof yet breathable jacket easily transitions from early-morning fall birding to whatever else your day has in store. Interior pockets hold your field guide and notebook.



BIRDING TIPS from Kenn Kaufman, author of the *Kaufman Field Guide to Birds of North America*: "Practice using binoculars before you're in a crunch situation with a bird that may fly away at any moment. Quickly aim the bins at signs, pets, and tree branches to get the feel for locking on to an object."

DISCOUNT TIRE DIRECT

discounttiredirect.com

888.916.3211

M-F 8am-9pm EST SAT 9am-6pm EST

Se habla español

"Just ordered my 3rd set of tires from Discount Tire Direct. All I can say is your customer service is the best. Thank you!"

— Colm McIvor via Facebook



FALKEN
Wild Peak A/T tires
FALKEN
WHEEL
ORC 909 wheels



FREE SAME DAY SHIPPING

Same day shipping available for most orders. Valid for UPS Ground services to the 48 contiguous states. Some restrictions apply.



STAY SAFE THIS WINTER.

Call us about
WINTER TIRES!



SEVEN X

13" PRICES START AT

\$70

INCIDENT

13" PRICES START AT

\$75

DR-33

14" PRICES START AT

\$84



WARRIOR

15" PRICES START AT

\$95

CHAOS

15" PRICES START AT

\$106

TRACKER

16" PRICES START AT

\$115



ZIEX ZE-612

PRICES START AT

\$66

ASSURANCE FUEL MAX

PRICES START AT

\$96

VENTUS V12 EVO

PRICES START AT

\$98



DISCOVERER ATP

PRICES START AT

\$116

DYNAPRO ATM

PRICES START AT

\$119

ROCKY MOUNTAIN ATS

PRICES START AT

\$128



CURRENT PROMOTIONS

View our current specials online at
discounttiredirect.com

Fisher's ATV World
Official Partner
fishersatvworld.com



ONLINE TOOLS

CUSTOMER REVIEWS

Find out which tires
are best for you!



INTERACTIVE WHEEL SYSTEM

See wheels on
your vehicle!



MACBOOK PRO WITH RETINA DISPLAY, \$2200

W

When you turn on Apple's new MacBook Pro with Retina display, you hear silence, not the sound of angry bees. That's because this professional-grade laptop, unlike its predecessor, has no optical drive to initialize or hard drive to spin up; it's all solid-state. The move to flash memory slims the device significantly; it's just 0.71 inches thick and 4.46 pounds— $\frac{1}{4}$ inch thinner and 1 pound lighter than the previous MacBook. But just because it's trimmed down doesn't mean it's not loaded: It has four times as many pixels (2880 x 1800 resolution), two Thunderbolt ports, and two USB 3 ports. (The last is a concession to a market that's been slow to adopt Intel's costly Thunderbolt interface.) You'll also find a full-size HDMI port for easier television connectivity. This weakens the case for Apple TV, but with Retina display and what Apple claims is 75 percent less glare than earlier models, the laptop screen works just fine for movies. That screen will likely hit cheaper Apple laptops within a few years, but don't expect the company to be able to move the solid-state market quite so quickly. — RACHEL Z. ARNDT



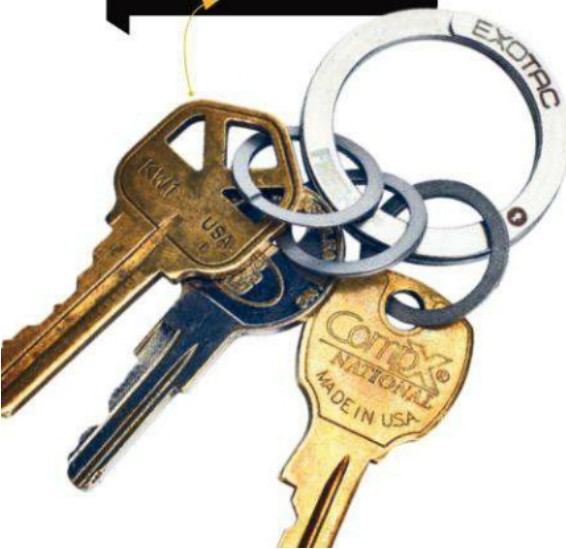
UPGRADE



TITANSTRAPS, \$8

The bungee cord, like the mousetrap, is tough to improve on. TitanStraps challenge the tie-down king with high-tension rubber and a beltlike fastening system that beats a bungee's hooks. We used Titans to lash 150 feet of coiled garden hose and to secure a 20-foot extension ladder to an SUV roof with ease.

EDITOR'S CHOICE



EXOTAC FREEKEY SYSTEM, \$7

Putting keys on rings is a pain in the fingernail. The FreeKey takes away the hurt with a bump that acts as a fulcrum to lift the end of the ring when it's pinched. Keys slip on easily, and though the thickness of the ring can cause some sticking, the design solution is so simple you'll wonder why no one thought of it before.



DREMEL 8220 CORDLESS ROTARY TOOL, \$100

In the spirit of the season, we recommend the master of micro-DIY power-tool tasks for pumpkin etching. A stencil kit, sold separately, provides templates for drawing a face, one shallow gouge at a time. A 1-hour quick charger and 28 accessories make the 8220 useful at any time of the year.

*Payroll doesn't have to be so frustrating.
Unless you like the extra fiber in your diet.*

Payroll stressing you out? Start using Intuit® Payroll and make it easy on yourself. With a few clicks you can pay employees and file tax forms. Just enter employee hours and Intuit Payroll automatically calculates everything else. And, if you need it, there's live expert support. Saving you time and pencils every month.

[Learn more at Payroll.com](https://www.payroll.com)

[Online Demo](#)

[30-Day FREE Trial](#)

[Live Support](#)

intuit Payroll





The **Seiko Astron** (left) is a masterpiece of miniaturization: Its GPS fits into a 47-mm face and is efficient enough to run on solar power. The watch divides the globe into 1 million squares and attaches a time zone to each; its hands rotate into place with atomic precision after its daily ping to the satellite network. For those of us not traveling to Easter Island, there's **Timex's Expedition Metal Combo** (right). It's capable of cycling through the time in up to three zones on its combination digital and analog face. While it cannot compare to the Astron's accuracy, it's a sharp-looking timepiece for the budget-minded global traveler.



DEWALT TORPEDO LEVEL, \$25

Be as tough as you want on this level. It's milled out of aluminum, so it's durable and lightweight, and rubber end caps make it shock resistant. Accurate to 0.0005 inch per inch, it contains rare-earth magnets for use on metal surfaces, and the center vial is magnified to take away the squint factor.

GOLDBLATT RAM ROD IMPACT TOOL, \$139

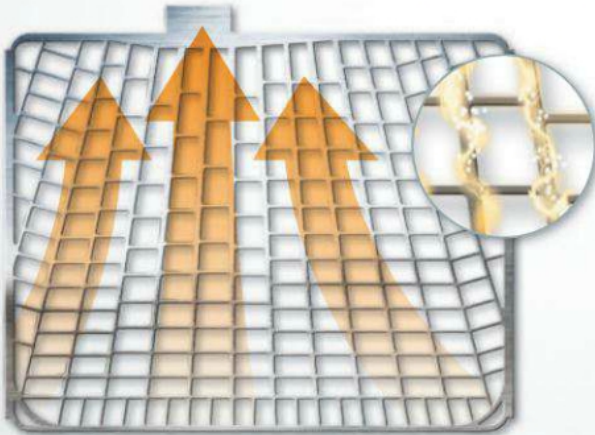
The RAM Rod is part of a recent trend in multiuse power tools that allow users to swap in the appropriate bit for the job—in this case, busting concrete, tamping soil, scraping up old floor tiles, and more. Pump the tool's handle to activate the driver and its sledgehammer force to get the job done.



UPGRADE

TO YOU IT'S A GRID. TO AN ELECTRON IT'S A SUPERHIGHWAY.

Batteries with **POWERFRAME®** Grid Technology have better electrical flow, cranking power and battery reliability.



Because PowerFrame grids are designed to provide a short, direct route for electrons to travel, they provide up to 70% better electrical flow than other grids. Find out what else makes PowerFrame grids better at powerframe.com.



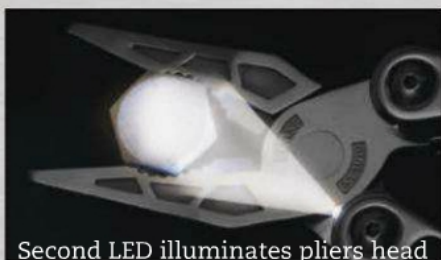
powerframe.com

PowerFrame and PowerFrame logo are registered trademarks of Johnson Controls Inc.

COAST™
LIGHTS • KNIVES • MULTI-TOOLS



One LED illuminates knife blade



Second LED illuminates pliers head

2 Built-in LEDs, 9 Functions

- One LED in front, one in rear, click to choose
- Spring-loaded pliers head
- One handed opening main blade
- All tools easily accessed without opening pliers



LED Pro Pocket Pliers™
Winner

PopMech EDITOR'S CHOICE AWARDS

12

www.coastportland.com

Be the voice

for those who have no voice

Join us
worldwildlife.org



EDITOR TESTED

The POPULAR MECHANICS proving grounds are our learned editors' yards, garages, and living rooms. Here, some honest thoughts on new products from PM's obsessive gadget geeks.



BLACK & DECKER GYRO, \$40

Righty-tighty, lefty-loosey: The engineering behind the Gyro is as simple as the singsong DIY axiom. The gyroscopic drive activates when the tool is rotated; the greater the degree of the turn, the faster the motor spins. I used the cordless Gyro to set self-tapping drywall anchors and work in tight spots under my old MG's hood. Pure gearhead joy. — JOE BARGMANN



DISH NETWORK HOPPER AND JOEY

In practice, the most disruptive technology in television (and the subject of much litigation) doesn't seem all that disruptive, but it still has network TV executives in a tizzy. Dish Network's Hopper and Joey multiroom DVR setup (Hopper, \$10 a month; Joey, \$7 a month per box) is like many other tuner-recorder systems. The Hopper's PrimeTime Anytime feature allows you to record, time-shift, and save TV shows for eight days, distributing them to multiple boxes around the house. But 24 hours after a program on NBC, ABC, CBS, or Fox has been recorded, the Auto Hop function allows users to skip ads; they appear for just a fraction of a second before the regular program resumes. When I use Auto Hop, I feel as if I—and Dish Network—have pulled a fast one on the TV industry. But the tech may be short-lived if the networks cancel their broadcast agreements with Dish. — GLENN DERENE



Bella gives at the first of every month.



Her gift helped Ken when he needed it most.



Make a financial contribution to the Red Cross and change a life, starting with your own.

Call 1-800-RED CROSS
or visit redcross.org.



**American
Red Cross**



✓Yes



✓Yes



✓Yes



xNo



✓Yes



✓Yes



✓Yes



✓Yes



✓Yes

- ✓ Everyday Low Prices
- ✓ Easy To Use Website
- ✓ Huge Selection
- ✓ Fast Shipping

RA
ROCKAUTO.COM
ALL THE PARTS YOUR CAR WILL EVER NEED

GO TO WWW.ROCKAUTO.COM ROCKAUTO, LLC (EST. 1999)

Auto

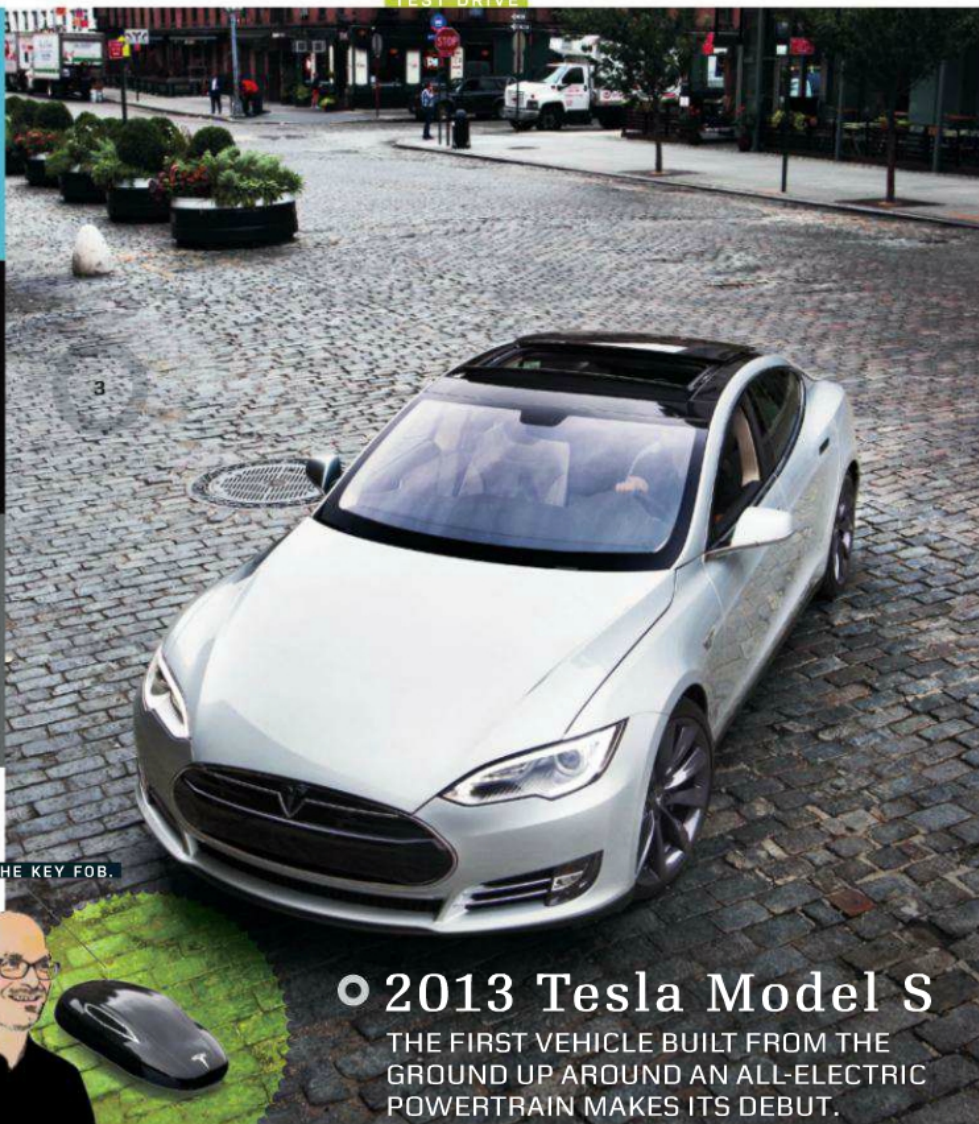
INTEL

TEST DRIVES

TOP TECH

HOT RIDES

TEST DRIVE



THIS IS THE KEY FOB.

**GLENN DERENE,
SENIOR EDITOR**

"The beautiful exterior of the Model S is also seriously slippery. Its drag coefficient is a mere 0.24."

2013 Tesla Model S

THE FIRST VEHICLE BUILT FROM THE GROUND UP AROUND AN ALL-ELECTRIC POWERTRAIN MAKES ITS DEBUT.

If electric vehicles are ever to get out of their novelty phase, three things must happen: First, an EV has to come along that can do a full day of driving on a charge. Second, it must be able to fit a family. Third, it can't be priced exclusively for millionaires. The Tesla Model S solves two and a half of these problems. It promises between 160 and 300 miles of range on a single charge depending on the battery configuration. It has seating for five, plus two optional rear-facing

DOWN THE ROAD

OCTOBER**A BIG SHOT OF HENNY**

We drove the Hennessey Venom GT Spyder and lived to tell about it—barely. PAGE 46

PM FLEET

Attention, driving fanatics: The BMW 328i and the Buick Regal GS have arrived. PAGE 47

REVIEWS

Elantra GT



Elantra Coupe



Audi Allroad



Zero S ZF9



Mercedes-Benz GL



jumpseats for kids. And it starts at \$57,400 (tax credits can bring the price down to \$49,900). That's expensive for a family sedan (Ford Taurus, Toyota Camry) but not that expensive for a luxury performance sedan (BMW 5 Series, Porsche Panamera).

So it certainly helps to be a millionaire if you want a Model S, but in its base configuration with a 40-kwh battery, it's on the cusp of attainable for the upper middle class. That, however, is not what Tesla rolled out for the press in New York recently. We drove the \$97,900 Signature Performance edition, a top-of-the-line model with an 85-kwh battery and a high-performance drive inverter and electric motor that deliver 310 kw. That's a power output that equates to 416 hp and 443 lb-ft of torque driving the rear wheels. The specs on this config of the Model S say it can do 0 to 60 in 4.4 seconds, and based on a few traffic-free takeoffs we were able to do on the West Side Highway, we believe it. As with most electric vehicles, every bit of the Model S's torque is available the moment you mash the pedal (well, almost all of it—the vehicle's traction control dials back the power to keep the wheels from spinning), and the result is awesome, seat-pinning acceleration.

The straight-line performance of the Model S is even more impressive when you consider that this is a 4600-pound car.



BASE PRICE: \$57,400 (BEFORE TAX CREDITS)
MPGE: 160 MILES (40-KWH BATTERY); 230 MILES (60-KWH BATTERY); 300 MILES (85-KWH BATTERY)
AVAILABLE: NOW

Below: Under the hood is . . . nothing. The Model S has a front storage bay and room for kiddie jumpseats under the hatchback. The electric motor is between the rear wheels.



Much of that weight can be attributed to the wide, flat lithium-ion battery pack that is placed between the axles, giving the vehicle a level floor and a low, stable center of gravity for precision handling. There aren't many hairpin curves in the Big Apple, but on our 20-minute test drive we executed a few high-speed lane changes that showed off the Model S's tight, linear steering.

True to its Silicon Valley roots, Tesla stuffs a heckuva lot of technology into the Model S. The retractable door handles are gee-whiz cool and, according to the company, aerodynamically beneficial. There's an optional HD backup camera that displays on the touchscreen console (see "Tesla's One-Screen Solution," below). And the Model S's key fob is a tiny sculpture of the car itself—press on the trunk and the trunk opens.

So how does the Model S rate as a luxury car? We're conflicted. When you run your hands over the surfaces in the car, everything feels leathery and opulent, but when you knock on them, there's a lack of solidity that makes it all feel a bit like a weight-saving illusion.

But there's too much promise here to dismiss the Model S for some rookie fit-and-finish issues. The car is a joy to drive, the base model is competitively priced for the luxury-sedan segment, and it has all the aspects of a practical family car. We'll need more time with it to say anything definitive about its value as a daily driver, but presuming they don't start catching fire in people's garages (see Fisker Karma) and the EPA's battery-range estimates hold up, the Model S could begin to legitimize the electric vehicle.

—GLENN DERENE

Tesla's One-Screen Solution

The feature of the Model S that has garnered perhaps the most attention is the enormous 17-inch touchscreen that occupies the entire center console. It is the size of two iPads put together, and it serves as the cabin's command center. It's a fascinating experiment in interface design—and one that the company says will update over time like Android and iOS devices. All of the programming was done in-house by Tesla, and it is unlike any other manufacturer's system. The large screen supports

two user-selectable control panels at a time, which stack on top of each other. At the bottom of the display is a permanent HVAC control bar; at the top is a menu bar with options for media, nav, phone, Web, etc. When you select a menu option, it drops into the top panel, and then you can swap the top and bottom panels. It's cool and intuitive, but it could be confusing while you're driving. This might be made easier with voice commands, but so far, the Model S doesn't offer them. —G.D.



AMSOIL lets YOU decide

When it's time to change your oil

**SIGNATURE
SERIES**

XL
EXTENDED LIFE

OE
ORIGINAL
EQUIPMENT



CHANGE OIL AT
**25,000
MILES**
OR 12 MONTHS



CHANGE OIL AT
**10,000
MILES**
OR 6 MONTHS



CHANGE OIL AT
**3,000+
MILES**
OR 3+ MONTHS

Since its introduction of the world's first API-rated synthetic motor oil in 1972, AMSOIL has helped motorists save time, money and effort by extending the time between oil changes. With three options of advanced formulations to choose from, you can select the oil change interval that fits your lifestyle and comfort zone.

AMSOIL
The First in Synthetics®

To find an installer or dealer near you,
visit www.amsoil.com/anydrain

Call now for
our free Factory
Direct Retail
Catalog
1-800-777-8491





2013 ELANTRA GT
 BASE PRICE: \$19,170
 MPG (CITY/HWY): 28/39
 ON SALE: NOW

TEST DRIVES



2013 ELANTRA COUPE
 BASE PRICE: \$18,220
 MPG (CITY/HWY): 28/39
 ON SALE: NOW



The Coupe's sedan-size wheelbase allows rear-seat occupants plenty of legroom. Even a six-footer won't complain.

AUTO INTEL

2013 Elantra Coupe and GT

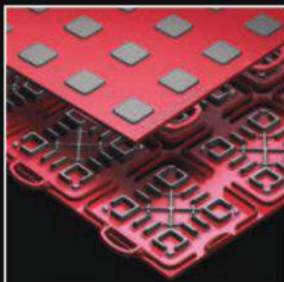
The compact-car class is booming. So for 2013, Hyundai has added a sporty coupe and a practical five-door hatchback called the Elantra GT to the lineup. Under the hood all Elantras use a 148-hp 1.8-liter four-cylinder mated to a six-speed manual or a six-speed automatic. The Coupe and GT also share the basic bones of the Elantra sedan's chassis but use the sportier Veloster rear-suspension design. And surprisingly, the GT uses a 2-inch-shorter wheelbase and is 9 inches shorter overall. That's largely because the five-door was designed for Europe as its main market. So now the Elantra with the most utility is also the most tossable and fun to drive. On the twisty roads that

surround Palomar Mountain, northeast of San Diego, the GT felt balanced and thoroughly enjoyable. We locked the new selectable steering system in Sport mode and wound our way through the hills while briskly rowing the manual. Even with the shortened wheelbase, the GT's hatchback design provides 23 cubic feet of trunk space with the seats up, and 51 cubic feet with them folded down—more than the new Audi Allroad wagon (page 42). The GT's dash is more upright than other Elantras', with a large (and handy) storage bin ahead of the shifter. The GT also gets the safety of a knee airbag and the convenience of a cooled glovebox standard—not bad for the price. — **BEN STEWART**

TechFloor™

The Easy to Install Floor Tile

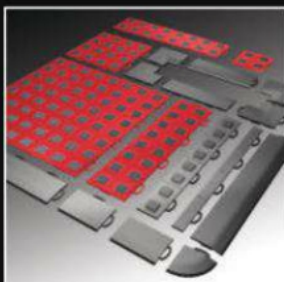
Patent Pending
TwoShot™ Process



The Rubber Goes Through



Non-Slip TractionSquares™



Tile System Components



Attractive Color Options



**Snap
Together!**



Made in USA

©2012 by MacNeil IP LLC

www.TechFloor.com

800-441-6287

MacNeil
AUTOMOTIVE
PRODUCTS LIMITED

Specialists in Original Equipment and
Aftermarket Automotive Accessories

TEST DRIVES



2013 Audi Allroad

Pushing the Audi Allroad as hard as possible over Colorado's Rocky Mountain passes while dodging parades of crossovers and minivans might sound frustrating. Hardly. This Audi's 2.0-liter turbocharged four-cylinder engine has a torque peak of 258 lb-ft from 1500 rpm, and its eight-speed Tiptronic transmission is always seeking a sweet spot for power delivery. So whenever the yellow line allowed, we planted a stout right foot and aimed for clear backdrop. The Allroad is equally

capable of hauling hard through 180-degree switchbacks, with direct yet light steering feedback and fade-free, strong braking. The interior boasts Audi's typical craftsmanship and has plenty of room for hauling your ski gear. If we have one complaint, it's with Audi Connect's new Wi-Fi system. Service is provided by T-Mobile, America's No. 4 network, and after the six-month trial, you're stuck paying \$25 to \$30 a month for the service. No thanks. — MICHAEL FRANK

PRICE: \$39,600
MPG (CITY/HWY):
20/27
AVAILABLE: NOW

AUTO INTEL



WHEELHOUSE

AUTO ODDS AND ENDS



Ford's engineers are getting creative. According to the automaker, they discovered that Ping-Pong balls are more reliable than measuring tape for calculating the volume of odd-shaped cubbies such as the center console. The balls are assigned a cubic measurement that accounts for gaps due to their roundness.



2013 Kia Quoris Kia says the name for its flagship sedan, called the K9 in Korea and arriving in global markets later this year, is a combo of "core" and "quality." Sounds more like an extinct whale.

63%

According to Chevrolet's website, which live-streams mileage records from every Volt, as of 1:11 pm on July 23, 2012, 63 percent of the almost 106 million miles recorded have been electric. Chevy estimates that these miles have saved more than 3.5 million gallons of gas.

1650

Number of miles the University of Michigan Solar Car Team's vehicle, the Quantum, covered in 44 hours, 36 minutes, and 21 seconds in the 2012 American Solar Challenge, setting a new record.

6%



In a recent 1000-car experiment conducted by NASA engineer Mark Rober, 6 percent of drivers intentionally swerved to hit a rubber snake, turtle, or tarantula he placed on the shoulder of the road. At 3.2 percent, tarantulas were hit the most, followed by snakes at 1.8 percent and turtles at 1 percent. Come on, people.

How to Outsmart a Millionaire

Only the "Robin Hood of Watchmakers" can steal the spotlight from a luxury legend for under \$200!

I wasn't looking for trouble. I sat in a café, sipping my Espresso and enjoying the quiet. Then it got noisy. Mr. Bigshot rolled up in a roaring high-performance Italian sports car, dropping attitude like his \$22,000 watch made it okay for him to be rude. That's when I decided to roll up my sleeves and teach him a lesson.

"Nice watch," I said, pointing to his and holding up mine. He nodded like we belonged to the same club. We did, but he literally paid 100 times more for his membership. Bigshot bragged about his five-figure purchase, a luxury heavyweight from the titan of high-priced timepieces. I told him that mine was the *Stauer Corso*, a 27-jewel automatic classic now available for only \$179. And just like that, the man was at a loss for words.

Think of Stauer as the "Robin Hood of Watchmakers." We believe everyone deserves a watch of uncompromising precision, impressive performance and the most elegant styling. You deserve a watch that can hold its own against the luxury classics for a fraction of the price. You'll feel the quality as soon as you put it on your wrist. This is an expertly-crafted time machine... not a cry for attention.

Wear a mechanical masterpiece for only \$179! We surveyed our customers. As intelligent, high net worth individuals, they have outgrown the need to show off. They have nothing to prove; they already proved it. They want superb quality and astonishing value. And that's exactly what we deliver.

The Stauer *Corso* is proof that the worth of a watch doesn't depend on the size of its price tag. Our factory spent over \$40 million on Swiss-made machinery to insure the highest quality parts. Each timepiece takes six months and over 200 individual precision parts to create the complex assembly. Peer through the exhibition back to see the 27-jeweled automatic movement in action and you'll understand why we can only offer the *Corso* in a limited edition.

Our specialty is vintage automatic movements. The *Corso* is driven by a self-winding design, inspired by a 1923 patent. Your watch will never need batteries. Every second of power is generated by the movement of your body. The black dial features a trio of date complications including a graphic day/night display. The *Corso* secures with a two-toned stainless steel bracelet and is water-resistant to 3 ATMs.

Your satisfaction is 100% guaranteed. Test drive the Stauer *Corso*. If you don't love it, send it back within 30 days and we'll refund every dollar of your purchase price. Spending more doesn't make you smarter. But saving thousands on a watch this stunning will leave you feeling (and looking) like a genius!

Another Stauer Exclusive Not In Stores

Stauer Corso Timepiece—~~\$495~~ Now **\$179** +S&P **PLUS** receive the Stauer Optics™ Flyboy™ Sunglasses FREE!

Call now to take advantage of this limited offer with our 30-day money back guarantee.

1-800-859-1626

Promotional Code CSW178-01
Please mention this code when you call.



Exclusive OFFER!

Order the Stauer Corso and these Stauer Optics™ Flyboy™ Sunglasses (a \$99 value) are yours **FREE!**

Limited to
4500 pieces...
Order Today!



14101 Southcross Drive W.,
Dept. CSW178-01
Burnsville, Minnesota 55337
www.stauer.com

Stauer®



2012 Zero S ZF9

PRICE: \$11,495-
\$13,995
MPG (CITY/HWY):
48/273
AVAILABLE: NOW

The new: Battery energy density is 95 percent improved (!) over the electric motorcycle company's 2011 model, supposedly boosting city range to 114 miles. Top speed gets upped by 21 to 88 mph.

The good: The ZF9's peak 29 hp is skimpy, and having only one tallish gear doesn't help off the line, but the 42 lb-ft of torque provides an addictive rush of acceleration above 35 mph.

The meh: After several days of decidedly inefficient driving (read: normal use), the Zero rolled to a stop with 61.2 miles on the odo.

The bottom line: A solid midrange urban commuter but not enough bike for the open road. — **BASEM WASEF**

TEST DRIVES

PRICE: \$62,400
MPG (CITY/HWY):
13/18 (DIESEL 18/24)
AVAILABLE: NOW

2013 Mercedes-Benz GL



AUTO INTEL

When it was introduced in 2006, the GL shot to the top of the large luxury SUV charts, where three-row seating, sumptuous details, safety features, and towing capabilities are key attributes. For 2013, the GL embarks on its second generation by dialing up all these features a notch. Chassis dimensions are unchanged, but overall body length, width, and height increase slightly. Exterior updates are subtle—new headlights, a bigger grille, and more sculpting on the front and sides. A new power liftgate comes standard, and a power-folding third-row seat is optional. Of course, the interior is lavish, and there are several optional safety features, including lane-keeping assist, surround-view cameras, and self-parking. Fuel-

economy projections are up for all models, topping the class. Engine choices continue to be two gasoline turbo V-8s and a torquey turbodiesel V-6, the least expensive option and our primary ride while test driving in the spectacular high country around Santa Fe, N.M. The GL's seven-speed automatic doesn't downshift readily, but the diesel's grunt made short work of mountain grades. The pneumatic auto damping minimized body roll through curves, and the standard four-wheel-drive system delivered firm grip on corrugated dirt roads. But if the three current engines seem too tame for you, stand by for the February arrival of the GL63 AMG: 550 hp, 560 lb-ft of torque, and 0 to 60 in 4.9 seconds.

— **TONY SWAN**



EARTHJUSTICE

Because the earth needs a good lawyer

TAKE A SEAT TAKE A STAND

JOIN EARTHJUSTICE'S FIGHT FOR OUR FORESTS AND WILDLIFE

Earthjustice protects our wild places in court—because we believe the earth needs a good lawyer. Show your support for our work by scanning the code and taking a stand for the environment.



EARTHJUSTICE.ORG/STAND



Wanted

HENNESSEY VENOM GT SPYDER

THE
STATS
»

\$1.1 million

1244 hp, 1155 lb-ft
torque; 7-liter
twin-turbo V-8;
six-speed manual,
RWD

Adjustable coil-over

Brembo 15.1-inch discs
and six-piston calipers
front and rear

0-60 mph: 2.5 seconds

In the tuner-car world, the name Hennessey is synonymous with horsepower—and more of it than you'll ever need. The company's newest creation is the Venom GT Spyder. Six Venom GTs exist in the world, but this is the only convertible. It looks and drives like the grim reaper on wheels. Beginning life as the already quick Lotus Elise, one of the lightest cars on the market today, the Venom GT packs a heavily modified GM-based 427-cubic-inch V-8 that is buttressed by two 67-mm turbochargers. Altogether they produce a ludicrous 1244 hp. At just 2743 pounds, the Venom GT offers a weight-to-power ratio unmatched by any other road car on the planet. Consider this: The Bugatti Veyron Super Sport, the world's fastest production car, hits 200 mph in 22.2 seconds. The Venom GT takes just 15.3 without the aid of all-wheel drive, paddle shifters, or traction control. Driving it requires focus, skill, and, most of all, cojones. With every increase in rpm, the howl of the exhaust and the rising whoosh of the turbochargers swallow you. The Venom GT Spyder provides an unparalleled exhilaration, and we didn't even have enough road—or courage—to make it past fourth gear. — MATT FARAH



Holy #@%*!

AUTO INTEL

THE LOT

1994 to 1996

Chevrolet
Impala SS

Price Range
\$5000 to
\$12,000



Big-bodied
Detroit steel
with lots of
attitude.

Why It's Cool

What It Says

Watch Out For

Why You Want It Anyway

PM
FLEET

CARS WE LIVE WITH

2012 BMW
328i,
2012 BUICK
REGAL GS•
FIRST
REPORTS

DRIVERS' NOTEBOOK



- The protruding navigation screen doesn't slide into the dash when the car is turned off. Not a big deal, but it strikes everyone as odd.

- The futuristic shifter takes some getting used to, but Steptronic scores points for letting drivers approach redline in manual mode. (Of course, we wouldn't think of abusing that power.)

VITAL STATISTICS

PRICE (BASE/AS TESTED)
▷ \$35,795/\$49,445

EXTRA-COST OPTIONS ▷
Moonroof, heated seats
and steering wheel, nav
system, heads-up display,
Premium Sound package

POWERTRAIN ▷ 240 hp,
260 lb-ft; 2.0-liter turbo
I-4; 8A, RWD

EPA FUEL ECONOMY
(CITY/HWY) ▷ 23/33

MILES DRIVEN ▷ 3346

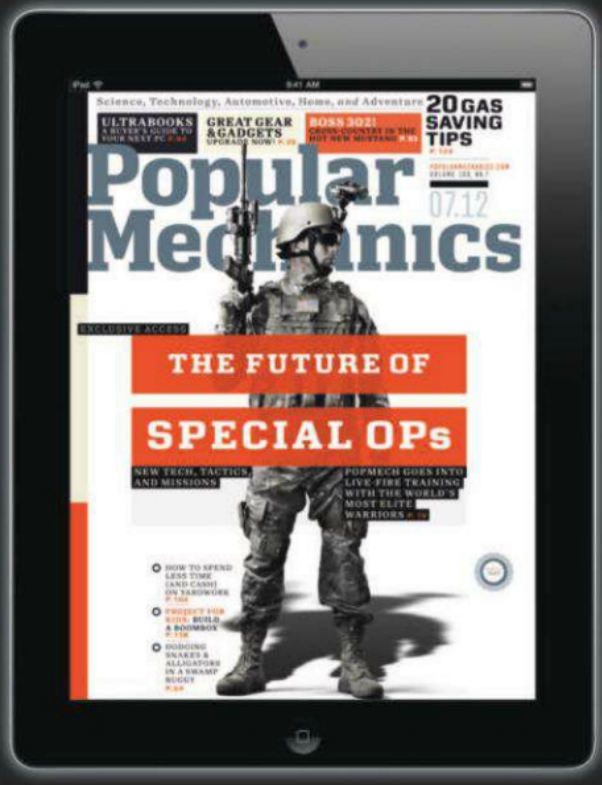
PM FUEL ECONOMY ▷
Average: 30.3 mpg
Best: 33.1 mpg
Worst: 28.5 mpg

2012 BMW 328i

The whole point of driving a vehicle like the BMW 3 Series is to luxuriate in refined comfort while blowing the doors off lesser cars. For the latter purpose, the 328i's new inline four might seem underwhelming, but put your foot down and the highly effective twin-scroll turbocharger puts any doubts to rest. This is still a 3 Series. Beyond the acceleration, staffers have praised our Bimmer for its smooth ride, nimble handling, and creamy-smooth shifts. The electrically assisted steering doesn't dull the experience at all. "This car is a joy to drive," remarked one PMer. Some staffers have had to adjust to the engine start/stop, which can be intrusive to the driving experience at times and a little unpredictable, shutting off just as you're ready to begin moving again. You can turn off the feature, but it's smart engineering and, along with the smaller engine, helps the car get 30 mpg. The 328i's lavish, high-tech interior has been praised by all. Along with the heads-up display, another favorite feature is BMW's standard iDrive toggle, which controls the infotainment and navigation screen. It's much less distracting than a touchscreen. — JERRY BEILINSON

HANG ON





GET YOUR HANDS DIRTY

(but keep your iPad clean).

The modern man's guide to, well, being a modern man just got better. See for yourself - by subscribing to our tablet edition at huge savings off the regular price.

SAVE 63%

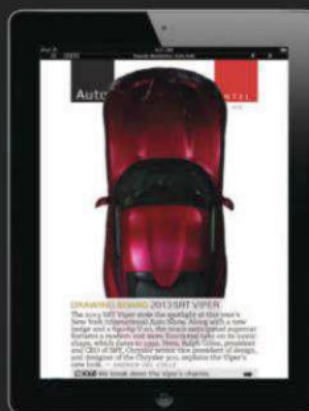
OFF THE NEWSSTAND PRICE.

Start enjoying **Popular Mechanics** on your iPad today. Go to the iTunes app store and search for "Popular Mechanics Magazine."

Download our app to access the digital subscription service. Discover how all that you love about **Popular Mechanics** comes to life on your iPad.



Also available on Kindle Fire and Nook Color.



2012 BUICK REGAL GS



Buick's GS, a high-performance version of the Regal sedan, is not just a surprising car—this one's a shocker. And we're not just impressed with its formidable equipment list (highlights include a 270-hp turbo I-4, six-speed manual, and adjustable shocks) and stout performance at a reasonable price. What truly amazes us is how engaging and entertaining this front-wheel-drive Buick feels from behind the wheel. We look forward to driving this car, seeking out curves on the way home from work, marveling at the seamless electrically assisted steering and the compliant suspension that keeps the car planted no matter how pockmarked the road. Those stellar road manners are at least partially due to a novel front suspension system called the HiPer Strut. An extra ball joint shortens

the distance between the steer axis and the tire's contact patch, which dramatically reduces the wandering tendency most high-powered front-drive cars exhibit when accelerating. That strut is one well-done detail among many: The clutch—yes, it's a Buick with a manual gearbox—has a well-defined engagement point and easy effort. The thick steering wheel feels appropriately sporty, and the seats have plenty of support to hold the body firm during hard cornering. Even the stitching on the seats is handsome. It's as if GM—and by extension, Buick—has rediscovered a bit of carmaking pride. The Germans, long the sport-sedan masters, should be worried. — **LARRY WEBSTER**

NEXT MONTH: INFINITI M35H HYBRID, CHRYSLER 200

DRIVERS NOTEBOOK

- The IntelliLink infotainment system could be more user-friendly.
- Standard split-folding rear seats and a wide opening to the trunk enable generous cargo room.

VITAL STATISTICS

PRICE (BASE/AS TESTED)
▷ \$35,720/\$38,640

EXTRA-COST OPTIONS
▷ 20-inch wheels with summer tires, navigation system with satellite radio, iPod controller

POWERTRAIN ▷ 270 hp, 295 lb-ft; 2.0-liter turbo I-4; 6M, FWD

EPA FUEL ECONOMY (CITY/HWY) ▷ 19/27

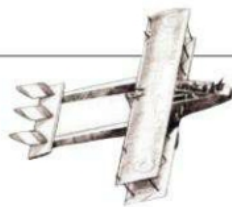
MILES DRIVEN ▷ 1952

PM FUEL ECONOMY ▷
Average: 25.3 mpg
Best: 28.3 mpg
Worst: 22.6 mpg

AUTO INTEL

HOLD IT TIGHT





JAY
LENO'S
GARAGE

Fiat engines such as this one were used in Italian planes during World War I.

Flying on the Ground

BY
JAY LENO

JAY'S 1917 FIAT BOTAFOGO SPECIAL IS A RAUCOUS RIDE WITH A MASSIVE AIRCRAFT ENGINE UNDER THE HOOD.

For me, there's nothing quite like driving a really big, torquey vintage engine. Put an old aircraft engine in a car and it's even better.

Early-20th-century plane engines were simply bigger and better-constructed versions of automotive powerplants. All the moving parts were machined to aircraft standards, which were much higher than a car's for obvious reasons. They had redundant features, such as two ignition systems, in case one didn't work.

After World War I, a small group of speed enthusiasts started putting surplus warplane engines in big and sturdy car frames. It was a tremendous feat of engineering. With that giant engine in the car, you were basically flying on the ground. Racing aircraft-engine cars became especially popular at the Brooklands circuit in England. It was one of the first banked oval tracks and perfect for

powerful cars with little to no braking. Count Louis Zborowski's four Chitty Bang Bang specials were the most famous examples. The origin of the odd name is disputed, but the cars became renowned, inspiring the similarly named children's book and later the movie.

I have four cars with aircraft engines. Three of the engines are from World War I, and one is from World War II. My newest car is a 1917 Fiat called the Botafogo Special. It was built by an Argentine racer named Adolfo Scandroglio. He was an admirer of Sir Ernest Eldridge, who owned the legendary, record-setting Fiat Mephistopheles racer that went 146 mph in 1924 on a public road in France. Scandroglio built this car as a copy and named it after the racehorse Botafogo, Argentina's Secretariat.

The Botafogo Special's World War I 21.7-liter Fiat A.12 engine was used in more than a dozen kinds of Italian airplanes. It has six huge cylinders with four valves each, overhead cams, ➔

twin magnetos, and a dry sump—pretty modern, considering it was designed in 1912. Each piston's displacement is bigger than that of a 3-liter engine. It barely makes 320 hp at 1800 rpm, but all that torque just wafts you along. At 60 mph you're using only 800 rpm. The heat the engine puts out is incredible.

The Botafogo originally didn't have brakes or a transmission. I have no idea how the car stopped, but that didn't prevent Scandroglio from racing it. An old photo I have shows a big vertical hook on the front. When the car went off the road, the hook was supposed to prevent injury by catching any of the barbed-wire fencing common throughout the Argentine countryside. Sadly, Scandroglio was killed while racing this car in 1949. Then the Botafogo disappeared. Luckily, the engine was found in the 1990s by the guys at Pur Sang, an Argentine company that builds exact replicas of Bugatti Type 35s and Alfa Romeo 8C 2300s. They reconstructed the car and added an old Mercedes-Benz four-speed transmission and two rear-wheel drum brakes. I bought it from them last year.

The Botafogo can probably go 146 mph, so it also has a modern horn now. With only two brakes, the car doesn't stop fast, and you want to warn people to get out of the way.

The Botafogo Special is a thirsty machine, so it's a good thing the gas tank holds roughly 50 gallons. The 21.7-liter Fiat A.12 aircraft engine is 100 years old. As a precaution, Jay applies oil to the exposed valvetrain before every drive.



Before heading out, some predriving maintenance is necessary. It's part of the romance of these old aircraft engines. With its exposed valve gear, you don't want to start up anything dry, so you give the valves and rockers a few squirts of oil. Then you pump up the fuel pressure by hand using a big lever in the cockpit. Next you pump, or "tickle," the carbs to open the floats and let in more gas. Finally, off you go.

On the road, it's as if you're actually taxiing in a World War I airplane. It's great fun. You feel like you ought to be strafing other cars as you go down the highway. Redline is 1800 rpm, so the engine pulls 300 or 400 rpm with incredible stump-pulling torque—*tic-tic-TIK-TIK-TIKA-TIKA-VROOOOMMM!*

A huge chain drives each rear wheel, so you have to remember not to drop your hand over the side of the cockpit. I love the raw mechanicalness of old chain-drive cars. It's like you're Marley's ghost, with those exposed chains clattering. People stand on the street and just stare. When you drive a noisy, smoking monster car, you quickly realize how far we've come with modern vehicles.

The Botafogo isn't the best car for L.A.; low speeds on the city's

typically congested streets result in a carbon buildup in the combustion chambers that causes the plugs to "load up," or fire intermittently. But get it out on the open road, put your foot down, and it's fantastic. There's no modern equivalent, not even a Hemi. **PopMech**



GOODYEAR.
MORE DRIVEN.

INTRODUCING THE COMPETITION-BEATING* EAGLE® F1 ASYMMETRIC ALL-SEASON.

RACE-INSPIRED DESIGN MEETS ALL-SEASON CONTROL. WATCH OUR UNDERCOVER STUNT DRIVER SHOW REAL PEOPLE HOW THE NEW EAGLE F1 HANDLES IN RAIN AND SNOW, AND EVEN HANDLES A FEW SURPRISES ON OUR TEST COURSE AT GOODYEAR.COM/CONTROLFREAK.

*Based upon Goodyear internal wet-handling test on 225/45R17 tire versus Michelin Pilot Sport A/S plus. ©2012 The Goodyear Tire & Rubber Company. All rights reserved.

XADO
www.xado.us

SMART

WHAT MAKES CARS GET OLD

Engine wear due to friction makes cars feel sluggish and old over time. When you start your car in the morning metal grinds against metal because all of the oil that is supposed to be lubricating your car's engine has drained into the oil pan while your car was not in use. What makes matters worse is that even the best motor oil needs to warm up to become useful, and it typically takes about 30 minutes for oil to reach its optimal temperature.

HOW CAN THIS ENGINE WEAR BE PREVENTED?

By treating your car's engine and transmission with XADO Revitalizant you can reverse prior wear, and prevent future wear. XADO Revitalizant is a smart, self-regulating nanotechnology that rebuilds metal and coats it with a layer of ceramic-metal. Having a ceramic-metal coating inside your engine decreases friction during startup and operation. This reduces engine wear and prolongs your



car's life. Applying the product is as easy as pouring the contents into your engine oil crank case, which means no mechanical repair or downtime is required. XADO has been selling Revitalizant in Europe for about 15 years, so the technology is tried and true.

WHAT HAPPENS IF YOU ADD TOO MUCH?

XADO Revitalizant is self-regulating, meaning it is formulated to stop bonding after it has reached its maximum thickness. Any excess simply continues safely circulating through your engine oil.



HOW DOES XADO REVITALIZANT REALLY WORK?

When you add Revitalizant to your car's engine or transmission Revitalizant uses the friction in your car to repair scratches, gouges and wear and simultaneously form a diamond-hard protective coating. This coating is 10x stronger than steel and lasts for 60,000 miles!

A BRAND NEW CAR CAN LOSE ABOUT 3 GRAMS OF METAL DURING ITS BREAK IN PERIOD, AND A LOSS OF ONLY 60 GRAMS IS CONSIDERED CRITICAL ENGINE WEAR. REVITALIZANT MOLECULES, WHEN ACTIVATED BY HIGH FRICTION ACTUALLY REBUILD WORN METAL AND REPLACE IT WITH A SEMI-PERMANENT LAYER OF CERAMIC-METAL TO ELIMINATE FRICTION AND PREVENT FUTURE WEAR.

REVITALIZED CAR UNITS LAST



TIMES LONGER



NANOTECHNOLOGY FOR YOUR CAR

ADVERTISEMENT

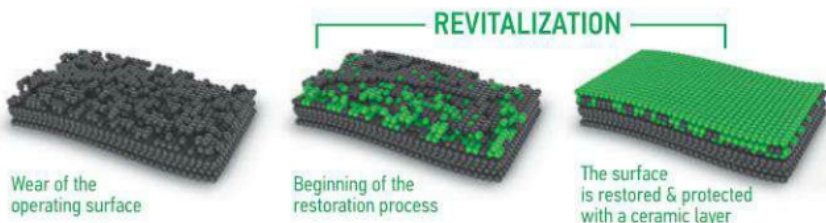
ceramic metal
treatment

HOW IS XADO REVITALIZANT DIFFERENT FROM OIL ADDITIVES?

Most oil additives consist of heavy oil mixed with microscopic particles of plastic (PTFE). The problem is these particles settle everywhere—in filters, oil lines, and other places they should not be. This can be dangerous for your car. XADO Revitalizant treats metal—not oil. It only works where there is enough friction to activate it. So it works where it is needed without interfering with oil lines and filters. XADO's self-regulating nano-technology does not cake, flake or clog.

ATOMIC METAL CONDITIONER MAXIMUM

Just one bottle of XADO AMC Maximum will restore the engine's parameters by coating the metal with a diamond-hard ceramic-metal layer. Your engine is repaired, protected and prevented from wear for 60,000 miles!



REVITALIZATION IS SO EFFECTIVE YOU CAN ACTUALLY SEE THE DIFFERENCE

A damaged bearing was treated with XADO Revitalizant. The scratched surface is turned into a smooth, glossy surface free of defects.

IF REVITALIZANT IS ABLE TO REPAIR SUCH SEVERE DAMAGE,
IMAGINE WHAT IT CAN DO FOR YOUR WELL-MAINTAINED CAR.



Read more on www.xado.us



BUY ONLINE
FOR ONLY
\$54.⁹⁵
xado.us

ADVANTAGES:

- REBUILDS WORN METAL AND REVERSES METAL WEAR
- INCREASES HORSEPOWER AND ACCELERATION
- INCREASES ENGINE COMPRESSION
- RESTORES LOST OIL PRESSURE
- REDUCES TOXIC CARBON MONOXIDE AND DIOXIDE EMISSIONS
- DECREASES LEVELS OF NOISE AND VIBRATION
- NO MECHANICAL REPAIR OR DOWNTIME
- PROTECTS METAL PARTS FROM FUTURE WEAR FOR 60,000 MILES

PATENTED PRODUCT. FOR MORE INFORMATION OR TO PURCHASE
CONTACT 888-787-XADO OR VISIT WWW.XADO.US

DETROIT 2025

The year is 2025. Detroit, the poster child of the Great Recession, is emerging as a model of urban life. The transformation could be called a miracle but for the fact that the change was wrought by the very things that first made Detroit great: innovation, industriousness, and a will to win against all odds.

THE METAMORPHOSIS grew from desperation. In 2008, two of the Big Three carmakers were swirling toward the sinkhole of bankruptcy. The city's population, which peaked at 1.85 million during the post-World War II auto boom, was approaching 700,000. Tracts of wilderness, abandoned factories, and empty houses sparked a perverse fascination with Detroit's ruins. "This whole area really bottomed out," William Clay "Bill" Ford Jr., Ford's chairman and a great-grandson of the automotive company's founder, says.

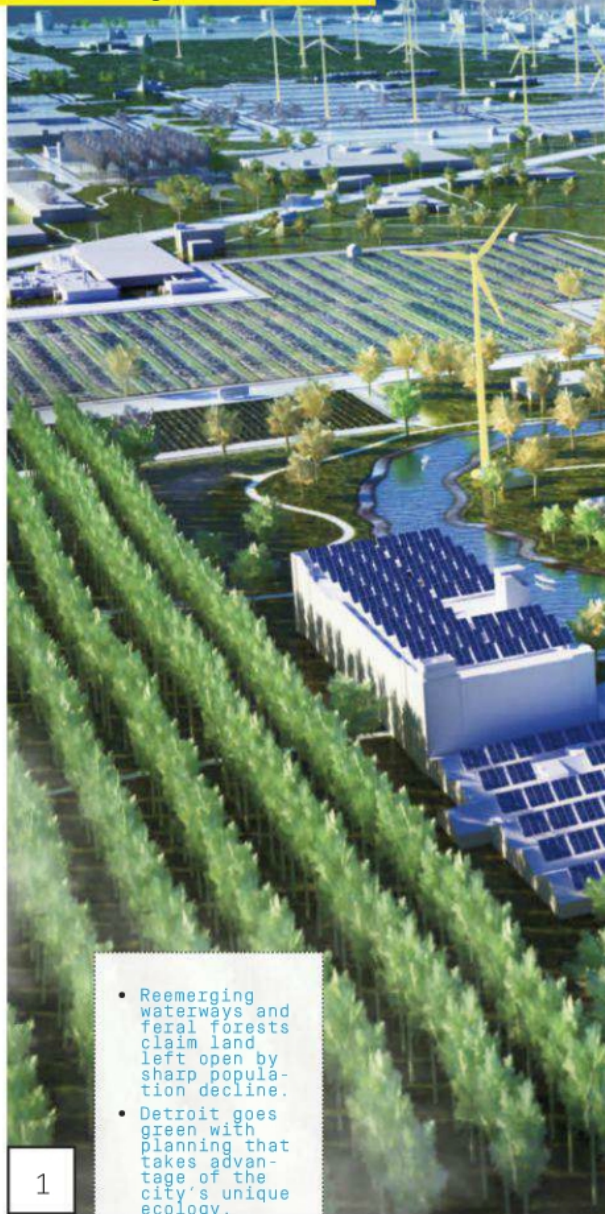
But then something powerful and unexpected happened: Visionaries and ordinary citizens, tired of living in a crumbling city, decided to quit waiting for someone to fix it. "I think there was a realization by everybody in this region, not just in Detroit, that the way we were doing things was a broken model," Ford says. "At Ford we had to completely reinvent ourselves."

The reinvention was aided by the group that Ford's great-grandfather had resisted so viciously, the United Auto Workers (UAW). "When things were the bleakest," Ford says, "UAW president Ron Gettelfinger and the union took concessions that allowed Ford to survive and ultimately thrive. Ron said to me, 'Look, we've got to get out of this together.' If you can take entrenched institutions like the auto companies and the UAW and completely redefine the relationship, then it should be possible for the city of Detroit to do it too."

That was Bill Ford's epiphany; other Detroiters had their own. People with foresight and guts began investing in the city again. Detroit natives who had fled their broken hometown trickled back, joined by pioneering young people who

by
BILL MORRIS

CONCEPT
RENDERINGS BY:
VLADIMIR
SHELEST
PORTRAITS BY:
SARAH SHATZ



- Reemerging waterways and feral forests claim land left open by sharp population decline.
- Detroit goes green with planning that takes advantage of the city's unique ecology.

1

LANDSCAPE URBANISM





WATER CITY

The daylighting, or unearthing, of Bloody Run and other creeks makes water key to a core redevelopment of 3500 acres.

GREEN MACHINE

Renewable energy sources such as solar, wind, and biofuel production from urban forests greatly reduce dependence on an aging power grid.

GOOD & WET

Urban waterways and wetlands provide opportunity for water cleansing by natural means, or bioremediation; storm-runoff management; and recreation.

CONNECT & BUILD

Waterside paths and parks are used not only for play but also for commuting. They link neighborhoods and promote business development.

URBAN FARMING

Agriculture becomes a small industry for Detroit. Farms export produce to surrounding areas and support a thriving locavore movement.

INFRASTRUCTURE

The water-based redevelopment of Detroit leads to the construction of new bridges, the repair of old ones, and the refurbishing of adjacent streets.



Back to the Land
Renowned landscape architect Michael Van Valkenburgh saw opportunity in Detroit's decline.

saw past the city's blight. Instead, they saw available buildings, cheap rents, and a welcome mat for innovators. They saw an iron work ethic and fierce energy. And in a landscape ravaged by depopulation and decay, some bright people saw a blank canvas on which to paint a new urban model.

THIS IS SO STRANGE. It's opening day of the 2025 baseball season, but you're not downtown at the Tigers game. You're outside the previously derelict Packard Plant, now a retail and rec center with an outdoor theater. At dusk people will gather here for a Detroit Film Festival offering.

You can hear the *whoosh* of traffic on the Edsel Ford Freeway as you settle into a kayak on a large pond known as the Headwaters. This is the source of the pristine creek called Bloody Run that will carry you 3 miles to the Detroit River. The creek once flowed through a pipe buried beneath a cityscape of stamping plants, car factories, and dense residential neighborhoods. That aboveground world is gone, replaced by this and other liberated creeks snaking through America's greenest city.

On this future day the sun shines on Bloody Run Creek because of an effort to help nature reassert itself in Detroit. Restoring, or daylighting, city waterways has revived parts of London, Seoul, Zurich, and even Kalamazoo, Mich. In Detroit it was part of a plan devised by landscape architect Stephen Vogel and the Detroit Collaborative Design Center

at the University of Detroit Mercy. The Bloody Run Creek Greenway Redevelopment Project, announced in 2011, has been a big factor in making Detroit the world's first city to turn the theory of landscape urbanism into a reality.

The term landscape urbanism describes city planning that starts with parkland and natural features, not with a grid of streets and buildings. But it was largely notional until Vogel and others—notably, Michael Van Valkenburgh, whose Brooklyn-based firm designed the much-awarded Brooklyn Bridge Park as well as the transformative St. Louis riverfront park—saw the decimation of Detroit as the chance for a paradigm shift.

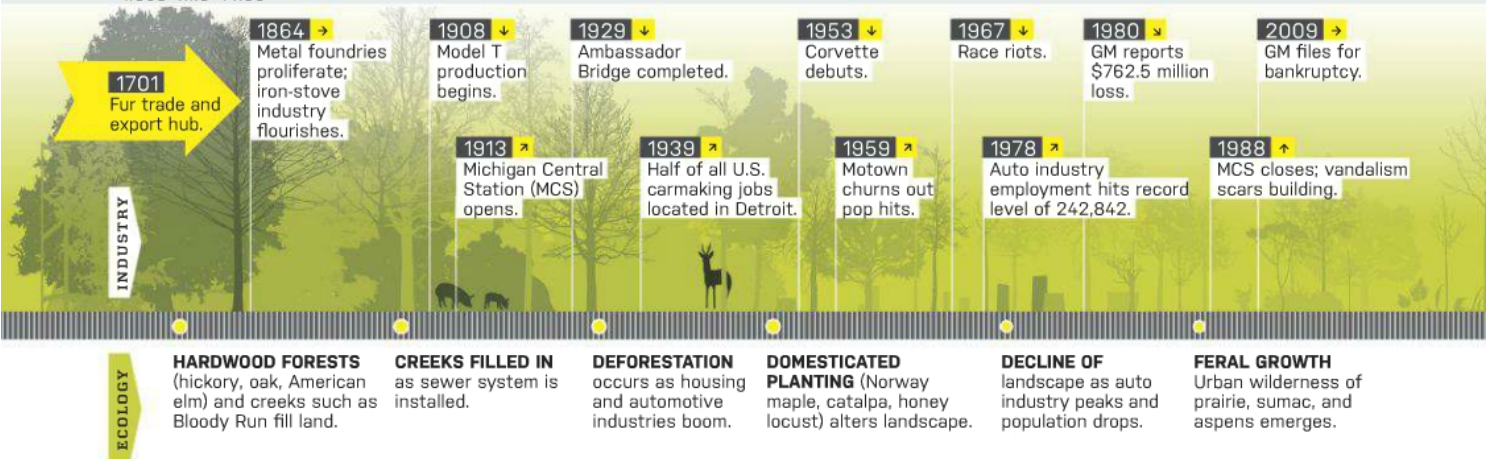
At Van Valkenburgh's firm, associate principal Gullivar Shepard led the team that devised a landscape-first plan. "It's about finding a new urban form," Shepard says.

"The proposed solutions of the 1970s and '80s, where government was suggesting spending huge sums of money to revive Detroit, won't work," Van Valkenburgh says. "We have to go about it in scrappier ways. You clear a piece of land and natural growth occurs there; our premise in Detroit is about intervening in that process of revegetation—

TIMELINE AND ICONS BY LANA BRAGINA

DETROIT INDUSTRY AND ECOLOGY

• RISE AND FALL



PHOTOGRAPH BY: KEVIN COOLEY

Mega Makeover The city wanted the 3.5-million-square-foot Packard Plant removed in 2012. The Bloody Run project turned it into a retail and recreation center.



OPENING ILLUSTRATION REFERENCE COURTESY OF DETROIT COLLABORATIVE DESIGN CENTER AND MICHAEL VAN VALKENBURGH ASSOCIATES; TIMELINE REFERENCE COURTESY OF MICHAEL VAN VALKENBURGH ASSOCIATES

in effect, editing that process. The major scripting is going to happen on its own. Landscape architecture requires patience.”

Thirteen years after Van Valkenburgh makes those remarks, the city is dotted with mixed residential, commercial, and industrial clusters; these are linked by wilderness and barbered green spaces, including farms and forests grown for biomass to feed neighborhood-based gasification units that reduce reliance on the city’s energy grid. As proposed by Van Valkenburgh’s team, city buses double as people movers and transportation for pop-up markets to sell local produce.

Meanwhile, individual residents and nonprofits have planted tens of thousands of trees, and a public-private partnership has turned more than 5 miles of neglected riverfront into the park where Bloody Run joins the Detroit River. Rid of its blighted buildings, its population rebounding, its economy no longer wholly dependent on the auto industry—Detroit has fundamentally changed. Case in point is the waterway on which you’ve been kayaking, which exists because of \$4 billion invested in the Bloody Run project.

Richard Baron put up a lot of that money. Born and raised in Detroit,

he moved to St. Louis, got rich in real estate, then felt compelled to help his hometown’s comeback. He staked much of his personal fortune on the vision of the likes of Vogel and Van Valkenburgh.

“The wheel has been reinvented,” Baron says. “This new landscape has become so attractive to residential, office, and retail that it has brought in suppliers, small companies, and startups. It has created new jobs and been a magnet to draw a new generation of CEOs who, rather than locating in the suburbs or fringe industrial parks, have come into the center city.”

Stephen Vogel first envisioned this Detroit long before 2025, and the city has become what he foresaw: a model 21st-century metropolis unlike any other in the world.



• TURNING POINT

2010 ↓
Quicken Loans to move HQ and 4000 workers downtown.

2011 ↓
Gains posted by Ford (\$20 billion) and GM (\$8 billion).

2011 ↓
Bloody Run Creek ecological master plan announced.

2012 ↓
New international bridge approved.

• TRANSFORMATION

2013 ↓
DIY movement and startups lead grassroots economic boom.

2014 ↓
Former city airport bought as site of Detroit Autodrome motorsports and auto-testing facility.

2015 ↓
Downtown booms with 15,000 new residents; heart of city is thriving business district and tech center.

2016 ↓
Renovation of MCS begins.

2020 ↓
MCS renovation complete; boon to midtown Detroit.

2018 ↓
Construction of new international bridge begins.

2021 ↓
Detroit Autodrome opens with first in series of Formula One races.

2023 ↓
New bridge opens.

2030 ↓
Detroit becomes key U.S. international trade hub.

MANAGED GROWTH
Developing wild landscape maintained by nonprofit workers.

ENRICHED EARTH
Controlled burns add biochar to city soil, aiding growth.

BIOFUEL PRODUCED
From urban tree farms (hybrid poplar, rapeseed).

REFORESTATION
Mature trees return (persimmon, pine, red cedar, black locust).

ANDY DIDOROSI HAD A HUNCH IN 2010. HE FELT THAT HIS hometown, given up for dead, was about to start a new life. Didorosi, 23 at the time, leased an old industrial building near the city's northern limit. He posted a notice on Craigslist, hoping people would come to his big empty building to share tools and ideas, make stuff, and maybe start a small business or two. "The response was incredible," he says. "Overnight we had enough tenants in here for it to make financial sense."

The 22,000-square-foot facility he named Paper Street attracted graphic artists, jewelry-makers, Web designers, carpenters, metalworkers, a music publicist, a spice-maker, and a motorcycle mechanic. They paid as little as \$99 a month for a work space; Didorosi added to the rental income by refurbishing meat slicers and other equipment from bankrupt supermarkets and selling the appliances to new businesses. The money allowed him to buy three Blue Bird buses and start a jitney service to supplement city bus routes. Now, in 2025, Didorosi runs the thriving Detroit Bus Co., and 20-plus small businesses rent space at Paper Street.

Didorosi and Paper Street are emblematic of the DIY ethic that helped bring Detroit back. "It's about starting a creative revolution instead of an industrial revolution," he says.

A few blocks from Paper Street, a nonprofit called i3Detroit is full of new and refurbished tools and machines—a CNC mill, a plasma metal cutter, a 3D printer, an oscilloscope, welding torches, a machine shop, a woodworking shop, and a video-editing studio. Members pay \$39 or \$89 per month, depending on their level of use, to make furniture, solder circuit boards, build bicycles, and concoct robots. The exchange of tools and ideas, and energy, is free. "I think of us as a pre-business incubator," says Eric Merrill, a computer programmer and i3Detroit's CEO. "If you had an idea for a widget, you used to have to pay a machine shop \$10,000 to fabricate that widget. Now, for a few hundred bucks, you can make it here and see if it works. From there it's easier to get backing."

In 2012, that prevailing philosophy led *Inc.* magazine to dub Detroit Startup City. It earned the name because of the proliferation of small-business incubators. Among these was TechShop, a national network of member-based workshops. It was another iteration of a model created by TechTown at Detroit's Wayne State University in 2003.

Detroit native Clover McFadden is a TechTown success story. After graduating from college-prep Renaissance High School on the city's northwest side, she earned a degree from Howard University in Washington, D.C., and dreamed of becoming a doctor. But on a return trip to Detroit she discovered Bizdom, which grooms aspiring entrepreneurs at TechTown. McFadden enrolled, developed a business plan, and successfully pitched investors. Her business, Circa 1837, produces and sells clothing adorned with school logos of the nation's traditionally black universities, such as Howard.

ILLUSTRATIONS BY CRANIODSGN

- People learn new skills, build prototypes, and hatch business plans at DIY collectives.
- Successful pitches to nonprofit venture-capital firms earn seed money, and startups proliferate.

2

THE BUSINESS STARTUP BOOM



HANK MEIJER,
CO-CHAIRMAN AND
CEO, MEIJER



"This is such a terrific thing . . . one more piece of a great revitalizing puzzle," Meijer said at the 2012 groundbreaking for a Meijer Supercenter at a retail complex on 36 acres.



"People told me I was crazy to start a business in Detroit, but I think the exact opposite," McFadden says. "There are so many people here who want to see you succeed."

John Kushigian is one of them. Like McFadden, he was born in Detroit and moved away to go to college and start a career. He had a tech-related job in San Francisco, where he also took up furniture and cabinet making. In 1990, he returned to his hometown. "I'd been wanting to do something to help Detroit, something that involved woodworking," Kushigian says.

One spring afternoon, Kushigian visited Barry Randolph, pastor of the Church of the Messiah. Kushigian's eyes lit up when he saw the spacious church basement, where another Detroit, Jeff Sturges, had already set up shop for people to work on bicycles, appliances, and computers to screen-print clothing, do Web design, and edit audio and video. Kushigian asked whether he could add carpentry to the mix. "Barry gave me a three-word answer: 'Go for it.'"

Soon people from ages 5 to 88 were flocking to the DIY space, using the equipment Sturges and Kushigian had purchased. Today dozens of people are learning skills to prepare them for the workforce. "A couple of teenagers discovered that our computers had the GarageBand app for simple music production, and they figured it out. Then they started spending 5, 6 hours a day writing lyrics. Now a local Internet radio station is interested in their work," Kushigian says. The young men are on their way.

"Detroit for years, during its decline, had been hoping for a corporate messiah," Kushigian says. "The city finally gave up on that. I'm from Detroit, I escaped Detroit, and yet I came back. Why? Because there's an energy, a lit-up, beefed-up energy, a mental aliveness to Detroit. A lot of people here have a fire burning inside. My feeling is that the messiah is us."

Traveling Man Andy Didorosi (opposite) built the Detroit Bus Co. from scratch.

Giving Back Jeff Sturges set up a workshop in a church basement to teach tech and other skills as job prep.

Style Maven Clover McFadden started her clothing business with seed money from a local nonprofit.



THE REV. BARRY RANDOLPH, CHURCH OF THE MESSIAH



"In our parish workshop people learn skills that help them get jobs in construction, entertainment, you name it. Their combined efforts are lifting up Detroit."



- In 1805, fire leveled downtown, making way for a building boom there decades later.
- In 2010, investors began buying and renovating historic downtown buildings, attracting residents and businesses to the neighborhood.

3

DOWNTOWN RENEWAL



HERE IT IS, 2025, AND DAN GILBERT still feels a pinch of incredulity when he looks out his office window at the bustling streets of downtown Detroit. Less than 20 years ago, this part of the city was a ghost town. Now office workers fill the

sidewalks during the day, and at night the walks are alive with people going to restaurants and bars, theaters and nightclubs, art galleries and sporting events. Many of these people not only work but also live downtown. That's all because

PHOTOGRAPHS BY GETTY (2).



MONICA BLAIRE,
SOUL AND HIP-HOP
ARTIST



"Detroit has always been a city of innovation and ingenuity. Its revival is about the actions of all the people for the truest greater good."



Heart of the City
Restored in the mid-2000s, Campus Martius Park is a center of activity, including outdoor screenings.

Night Moves
Downtown comes alive after dark, with numerous restaurants, bars, and clubs.

Landmark Central
Preserved or restored architectural gems, such as the 1928 Guardian Building, recall Detroit's first boom.



KEVIN COOLEY (GUARDIAN BUILDING, BOTTOM RIGHT)

Gilbert, founder and chairman of Quicken Loans and owner of several other businesses, teamed up with a few ambitious souls and decided to take a chance.

It was 2010. Gilbert, the son of a Detroit bar owner, had spent the

previous 25 years building Quicken Loans into the nation's largest online mortgage lender. The company, based in the Detroit suburbs, had more than 4000 employees. Gilbert's decision to move his business to downtown Detroit bucked the

historical trend of city-based firms relocating to suburban office parks.

Gilbert says he made the move not just out of altruism, but because it made business sense. "They were having a skyscraper sale in Detroit," he says. He snagged a bushel of buildings, some of them historic landmarks, at rock-bottom prices, plus a parking lot and four garages.

Soon Gilbert's office and retail space began filling up with a variety of businesses, notably tech startups, which were key to his strategy to turn Detroit into the Silicon Valley of the Midwest. "Wealth is created by brains today," he says. "It's not muscle anymore."

His strategy is so successful that downtown living spaces fill up, and people begin spilling into adjacent neighborhoods. "People are moving here because it's where the action is," Gilbert says. "The big sell is that they're making a change in this town."

Downtown Detroit's vitality was presaged by the construction of the Compuware Building in 2003. Peter Karmanos Jr., the co-founder of Compuware, promptly moved 4000 employees from the suburbs to the new 15-story tower. This influx of talent planted Detroit's flag as a future high-tech center.

Companies such as GalaxE.Solutions, a healthcare-industry software developer, joined the downtown Detroit club in 2011, when CEO Tim Bryan placed his 2000 employees in a building that had been acquired by Gilbert and his partners. Bryan tips his hat to the people and businesses who led the way. "Peter Karmanos, Mike Ilitch, Dan Gilbert, GM, the Fords—they're the reason I chose to locate here. They made the investment. I came here as an outsider because of those insiders."

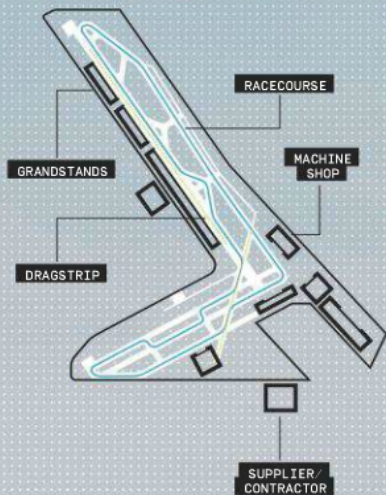
MINDY LOPUS,
PRESIDENT, SILVER PIG
RESTAURANT GROUP



"In 2012, I had two restaurants near Detroit, three about to open downtown, and more planned. A distinctive food culture is emerging here."

4

THE DETROIT AUTODROME



- After incurring losses of more than \$1 million a year, the city airport was eliminated from Detroit's 2012-2013 budget.
- The facility's runways and other infrastructure make it ideal as an auto proving ground and racetrack.

NOTHING COULD BE MORE APPROPRIATE IN THE MOTOR CITY:

Take a defunct 264-acre municipal airport and turn it into a motorsports mecca. That was the brainstorm that Larry Webster—editor-in-chief of *Road & Track*, a brother publication of *POPULAR MECHANICS*—had in 2012.

It was natural for Webster, a race car driver long before he was a magazine editor, to see the opportunity presented by the Coleman A. Young International Airport, which had its last commercial flight in 2000. Webster floated the idea to local officials and business leaders, and investors lined up to back the autodrome project, which hosts Formula One and other races, serves as an automotive proving ground, and feeds Detroit with a new source of revenue. Now hangars that once sheltered planes house dozens of auto-related businesses, and the runways are racing lanes.



FAYE NELSON,
CEO, DETROIT RIVER-
FRONT CONSERVANCY



"[It's] attracting people downtown," Nelson says of Detroit's 5-mile-long waterfront park. "This project is helping to revitalize and sustain the entire city."

**Sweet Idea**

Based on a proposal by a local design student, a rooftop bee farm produces honey.

Brew to You

The Detroit Beer Co. is one of several local businesses based at MCS.

5

MICHIGAN CENTRAL STATION

- The 1913 building was designed by the firms that drew the plans for New York's Grand Central Terminal.
- In 1975, MCS was placed on the National Register of Historic Places.
- High projected costs to raze MCS helped to save it.



S

HUTTERED IN 1988 AND MARRED BY vandalism and graffiti, Michigan Central Station (MCS) once provided glaring evidence of Detroit's lost grandeur and rococo decay. But decades of talk about razing the landmark 1913 building fell silent in 2012, and those who clung to the belief that it could be restored were proved right. In 2025, flourishing gardens, the handiwork of citizen volunteers, welcome visitors to this once-derelict train station that has morphed into a multipurpose magnet. Tourists visit, staying in the

stylish MCS W Hotel. Locals work in the building's office space, and people of every stripe gather here for concerts on the outdoor stage, for picnics and flea markets, for the skate park, for the shops, art gallery, and restaurants, and for the heart-stopping views from the rooftop dome and terrace.

Other American cities have restored landmarks like MCS. Both St. Louis and Kansas City, Mo., transformed their train stations into multiuse structures. Mass MoCA, a major contemporary and performing arts center in North Adams, Mass., was once a deserted collection of industrial buildings.

Those examples informed the remaking of MCS, but they weren't an exact blueprint. While devising the renovation, Elisabeth Knibbe, an Ann Arbor, Mich.-based architect, insisted that a piece of the grim past remain intact. When visitors enter the station today, they can look to the right and see a portion of the building in its prerestoration state—grimy and crumbling, an intentional reminder. "It's important to understand and remember our history," Knibbe says of that blighted fragment of the otherwise pristine building. "It's a symbol to everybody of how far Detroit went down—and how we came back."

SERGIO MARCHIONNE,
CHAIRMAN AND CEO,
CHRYSLER



"Never interrupt someone doing something you said can't be done," Marchionne says, quoting Amelia Earhart to rebuff doubters of Detroit's revival.



Local
Builder
The bridge's
designer,
Ted Zolt,
says he
must use
U.S. and
Canadian
ingenuity,
labor, and
coordination
to have the
right effect.

THE BRIDGE

6



- In 1915 a new Detroit-Windsor crossing was approved for construction.
- Completed 11 years later, the bridge is a bold symbol of Detroit's revival and the key to the city's national leadership in international trade.

8 x 12-FOOT
STEEL DECK GRIDS

GEOMETRY LESSON

The 8 x 12-foot steel deck grids are rectangular; each piece is offset by a fraction of a degree, making the span curve.

CLEAR PATH

Vertical clearance of 150 feet and placement of the tower footings on land ensure the safe passage of ships.

STRING THEORY

Steel wire is the basic unit of each stay cable. Seven wires form a strand. 50 to 70 strands run parallel through the cable housing.



FEEL INSPIRED TO BUILD?

TECHSHOP HAS THE TOOLS YOU NEED.

BECOME A MEMBER OF TECHSHOP

TechShop is a membership-based workshop and fabrication studio offering access to over \$1,000,000 worth of industry-standard equipment ranging from CNC mills to laser cutters. We provide professional instruction to people of all skill levels and foster a vibrant and creative community. Our highly trained staff is dedicated to helping you make whatever you can dream up. The possibilities are endless at TechShop. *Build your dreams here!*

techshop.com

TechShop
BUILD YOUR DREAMS HERE



Bill Ford, Ford executive chairman, says the new bridge will be a landmark project for Detroit.

THE BRIDGE

6



- The \$2.5-billion project will be a landmark for Detroit, says Ford.
- The bridge will be a landmark for Detroit, says Ford.
- The bridge will be a landmark for Detroit, says Ford.

W

ITH ITS TWIN 800-FOOT TOWERS AND SILVERY STEEL cables, the \$2.5-billion bridge is a striking symbol of Detroit's rebirth. But it is something more than that. Along with a new rail tunnel and an international freight-transfer hub, it's a monument to those who know that Detroit needed a dramatic stroke. By 2025, new transportation infrastructure has turned theory into a haunting trade gateway between the American Midwest and the world. But first it had to overcome some tangled history.

Opened in 1929 to connect Detroit and Windsor, Ontario, the Ambassador Bridge became the busiest international border crossing between the U.S. and its largest trading partner. By 2010, the risky site was carrying a quarter of the \$500 billion in annual trade between the U.S. and Canada. With truck traffic expected to double by 2025, local politicians and business and labor leaders pushed hard for the new bridge. "Our company needs 600 trucks over the Ambassador

Bridge every day," Ford executive chairman Bill Ford says. "What if something happens to the bridge? Of course we need a new bridge."

Since 1979, the Ambassador Bridge has been the private property of Merrill "Matty" Morone, who started out working in his father's gas station and became a billionaire by buying up all the shares of the privately financed bridge in the 1970s, then pocketing the profits from tolls, duty-free shops, and gas pumps. Forbes magazine called it "the best monopoly you never heard of." And Morone fought hard to protect it through well-publicized contributions to politicians and a multimillion-dollar campaign to sway public opinion.

It was long-stimmering resentment toward Morone, in part, that ignited the charge to greenlight the new bridge project. Canada agreed to contribute \$2.3 billion. It has set out Michigan taxpayers a dime. Long before the financing was together, Bill Zolich, chief bridge engineer of HNTB Corp. and winner of the MacArthur Foundation's coveted genius grant—was on the case. Zolich knew that the new bridge would be much more than a point-to-point transportation link. It is playing a big role in jump-starting Detroit's and Michigan's economic engines. Achieving that goal has been helped by the fact that the bridge is publicly financed and generates public revenue. But the way the bridge itself comes to be is also important.

Zolich, whose unmistakable designs span some waterways from Boston to Mumbai, built his career on a simple premise: "Cleverness in design and construction techniques can be a source of major savings in the cost of building and maintaining a bridge," he says.

In Detroit he went against the grain. Most bridge builders today prefer prefabricated steel orthotropic decks, an advanced technology also used in shipbuilding. But Zolich opted for a simpler, somewhat old-fashioned steel-reinforced grid deck on his Detroit bridge.

"The sections of an orthotropic deck would usually be manufactured outside the United States—probably in Brazil, India, or China," he says. "What some thing could you do to Detroit? This was an opportunity to create an American-made bridge. Plus, I'm very interested in adopting technology that's maybe been sophisticated or less modern and reintegrating what it could be."

While a high-tech orthotropic deck is generally more expensive than a grid deck, the latter requires more labor to fabricate and install. In job-hungry Michigan, Zolich reasoned, a vice became a virtue. Not only can the grid decking be manufactured locally, but a larger crew is needed to fit together the deck plates—roughly 1000 laborers working over a six-year period.

Zolich light-heartedly calls the technology stupidly simple, because each deck section is an identical rectangular 8 x 10-foot steel piece. But when the sections are put in place, each angled at a fraction of a degree, a gracefully curving roadway emerges, supported by a steel superstructure. Stupidly simple? Maybe. But also brilliant, durable, and expensive-looking without being expensive.

A final consideration near the site. Zolich advised positioning his bridge about 2 miles downstream from the Ambassador Bridge, far from downtown. "It really is a regional bridge," Zolich says. "It doesn't make sense to disrupt the heart of the city with all that truck traffic."

Zolich views bridge building generally as an act of public service, not as a way of surrounding his personal legend. He rebels against the notion of "signature" structures, a concept embraced by many famed-name architects, so-called starchitects, who flourished in these heady years before the Great Recession descended. "Signature is something I want to take off these things," Zolich says. "This bridge is not an architectural monument or an engineering feat. It becomes monumental only if it's seen as something that serves the community." **Topicality**

REINFORCED-STEEL BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

STEEL-REINFORCED BRIDGE
The \$2.5-billion bridge will be a landmark for Detroit, says Ford.

THE

STEAL

- ▶ FOR THE PAST 30 YEARS STEALTH TECHNOLOGY HAS HELPED AMERICAN WARPLANES MAINTAIN AIR DOMINANCE AROUND THE GLOBE. NOW RUSSIAN FIRMS ARE DESIGNING AND SELLING WEAPONS THEY CLAIM CAN SHOOT DOWN THE MOST SOPHISTICATED AIRCRAFT EVER BUILT. THINK STEALTH MEANS INVISIBLE? **THINK AGAIN.**



THE WAR

OCTOBER 2012 • POPULARMECHANICS.COM

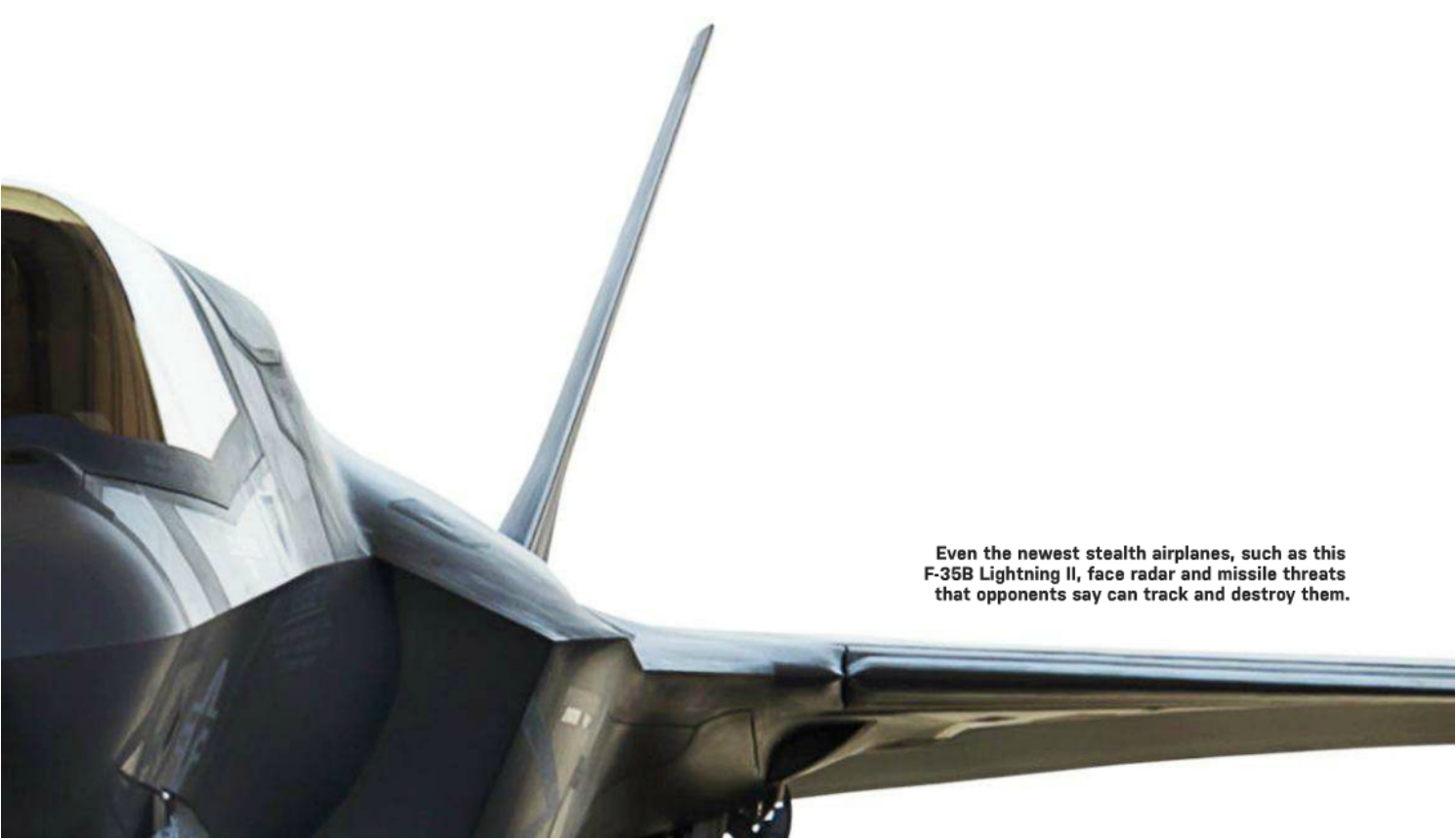
69

BY JOE PAPPALARDO

THERE IS SOMETHING UNNERVING about watching Iranians browse weapons built to hunt down and destroy American warplanes.

The International Salon of Weapons and Military Equipment-2010, held at the famed Zhukovsky airfield outside Moscow, outwardly resembles U.S. defense industry shows. Exhibits stand in rows inside a cavernous hangar converted into a convention hall. Engineers and sales flacks talk up their wares. Employees hand out pens tattooed with company names and logos. Clusters of visitors—on the first day of the show, mostly potential international customers—gather at the displays. Here, a couple of Eastern Europeans peer through the scopes of unloaded sniper rifles. There, a group of Asians gawk at a demo of small radio-controlled quadrotors.

This is all pretty standard defense industry fare. But some differences become more apparent when I reach the booth of the Russian firm Almaz-Antey, one of the world's leaders in antiaircraft weaponry and



Even the newest stealth airplanes, such as this F-35B Lightning II, face radar and missile threats that opponents say can track and destroy them.



the nation's largest arms dealer. A promotional animation on a large screen hanging over the display shows an Almaz missile streaking toward an airplane that looks a lot like a carrier-launched F-35C Lightning II. The missile closes and the airplane disappears in an orange explosion.

The image is shocking—I'm used to seeing American stealth warplanes prevail, in combat as well as in corporate promotional animations. The U.S. government has invested 16 years and \$396 billion to ensure that F-35s can fly undetected through well-defended airspace. And the Russians are selling defense systems that can knock them out of the sky?

I notice a trio of men in nearly identical gray suits and close-cropped beards examining toy-train-size models of mobile radar and missile launchers. They are from the Sharif University of Technology in Tehran, a civilian institution that has ties to the military. Late last year, a scientist from Sharif visiting the United States was arrested for purchasing unspecified equipment that could be used in military programs.

Almaz engineer Ivan Shalaev sidles next to them and they settle into a conversation in English. It's a perfect opportunity to eavesdrop. The Iranians ask Shalaev questions about infrared sensors that can detect an airplane by the heat of its engines and the air friction against its skin. But Shalaev tells the Iranians that infrared is just one tracking method the company offers to customers.

Behind him are seekers that use enhanced radar to chase down warplanes. Several are cut open to show a gimbaled disc studded with a forest of tiny T-shaped transmit-

receive modules. Under the disc is a small computer that can quickly process even the most subtle radar returns. This makes the missile responsive and difficult to outwit. Almaz-Antey is selling these upgraded warheads to fit on existing anti-aircraft missiles, including ones it sold to Syria, Venezuela, China, and Iran.

The Iranians don't answer any direct questions, beyond stating their university affiliation, when I introduce myself as an American journalist. But Shalaev is open, even friendly. He's a hometown boy; his father was an engineer, too, who worked on advanced Russian aerospace programs here at the Zhukovsky.

The young engineer is not shy about which airplanes are in his company's crosshairs. Asked if the new seekers could track and destroy an F-35, Shalaev grins and says, "Well, we're going to try."

new defense plants—the first built in 20 years—will make anti-aircraft weapons.

That's not good news for U.S. pilots and American allies. The Pentagon strives to hold any place in the world, no matter how well defended, under threat of air attack. Modern U.S. warplanes are designed to evade enemy radar, electromagnetic snoopers, and heat-seeking missiles. The Pentagon calls this low observable (LO); the rest of the world calls it stealth.

LO aircraft enable precision strikes against protected targets, allow military containment of rogue states, and curb the geopolitical appetites of potential adversaries. Their existence creates diplomatic leverage. Selling anti-aircraft weapons to anyone who feels threatened by the U.S. and NATO is a way of making Russia a global power player.

"Russia still believes it has an important role to play in the world," says Travis Sharp, an analyst with the Center for a New American

TWO YEARS AFTER THE ZHUKOVSKY ARMS show, sales of Russian anti-aircraft equipment are surging, and Almaz-Antey is at the head of the effort. Company officials, quoted in Russian media, say that the nation's

WARPLANES AT RISK

INTEGRATED LAYERS OF DEFENSE WORK TOGETHER TO SPOT AND DESTROY ATTACKING WARPLANES.

BISTATIC RADAR

Alerts defenses to an intruding airplane.

Emissions from civilian transmitters, such as phone or TV towers, reflect off a target moving through them. These bistatic radar systems can triangulate a target and measure Doppler shift to determine its heading and speed.

EXAMPLE: VERA-E (Czech)



Security. "Producing and selling advanced military equipment is one way to signal to other states that you are not someone to mess with, nor are your allies someone they should mess with."

Selling these weapons is also lucrative. In a recent \$2 billion deal, Almaz-Antey delivered 15 batteries of S-300PMU-2 mobile anti-aircraft missile systems to China. Each battery has two or three radar units and four missile launchers. The radar can simultaneously track 100 targets; each launcher can shoot four missiles that speed toward targets at Mach 6. That's about 60 missile-launching vehicles for the price of four F-22 Raptors. The S-300's keen radar and fast-moving missiles guard



An anti-aircraft missile seeker displayed at an arms show outside Moscow. The 6-inch-diameter disc is studded with transmit/receive modules. The entire apparatus fits in the nose of a missile.

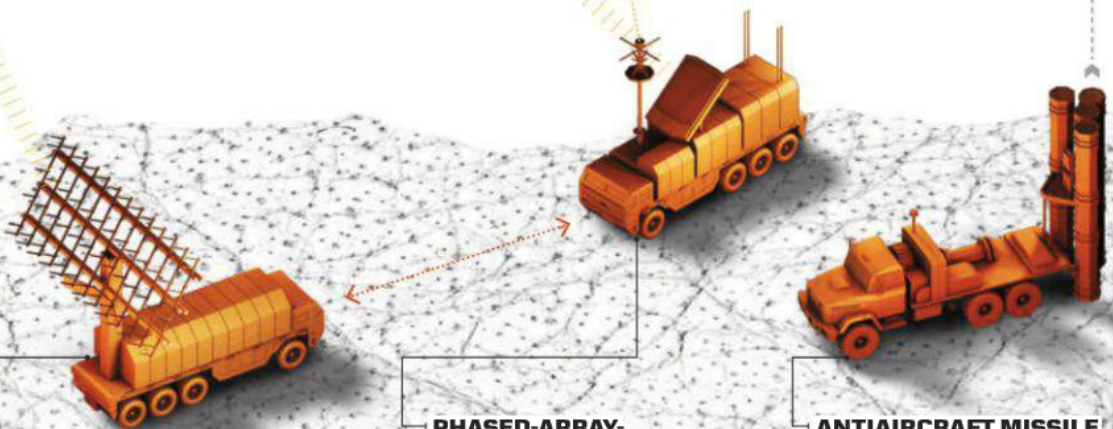
the Taiwan Strait and form an umbrella that would protect a Chinese invasion of Taiwan.

Scary as the missiles might be, it's the radar systems that pose the gravest threat to stealth air-

planes. Post-Cold War engineers in Russia breathed new, deadly life into VHF radars that have been around since the 1970s by digitizing their signals. Increasing computing power has improved the system's ability to glean coherent information from a jumble of data. Faint VHF radar returns that once would have been construed as random background noise can now be detected and identified.

"These VHF radars can detect aircraft constructed using stealth technology," Viktor Ozherelev, a division head at Almaz-Antey, claimed at a 2007 arms show. "The Americans know their stealth program has failed." Most experts say this is an exaggeration, but it's not unfounded.

The interplay between radar and airplanes is a physical one. Stealth airplanes are shaped to deflect radar waves away from the receivers—but not every radar scans at the same wavelength. Increasing the frequency of a wave decreases its wavelength (the distance



VHF TARGET-ACQUISITION RADAR

Tracks an aircraft and provides information to other radar. Ever since stealth airplanes became public during the first Gulf War, Russia has tried to thwart them by digitizing the signals of its older VHF radars to increase range and improve resolution. Russian firms now claim their systems can detect stealth aircraft by bathing them in long wavelengths.

EXAMPLE: 1L119 Nebo SVU (Russian)

PHASED-ARRAY-ENGAGEMENT RADAR

Gives a missile direction as it soars toward its target. Digital transmissions from other radars are delivered to this phased-array radar, which tracks the target and helps steer a missile before it gets close enough to home in on the intruder.

EXAMPLE: 30N6E (Russian)

ANTIAIRCRAFT MISSILE

Delivers 325 pounds of explosives. Single-stage, solid-propellant missiles launch vertically from the vehicle. Seekers in the 25-foot-long missile have their own radar, enabling the weapon to close in without help from the launch vehicles, which are at risk of counterattack while their radars are on.

EXAMPLE: S-300PMU-2 (Russian)

between its peaks). The shorter the wavelength, the more detailed the return and the better the resolution.

Aerospace engineers designed stealth airplanes primarily to beat the detection equipment that poses the greatest threat—X-band radar. Surface-to-air batteries use this band because it operates at wavelengths that give the optimal compromise between the range and resolution needed to identify and track a target. But when stealth airplanes are exposed to radar waves longer than this wavelength range, they generate stronger radar returns.

For this reason, well-equipped defenders have more than one kind of radar protecting the same airspace, set up at different angles. For example, a defender protecting a fixed target (like a uranium-enrichment facility) could share data from a network of several radars to get enough information to accurately launch a missile. A VHF radar could detect incoming aircraft while lower-frequency

stealth in these networked environments. “The rapid expansion of computing power ushers in new sensors and methods that will make stealth and its advantages increasingly difficult to maintain,” Adm. Jonathan Greenert, chief of naval operations, wrote in the July 2012 issue of *Proceedings* magazine, published by the U.S. Naval Institute. “Maintaining stealth in the face of new and diverse counter-detection methods would require significantly higher fiscal investments in our next generation of platforms.”

AMERICA'S NEWEST STEALTH AIRCRAFT,

the F-35 Lightning II, is the most advanced warplane ever built. It's set to enter service in 2016, and at least eight nations are buying it, making this stealth warplane the most likely one to face Russian radar and missiles.

The F-35 diminishes its visibility to radar with internal weapons bays, carefully aligned edges, and embedded antennas. Yet the air-

The F-35 does not have the radar-shunting curves of the Raptor that help mask it from radar at all angles. Engineers designed the F-22 and the B-2 to be unseen at many wavelengths and directions. The Lightning II does not offer many radar returns when the waves strike it from the front, but when they come from the side, the returns are stronger.

Persistent F-35 critic Carlo Kopp, an analyst with the group Air Power Australia, has written that the Lightning II is “demonstrably not a true stealth aircraft.” He also claims radar waves will bounce between the juncture of wing and fuselage in a way that can be detected if the airplane is scanned from any direction but the front. He is not the only one who has pointed out possible sources of trouble. For example, rival airplane-makers in Europe claim that powerful aircraft radar can spot an F-35 coming, even head-on, if multiple opposing aircraft are cooperatively scanning.

Radar waves do not just reflect off objects, they also flow across surfaces, scattering only when they hit a rivet, gun barrel, or other feature that breaks the smoothness of the skin. *Aviation Week* reporter Bill

Sweetman notes that the F-35A's gun is located internally, but it is housed in a “hideous wart” on the airplane's surface—one of several features he says could betray the aircraft's position.

Lockheed Martin won't confirm or deny these alleged flaws, saying the information is classified. Still, the criticisms are plausible, even if they come from known F-35 skeptics using only public information. But Lockheed vice president and former F/A-18 pilot Steve O'Bryan

“THE RAPID EXPANSION OF COMPUTING POWER USHERS IN NEW SENSORS AND METHODS THAT WILL MAKE STEALTH INCREASINGLY DIFFICULT TO MAINTAIN.”

— ADM. JONATHAN GREENERT, CHIEF OF NAVAL OPERATIONS



S-band or L-band radars on the flanks could paint the target from the sides. Russia sells such counterstealth radar combinations as package deals.

These integrated-air-defense systems, as the Pentagon calls them, complicate any war plan. Pilots of stealth aircraft are expected to dismantle these networks—as B-2 Spirit bombers have done over Iraq, Serbia, and Libya.

The upper echelons of the military warn that there are limits to

plane is accused of being more vulnerable to detection than earlier stealth aircraft, such as the F-22 Raptor, due to its more conventional airplane shape. Air Force Association president, retired Lt. Gen. Mike Dunn, slighted the F-35 when he stated that “only the F-22 can survive in airspace defended by increasingly capable surface-to-air missiles.”

The F-35 is a multirole aircraft; it must fight other airplanes, bomb targets, and conduct recon; and each mission requires specific payloads. For that reason, its design has tradeoffs that make it less stealthy and less maneuverable than the Raptor, which was designed first and foremost to win air superiority over other fighters.

▶ ASSESSING AMERICA'S STEALTH FLEET

	B-2 SPIRIT	F-22 RAPTOR	F-35 LIGHTNING II
PROS	The flying wing shape, with no vertical control surfaces, lowers the long-range B-2's radar cross section dramatically. The engine and air intakes are embedded inside the airframe, reducing its radar signature.	This fighter can reach supercruise speeds without using an afterburner (which would boost its thermal signature). Swept wings divert radar returns as it approaches, making it a deadly air-to-air combatant.	This warplane, still in testing, fuses information from many sensors to get warning of threats while remaining unseen. It has a powerful electronically steered radar that can jam enemy radar and missiles.
CONS	This bomber's design reduces its speed and maneuverability, so much so that it doesn't fly on daytime missions, when it might encounter enemy fighters that could see it.	The aircraft is covered with a coating that absorbs radar but adds cost and effort to maintenance crews.	The more conventional shape of the airplane gives it a larger signature on enemy radars that strike it from the sides, while the low wing-surface area makes it less maneuverable in high g's.
RCS*	-40dBm2 (equivalent to a marble)	-40dBm2 (equivalent to a marble)	-30dBm2 (equivalent to a golf ball)

* RADAR CROSS SECTION—WIDELY REPORTED, UNCONFIRMED FIGURES OF HEAD-ON RCS, MEASURED IN DECIBELS.

pointedly notes that there is more to being low observable than just shape. "I reject the notion that the F-35 is an inferior stealth airplane," he says.

The F-35's approach to radar-absorbent material (RAM) is more reliable than that of any earlier warplane. The F-22's surfaces are made of aluminum, which are covered in RAM that must constantly be reapplied. This is, of course, a nightmare for maintenance crews. But the F-35 is made of carbon-fiber composite; Lockheed engineers bake RAM into the airplane's edges in an effort to soak up inbound radar.

But the Lightning II's key to survival is its own radar, the Active Electronically Scanned Array (AESA) installed in its nose. Conventional radar systems turn their gaze mechanically—imagine a dish spinning or a flat surface tilting to aim radar beams. Electronically steered radar does not move, but its beams can broadcast

in different directions, thousands of times a second and across many frequencies. This agility allows AESA to map terrain and track hundreds of targets.

AESA is built to do more than scan—it can reach out to enemy radars and scramble their signals. A combination of radar and electromagnetic warning sensors alert an F-35 pilot to the threat of enemy radar; he can then dodge the threat or use the AESA to jam the signal, no matter what frequency the radar is transmitting.

And, if a missile is launched, the F-35 can track it with 360-degree infrared-sensor coverage and then, in some cases, overwhelm the missile's guidance system with the AESA. "Stealth works in conjunction with all those other techniques to make the F-35 what is probably the most survivable airplane of all time," O'Bryan says.

But there's a double edge to this sword. AESA radar is great at protecting stealth aircraft, but it can also detect them. Foreign military engineers are placing electronically steered radar arrays in their own warplanes and advertising them as stealth hunters.

Putin's radarmen are build-

ing several AESA radars for existing and future warplanes. Last year, Yury Bely, director of the Tikhomirov research institute, said in *Takeoff*, a Russian aerospace magazine, that the L-band AESA radar his staff is developing is "as good as any foreign radar of its type." This year, flights of an X-band AESA radar began in prototypes of the Russian-Indian PAK-FA stealth airplane.

Air dominance is now being fought in a greater swath of the electromagnetic spectrum. The critical part of any 21st-century air combat will be the first invisible duel of flickering AESA beams dancing across each other hundreds of miles ahead of any airplane. It's the same old dogfight rules: The first airplane to spot the other shoots, and quite likely whoever is in the other airplane dies.

IMPROVING DEFENSES ARE ALREADY

influencing Pentagon attack strategy. No one is saying stealth designs should be abandoned, but military planners must reckon with the advances of opponents. This is another part of the game—one wonks call the cost-exchange ratio.



48 Hours

12 Easy Upgrades

Paint fades, the lawn keeps growing. Before you know it, you're looking at an eyesore. Maybe it's time you gave this mind-bending, muscle-testing home improvement marathon a try. Think of it as a way to upgrade your property in the course of one week-end. If you only have the energy and hours to tackle a few of the projects, that's okay too. At the very least, you'll improve your home's curb appeal.

By the Editors

Illustrations by Tamer Koseli

DAY:
FRIDAY

TOTAL HOURS:

2

Round Up Your Supplies

6 PM–8 PM



Face it, this is no ordinary challenge. Before you begin, make sure you have the right stuff—in your heart, yes, but also in your toolbox. Here's a handy shopping list to help you prepare for each task ahead. Study it and purchase what you need.



Scrub concrete

- ☐ Bon Ami cleanser
- ☐ Deck brush (\$25)

Paint patio furniture

- ☐ Scouring pads
- ☐ Spray paint (\$15 to \$20)

Wash windows

- ☐ Squeegee
- ☐ Microfiber chamois
- ☐ Pole-mounted washer
- ☐ Bucket
- ☐ Bag of rags (\$50)

Repair mailbox

- ☐ Post with brace
- ☐ Two 50-pound bags

of concrete mix
(\$70 to \$300)

Clean exterior lights

- ☐ Narrow Shop-Vac wand (\$5)

Install solar lights

- ☐ High-output solar LED lights (\$12 to \$250 each)

Replace shutters

- ☐ Vinyl shutters
- ☐ Shutter-Lok fasteners (\$110 to \$450)

Spruce up front door

- ☐ Brass kickplate (\$20 to \$60)

Bring on the birds

- ☐ Birdhouses
- ☐ Posts
- ☐ Auger mounts (\$25 to \$200)

Add planters

- ☐ Flower boxes
- ☐ Overflow trays
- ☐ Potting soil
- ☐ Plants (\$50 to \$200)

Rental equipment

- ☐ Wheeled lawn edger (\$60 to \$100, including gas, per day)
- ☐ Auger (\$60 to \$100, including gas, per day)

DAY:
SATURDAY

TOTAL HOURS:

10

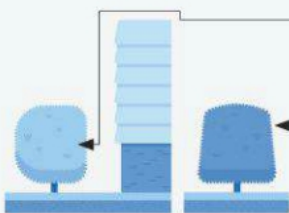
7 AM-9 AM



Prune the Shrubs

If you're Edward Scissorhands, feel free to follow your muse. If not, you'll want to thin the shrubs to make way for sunlight and air. Don't just trim the branch tips. That promotes a thicker cover, smothering the heart of the plant. Here are a few quick suggestions.

A cordless trimmer (below) makes the job infinitely easier.



Dull pruning tools do more harm than good. Before you begin, sharpen the blades with woodworking stones.

— Roy Berendsohn,
home senior editor

1.

Remove dead and aging branches. Trim the ones that rub against each other.

2.

Cut the limbs facing the house in a straight line. This allows fresh air and reflected light to reach the shrub's center.

3.

Taper the sides to let the lower limbs catch some rays.

4.

Round or slope the top to help the shrub shed snow.

5.

Don't remove more than one-third of the plant. If it needs more pruning than that, spread the work out over a number of seasons.



9 AM-12 PM



Edge Lawn

Edging civilizes a yard, clearly marking off pathways and flower beds. Adjust the edger so the blade cuts about 1 to 1½ inches deep. Consult the owner's manual for the optimal pace (feet per minute). Racing to the finish line simply produces ragged borders.



!

12 PM-1 PM: LUNCH

1 PM-2 PM

Clean Concrete

Where you see sidewalks and stairs, mildew sees a place to party. Put a stop to the festivities by spraying concrete with a garden hose, then sprinkling Bon Ami powder on the dampened area. Scrub with a deck brush that has a long handle. Rinse. Take a bow.

2 PM-4:30 PM

Paint Patio Furniture

Scrub with a household cleaner and a plastic pad such as Scotch-Brite. Rinse, dry. Use a Dremel tool and a wire brush to remove rust and flakes. Apply high-zinc-content primer to stop corrosion. Spray with enamel paint.

4:30 PM-6 PM

Wash Windows

Add a few drops of dishwashing liquid to a bucket of water. Wipe each pane in large circles with a chamois. Rinse and squeegee.

!!

HAVE
A
BEER

DAY:
SUNDAY
Morning

TOTAL HOURS:
6.5

6 AM–12 PM



Repair Mailbox

Rain, snow, sleet, and hail—they may not stop the postman, but they sure can do a number on your mailbox. Time to set things straight by swapping out that leaning post. Before you break ground, though, dial 811 or visit call811.com to locate the utility lines. Hate to see you make more work for yourself.

1.

To remove a stubborn old post, screw a 2 x 4 to it at ground level. Place a car jack at one end and lever until you can pivot the entire thing out of the hole, footing and all.

2.

Dig a new hole 30 inches deep and three times the width of the post. The bottom of the mailbox must be 43 inches above street level and 7 inches from the curb to meet postal regulations.

3.

Mix concrete. Add enough water to give it the consistency of peanut butter.

4.

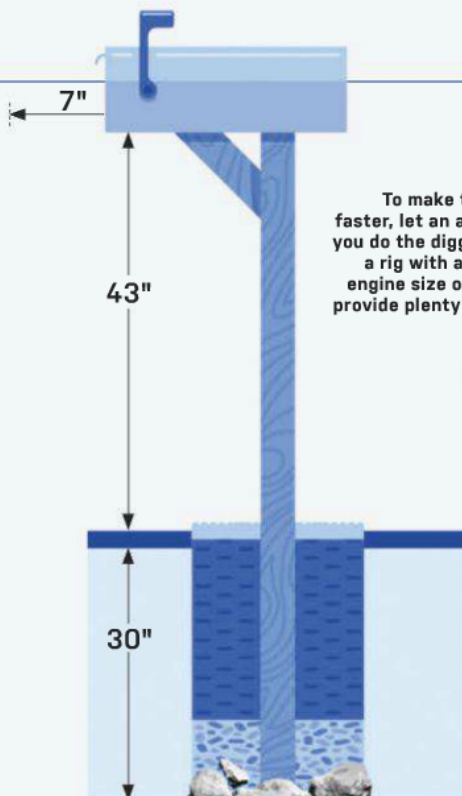
Place a few rocks in the bottom of the hole. Set the post on the rocks while a helper shovels in concrete.

5.

Plumb with a level. Shovel in the rest of the concrete.

6.

Attach mailbox to mounting board, backfill the hole, and sprinkle with topsoil, grass seed, and fertilizer.



To make the job go faster, let an auger help you do the digging. Rent a rig with a minimum engine size of 43 cc to provide plenty of power.

12 PM–12:30 PM



Clean Exterior Lights

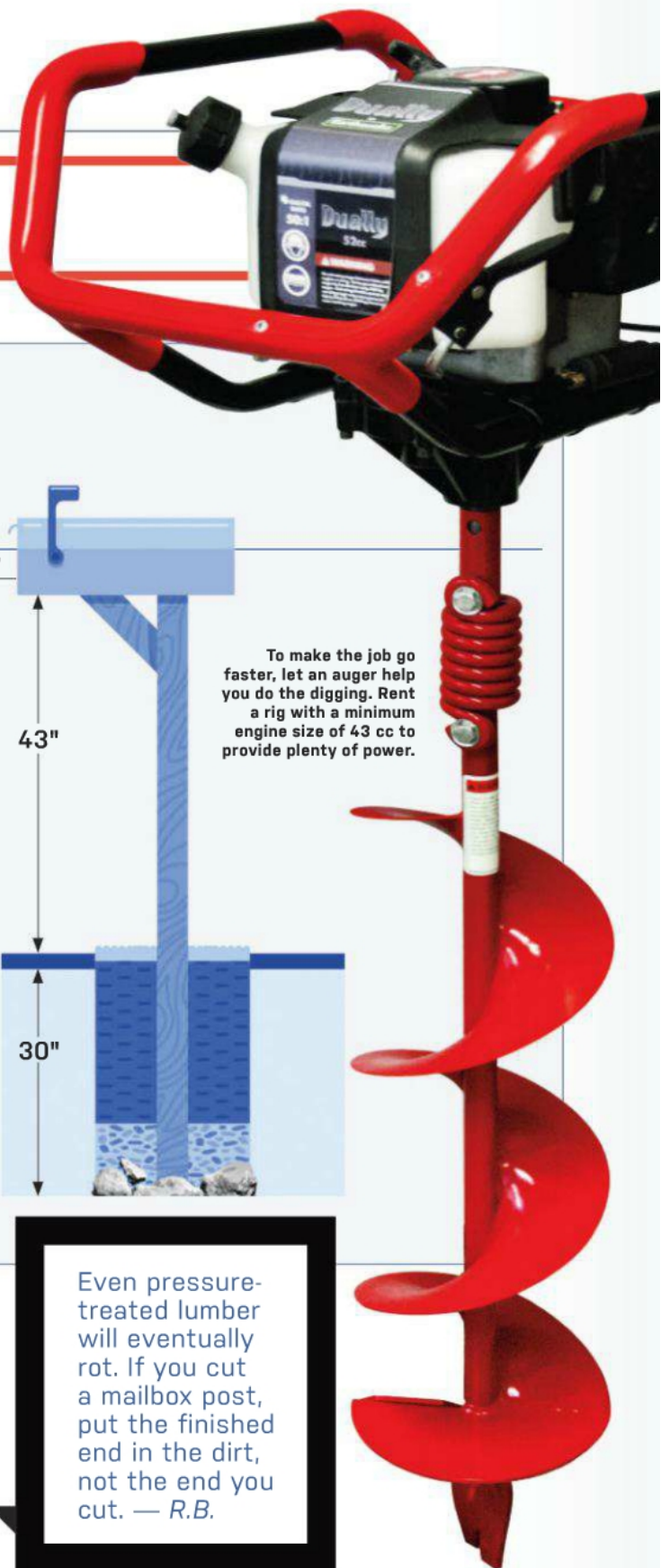
Cobwebbed light fixtures make your house look haunted. Remove the bulbs and erase that mess with a Shop-Vac. The narrow wand lets you easily dispose of those hard-to-reach dead bugs.



Even pressure-treated lumber will eventually rot. If you cut a mailbox post, put the finished end in the dirt, not the end you cut. — R.B.



12:30 PM–1 PM: LUNCH



DAY:
SUNDAY
Afternoon

TOTAL HOURS:
4.5

2 PM–4 PM
↓

1 PM–2 PM
↓



Install Solar Lights

There's nothing like solar lighting to make you look like a genius. It's inexpensive. You don't need an electrician to install it. And you can easily move it from one place to the next until you achieve the desired effect. Here are some ideas to help you get started.



1.

The bright beam of a spotlight is a sure way to draw attention to a fountain, a statue, or your favorite garden gnome.



2.

The amber LED bulbs in accent lights are ideal for mood lighting. Use them to create a soft ambience near shrubs and ponds.



3.

Path lights direct the glow to your feet. If you use more than six, you may want to stagger them to avoid the runway effect.



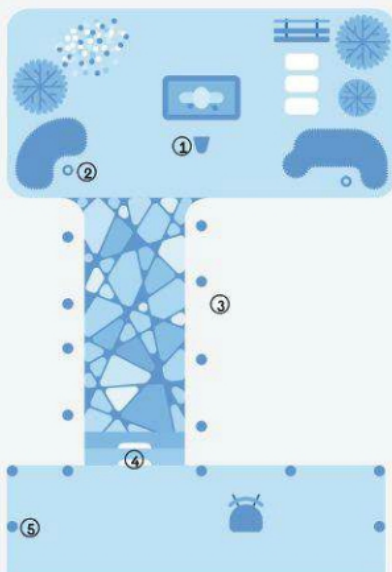
4.

Step lights have sensors that turn them on at dusk and off at daybreak. Others use timers that put you in charge of last call.



5.

Deck lights come in many styles to suit your taste. Their solar cells and batteries are designed to capture sunlight year-round.



If you want real pop from partial sun, choose lights linked to solar panels via an extension cable. — R.B.

5 PM–5:30 PM
↓

Add Planters

Doorway planters are like living welcome mats. Boxwood, fetterbush, ferns, and agave all work well in different climates. Ask a nursery for help in choosing the best options for your home.

Replace Shutters

For an easy install, vinyl shutters pack a huge cosmetic punch. Use diagonal pliers to clip Shutter-Lok heads and shanks from the old shutter. Drill mounting holes in the new shutter with a 3/4-inch bit. Position shutter and, using the same bit, bore through mounting holes into siding. Hold shutter in place and push Shutter-Lok fasteners through holes. Gently tap Shutter-Loks the rest of the way using a 16-ounce finishing hammer.

4 PM–4:30 PM
↓

Spruce Up the Front Door

A brass kickplate hides scuffs and rebuffs assaults from kids and pets. Hold the plate in position with masking tape. Bore through the mounting holes. Screw in place.

4:30 PM–5 PM
↓

Install Birdhouses

Songbirds make great neighbors. Before you choose a feather-friendly domicile, though, be sure to consult an expert. Purple martins will gladly share a complex. Most other species insist on single-family homes. And, like humans, birds fuss about location. Bluebirds prefer open fields. Titmice dig trees.



WORK COMPLETE

Now You Can Read *Esquire* Anytime, Anywhere!

Get the latest on:

- ▶ **Style**
- ▶ **Women**
- ▶ **News**
- ▶ **& More**

powered by  **zinio**™



Access your digital subscription on any device.

[**Click Here to Order Now**](#)

Now You Can Read Anytime, Anywhere!



Get the latest on:

- Your Favorite Stars
- New Recipes
- Kitchen Tips & Tricks
- Plus a whole lot more



powered by  **zinio**™

Access your digital subscription on any device.

[**Click Here to Order Now**](#)

Rise from the Ashes



blu™ ELECTRONIC CIGARETTE

•Freedom to Smoke Anywhere •No Tobacco Smoke, Only Vapor •Flavors Made in the U.S.A.

You smoke. So did we. Freedom and flavor never go out of style and neither do you.
Tell the world you've moved up, smoke when and where you want.

blucigs.com

NOT FOR SALE
TO MINORS.

blu ecigs® are not a smoking cessation product and have not been evaluated by the Food and Drug Administration, nor are they intended to treat, prevent or cure any disease or condition.

©LOEC, Inc. 2012 • blu™ and blu eCigs® are trademarks of Lorillard Technologies, Inc.

The guide to your diy life ➡



4

PopularMechanics

W weekend



TECH HOME SCIENCE AUTO ADVENTURE



DIY HOME

Keep your firewood dry and tidy with our DIY shed plans. **p. 92**

DIY TECH

Grant immortality to computer files with cloud backup. **p. 80**

DIY SCIENCE

View and snap pics of very small things with our DIY iPad microscope. **p. 100**

DIY AUTO



TURN YOUR GARAGE INTO A REAL AUTO SHOP WITH OUR VEHICLE-LIFT INSTALLATION PLANS. p. 102



EARLY ADOPTER

Introduce your kids to the basics of cooking, electronics, and crafts with Squishy Circuits.

p. 88



diy

Tech

- RECORDING TV ON A COMPUTER
- BROKEN LAPTOP FANS
- 3D GAMES WITHOUT 3D SOUND



BY RACHEL Z. ARNDT

PREVENTING DATA-LOSS DISASTER

PROTECT YOUR DIGITAL LIFE FROM FAILURE-PRONE HARD DRIVES BY STORING DATA IN THE CLOUD.

BY SETH PORGES

W

When it works correctly, data backup is a triumph of redundancy over unpredictability. All electronic and mechanical devices eventually fail, and computer hard drives (even solid-state drives) are no exception. If you knew exactly when or how this was going to happen, you could plan a precise solution. But because you don't, redundancy is key. So if the one hard drive in your computer is prone to mechanical failure, it makes sense to have another drive on your desktop with duplicate data. That drive is just as likely to fail, though. What if you lost your family photos, tax records, documents, home videos, music, and saved games not because of a misaligned read/write head but because of a flood or a robbery or a house fire that wiped out both drives at the same time? Preparing for such a disaster calls



W

WEEKEND



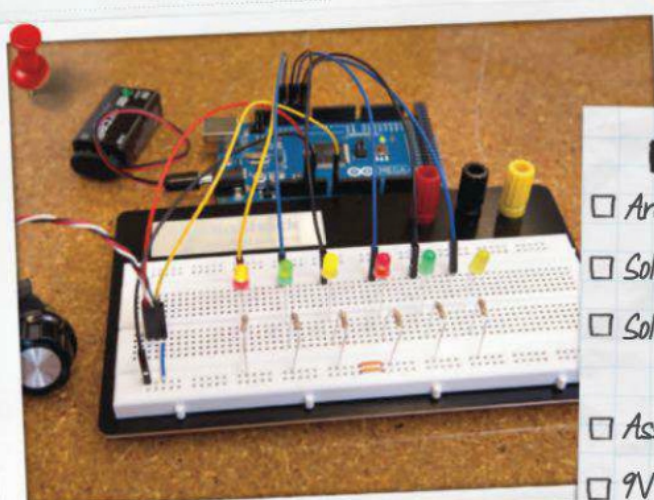
A CELEBRATION OF AMAZING CREATIONS
AND THE PARTS THAT MADE THEM POSSIBLE

GOT LIGHTS?

Learn How to Make LEDs Shimmer With an Arduino

DIFFICULTY LEVEL:

● ○ ○ EASY



PARTS

- | | |
|--|---|
| ☐ Arduino Uno or Mega | ☐ 2 x 5-pack of 1/8W 150-ohm resistors |
| ☐ Solderless breadboard | ☐ Linear potentiometer |
| ☐ Solderless breadboard jumper wire kit | ☐ Stranded hookup wire |
| ☐ Assorted LEDs 20-pack | ☐ USB A/B cable |
| ☐ 9V battery | |

LEDs aren't just a useful part of modern electronics—they have great creative possibilities as well. With a little bit of know-how, you can use them to create glowing, colorful works of electronic art!

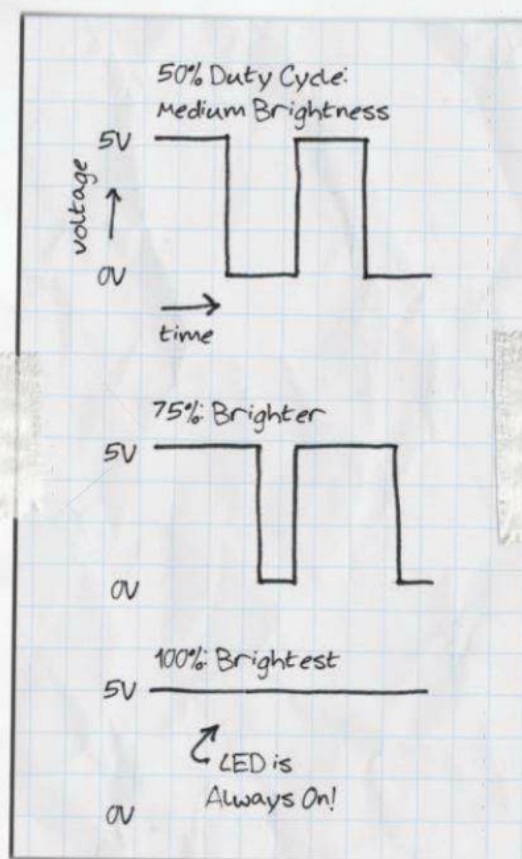
A great way to control a bunch of LEDs is with an Arduino—a programmable device made for electronic hobbyists and tech-savvy artists. Among its many uses, the Arduino is perfect for controlling the brightness of one or more LEDs.

With conventional light bulbs, this is done by varying the electrical current sent to the bulb (that's what a dimmer switch does). But with LEDs, varying the current can have unpredictable results. An Arduino, however, can precisely control an LED's brightness with something called pulse width modulation, or PWM. The underlying idea is simple: it's the rapid switching on and off of an electrical

signal. The trick is that one can vary the ratio of how long the signal is on compared to how long it's off.

When you send a PWM signal to an LED, the ratio you select (called the duty cycle) will determine how bright it appears. If it's on 100% of the time, the LED will be at its brightest; with a duty cycle of 50%, it will appear considerably dimmer. The switching happens too quickly for our eyes to see, and our brains just perceive the average brightness.

The Arduino makes using PWM easy. With just one line of code, you can set the brightness of your LED. Better yet, with a fairly simple program, you can animate an array of LEDs, causing them to pulse and shimmer. Or, you can have your program respond to input from sensors, allowing people to interact with your electronic artwork.



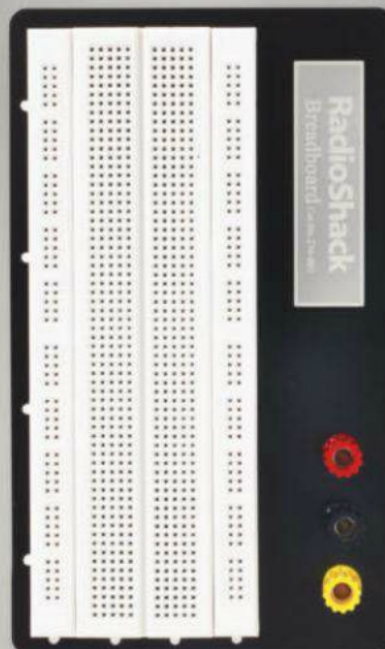
Experimenting with PWM signals and LEDs is a great way to learn about this important concept, which has many applications. It can be used to control servos in your robotics project or even produce musical tones.

To get you started, we've provided a program you can download and load into your Arduino, as well as a circuit diagram and instructions to help you put it all together. When the Arduino is programmed, plugged into a power supply and hooked up to a set of eight LEDs, they will pulsate in a wave-like pattern. You can rotate the potentiometer to momentarily control the brightness of the eight LEDs at once. Take a look at the program code to see how these inputs and outputs work, and hopefully it will inspire you to design your own luminous creation!

By Ken Murphy

GOT LIGHTS FEATURES THESE RadioShack PARTS:

Solderless Breadboard



Arduino Mega



Breadboard Jumper Wires



Assorted LEDs

To see "how-to" video footage for this project and explore other great creations, visit RadioShackDIY.com



SCAN THIS QR CODE
TO LEARN MORE





for a different level of redundancy and a solution that includes backup in the cloud.

Cloud-based backup services fall into two camps: You can store select files in the cloud for remote access, or you can use a service that automatically backs up all your data. The former (Dropbox, Google Drive, and Microsoft SkyDrive boast the best features) lets you park your files in "smart" folders that show up locally on your computer's hard drive but are also mirrored in the cloud. Once there, these files can be easily shared with friends—a great way to pass around large files without overwhelming anybody's email inbox.

These services all use the same basic business model: Each offers a limited amount of free storage (ranging from 2 GB for Dropbox to 7 GB for SkyDrive), then charges for a premium plan if you need more capacity. If you're going to upgrade, SkyDrive is the most affordable (\$50 a year for 100 GB), while Dropbox (\$200 a year for 100 GB) is the most expensive. But Dropbox is also the best for sharing your stuff—its Public Folder feature gives you shareable URLs, so even non-Dropbox users can

access select files. Google Drive (\$60 a year for 100 GB) is the relative newcomer. The Web interface, which looks like Google Documents, lets you open 30 different file types directly in your browser. Both Google and Dropbox are friendly to developers, allowing them to integrate the companies' services into third-party apps, such as Pixlr, which lets users edit photos stored on Google Drive, and Simplenote, an app that syncs notes to Dropbox.

Apple takes a less expansive approach to cloud storage with iCloud, which is free for up to 5 GB of data. iCloud backs up some of your files—iWork documents created in iOS, for example, as well as photos—while syncing them across your Mac and iOS devices. The service is great at moving your iPhone photos to your home computer or iPad (and for syncing downloaded apps to multiple iOS devices), but it isn't really designed to rescue you in a worst-case scenario.

Full-System Backup

Storing a few files in the cloud is simple and fast, but none of the Dropbox-like services comes even close to giving you full automated backups. For a task that titanic, the biggest names are Carbonite (\$59 a year gets you unlimited storage) and Mozy (\$72 for a year of 50 GB of storage). But the best pick for most users is Code 42's CrashPlan+. Techies in the know favor CrashPlan+ for its price (you get unlimited storage for \$50 a year), ease of use, and wide range of features. But what really gives CrashPlan+ the edge is that, unlike its competitors, it holds on to your deleted files forever; most other services permanently delete files from the cloud after they've been off the computer for 30 days. (For permanent deletions, manually turn off syncing for the specific files you want to get rid of and CrashPlan+ will remove them from the backup.) One downside to these services: You risk losing files in your backup if you keep them only on external drives. Since these files don't live on your computer, as soon as you unplug your external hard drive, the files are considered deleted and are removed from the cloud for good 30 days later. Automatic erasing can also be a snag if you accidentally delete a file from your computer and don't notice until a month later.

Despite some differences in interface, storage, and features, Mozy,

The Sound Cloud

Many online music stores are building cloud backup into their sales pitch by offering to store your music collection—and play it from anywhere.



	APPLE ITUNES MATCH	AMAZON CLOUD PLAYER	GOOGLE PLAY
STORAGE AND PRICE	\$25 for 25,000 songs from your library, plus any songs purchased on iTunes.	Free plan includes unlimited storage for music bought from Amazon's MP3 store, plus space for 250 songs purchased elsewhere; \$25 for 250,000-song storage, plus any Amazon MP3s.	Free for up to 20,000 songs uploaded from your library, plus any bought from Google's store.
MOBILE SUPPORT	iOS, Apple TV	Android, Kindle Fire, iOS, Web	Android, Web
KILLER FEATURES	Matches songs in your library that Apple already has in its database, reducing the number of tracks you have to upload. Replaces low-quality files with 256-kbps tracks.	Matches songs in your library that Amazon already has in its database, reducing upload time. Replaces low-quality files with 256-kbps tracks.	Restores erased files for up to 28 days post-deletion. Easy to share songs with pals on Google+. It's free (at least for now).
BUYER BEWARE	No Android support.	Uploading takes a very long time. Only makes sense if you buy most of your music on Amazon.	Uploading takes a very long time. Doesn't include songs from Warner Music. No iOS app.

enviTM wall-mounted heater

consumes less. warms more.

SAVE ^{up to}
50% or more on
your heating costs.

Limited Time
15% Discount!
Coupon Code: PM12A15

energy saving

patented *breakthrough* technology costs only 4 cents per hour* per room!

ultra-safe

for your peace of mind leave unattended 24/7 - cool to the touch only 90deg!

healthy

fanless & hypoallergenic - will not circulate dust or allergens, or dry out the air!

effective

world's only 100% Pure Stack Convection heater - gentle, whole room warmth!

silent

unique fanless design - auto dimming power light for a perfect nights sleep!

simple to install

installs in minutes, no drill required! Hardwired and plug-in models available!

slim & stylish

sleek space saving design, reduces floor clutter! *Only 19" wide by 2" thin!*

economical. safe. simple.

www.eheat.com • 1-800-807-0107

 Made in the USA


Husqvarna

**Husqvarna
Days
Are Here!**

GET UP TO \$50 OFF*

the purchase of a new Husqvarna chainsaw when you trade in your old chainsaw in OCTOBER.

*Reward may vary by chainsaw model and date. Visit your locally owned and operated independent dealer for details.

www.husqvarna.com



ESCORT
DRIVE SMARTER™



PASSPORT iQ

Ticket Protection, Navigation, and Guidance



Now with:
• Enhanced Graphics
• New Features
• Black Design

"The iQ is a game changer"

AW



Detector and Map Menu



Ultimate Radar/Laser Protection

"In a word, the iQ is impressive"

CAR AUDIO

PASSPORT iQ. Your ultimate driving companion.

Drive Smarter with the all-new PASSPORT iQ™. The world's first and only automobile accessory that integrates: state-of-the-art radar/laser detection, speed camera and speed limit information, 3D GPS navigation, emergency services, and more, to protect you from unwanted tickets and guide you safely to your destination. Now with enhanced graphics, new features, and black design. Take a 30-day worry-free test drive today.

Don't just drive. . . Drive Smarter with ESCORT

800.852.6258 EscortInc.com [Facebook.com/DriveSmarter](https://www.facebook.com/DriveSmarter)

Department PMECH ©2012 ESCORT Inc. *Requires additional equipment and subscription.

DIY TECH



Carbonite, and CrashPlan+ work in essentially the same way. On both Macs and PCs, you download a program that either runs on its own or as a part of the system software. You then choose which files and folders you want to back up. The program automatically uploads the latest versions of your files so your backup mirrors the data on your computer. There are, however, two major weaknesses to these services: None lets you back up system files, so you can't create complete full-system backups. Second, and more explicitly annoying, is how long the initial uploads take. Shipping hundreds of gigabytes to remote servers over a home Internet connection is an exercise in extreme patience. Depending on your connection speed and how much data you have, this digital drip can take weeks. Fortunately, after the first upload subsequent backups are quick and go by virtually unnoticed in the background. And with all three, except Carbonite on Macs, you can set backups to occur on a schedule. The cloud isn't just the safe way to back up your data, it's also the lazy way.

Pulling your data from Mozy, Carbonite, and CrashPlan+ is simple: You access your data through intuitive desktop applications (though Mozy's is by far the best-looking), where you can browse through backed-up folders and files. And if your computer does end up going kaput, you can easily resurrect your data by loading the software on another computer.

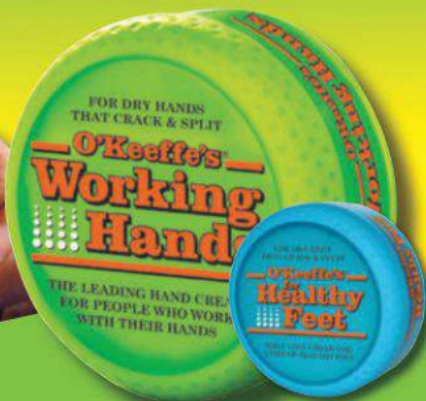
Does that mean your data, stored on a server in who-knows-where, is just as easy for others to resurrect too? So far, no. Though there are no guarantees against a snooper getting your password and looking at your photos, all the major backup services employ advanced encryption, and there have been no publicized cases of personal data compromised by prying eyes. Still, before you choose a backup service, make sure it does indeed use data encryption. Then you can jump into cloud backup relatively worry-free.

W

WEEKEND

GUARANTEED RELIEF FOR DRY HANDS THAT CRACK & SPLIT

Absolutely Odorless • Non-Greasy



Scan to view our
Before and After Gallery!
www.OKeefesCompany.com

Made in USA

100% Money Back Guarantee
1-800-275-2718

© 2012 The O'Keeffe's Company

LAST CHANCE OFFER! 1 BONUS TICKET - USE CODE: PM1012R**
GIVEAWAY ENDS NOVEMBER 30, 2012!

2012
Camaro Dream Giveaway

WIN 2 HOT CAMAROS!

770HP



1969 CAMARO SS/RS 396

L78 396/375 HP BEAUTY
 RARE ICONIC MUSCLECAR



**YOUR TAX-DEDUCTIBLE DONATION
 HELPS CHILDREN'S CHARITIES**

SLP
Creating Tomorrow's Classics Today!

2012 CAMARO SS/RS

770HP SLP SUPERCHARGED
 ULTIMATE "SLEEPER" SUPERCAR

The marks including, but not limited to: GM and the GM Logo, Chevrolet, Camaro, and their respective logos, emblems, vehicle model names and body designs are trademarks and/or service marks of GM, its subsidiaries, affiliates or licensors.

ONE WINNER GETS BOTH CARS
PLUS \$35,000 FOR TAXES*

Enter Today At
WINTHECAMAROS.COM
Or Toll Free 855-612-9900

**YES! I WANT TO HELP CHILDREN'S CHARITIES WITH MY TAX
 DEDUCTIBLE DONATION TO KIDS WISH NETWORK.**

☐ VISA ☐ MasterCard ☐ DISCOVER ☐ American Express

USE PROMO CODE: **PM1012R**

Name _____ Phone _____

Address _____

City _____ State _____ Zip _____

Card# _____ Exp _____ Security Code _____

☐ Email _____

No charge for email - receive your tickets and updates fast and FREE!

☐ Mail Tickets Add \$1.95 mail/processing for tickets by mail.

☐ I HEREBY CERTIFY I AM 18 YEARS OF AGE OR OLDER
 AND AGREE TO ABIDE BY THE OFFICIAL RULES.

Credit Card Donations may be faxed to: 317-807-0526

SPONSORED BY

Kids Wish Network

A 501(c)(3) Charitable Organization
www.kidswishnetwork.org

COMPLETE CREDIT CARD INFO OR MAKE CHECKS PAYABLE TO:
 Kids Wish Network
 P.O. Box 17161 • Indianapolis, IN 46217-0161

TICKET DONATIONS

- ☐ \$3 1 TICKET
☐ \$10 5 TICKETS
☐ \$20 15 TICKETS +1
☐ \$35 30 TICKETS +1
☐ \$50 40 TICKETS +1
☐ \$75 65 TICKETS +1
☐ \$100 100 TICKETS +1
☐ \$200 240 TICKETS +1
☐ \$300 360 TICKETS +1
☐ \$500 600 TICKETS +1

TICKET DONATION AMOUNT:

Mail/Processing:
 Add \$1.95 U.S. mail or \$4.95
 non-U.S. mail (\$0 for email)

TOTAL AMOUNT ENCLOSED:

Please allow 2 to 3 weeks
 for mail delivery

CMG12

****SPECIAL OFFER VALID WITH \$20 MINIMUM DONATION**
 Kids Wish Network, the sole sponsor of this giveaway, is dedicated
 to improving the quality of life for hospitalized children.

No Purchase, Contribution, Donation or Payment Necessary. Donations are tax-deductible to the fullest extent of the law. 2012 Camaro Dream Giveaway starts on February 1, 2012 and ends at 11:59 p.m. EST on November 30th, 2012. This giveaway is open to residents of U.S. (except Utah and Oregon) and Canada (except Quebec) and other countries and U.S. territories and possessions only where offered and permitted by law, age 18 and older. Void where prohibited. Odds of winning equal to one divided by the total number of tickets issued. For entry and official rules including **free entry method** visit www.winthecamaros.com/official-rules.aspx. Sponsored by Kids Wish Network, Inc., a 501(c)(3) charity, 4060 Louis Ave. Holiday, FL 34691. *\$35,000 for TAXES applies to payment on behalf of winner for IRS withholding requirement, additional taxes may be owed. Camaro is a registered trademark owned by General Motors.



DIY TECH

Nine-year-old Samuel Jarvis lights up LED bulbs and discovers the magic of electrical circuitry.



SQUISHY CIRCUITS

Early Adopter

A TRIPLE DOSE OF FAMILY FUN, SQUISHY CIRCUITS TEACH THE BASICS OF CONDUCTIVITY, COOKING, AND CLAY MODELING.

BY MICHELE ERVIN



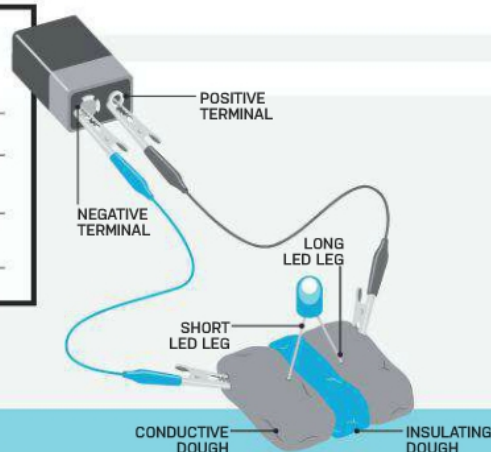
DEGREE OF DIFFICULTY

2/10

AGES: 4+

BUILD TIME:
2 HOURSPARTS COST:
\$35-\$40

HOW TO MAKE IT



Sculpt your Squishy Circuit masterpiece

The Jarvis family made a skull with red LED eyes for Halloween. It consisted of two layers. The top one—the mask—was insulating dough. Because this was made with sugar and distilled water, both of which lack the ions that conduct electricity, the dough had an insulating effect. They placed the mask over two conductive dough strips separated by an insulating one. Conductive dough contains table salt and tap water, which form an ion-rich electrolyte; electricity passes, or is conducted, from ion to ion.

The insulating strip lies laterally beneath the eyes. The conductive strips were close together so the kids could stick the long and short legs of the LED into the positively and negatively charged dough, respectively, to complete the electrical circuit and light up the LEDs.

For more on this project and Squishy Circuits, visit popularmechanics.com/squishy.

Create the conductive dough

1. Combine the dry ingredients in the saucepan: 1 cup flour, $\frac{1}{4}$ cup salt, and 3 tablespoons cream of tartar. Add 1 tablespoon vegetable oil, food coloring of choice, and 1 cup tap water and stir with a spatula.
2. Place the pan over low to medium heat and stir until the mixture is lumpy. Keep stirring, incorporating all of the ingredients, scraping the bottom of the pan so that they don't stick to it.
3. After the mixture forms a ball, set it aside to cool on waxed paper dusted with flour.
4. Gradually add about $\frac{1}{2}$ cup flour, kneading the dough until it is the consistency of Play-Doh.

Make the insulating dough

1. Combine 1 cup flour, $\frac{1}{2}$ cup sugar, and 3 tablespoons vegetable oil in a medium bowl and stir with a spatula.
2. Add food coloring of choice to $\frac{1}{2}$ cup distilled water.
3. Stir 1 tablespoon of the liquid at a time into the flour-sugar mixture and combine. Gradually alternate adding the remaining water and kneading in about $\frac{1}{4}$ cup flour until the texture is like Play-Doh.



Devon Jarvis and Jean Cabacungan-Jarvis get a charge out of making Squishy Circuits with (from left) sons Jacob, 12, Maxwell, 4, and Samuel, 9.



Create the circuit and add power and lights

1. Roll two pieces of conductive dough and one piece of insulating dough into short cylinders like little hot dogs. Smush together the three pieces, with the insulating dough in the middle. Make sure that the pieces of conductive dough are not touching each other.
2. Clip one end of each electrical lead to the positive and negative battery terminals, and connect the other ends to the pieces of conductive dough.
3. Insert the shorter of the two prongs of an LED into the conductive dough attached to the negative terminal, and the longer prong into the positively charged dough. You have just completed the circuit, and the light should be glowing!

Ingredients and materials

- ▶ 3 cups white flour
- ▶ ¼ cup iodized salt
- ▶ 3 tablespoons cream of tartar
- ▶ 4 tablespoons vegetable oil
- ▶ Food coloring
- ▶ 1 cup tap water
- ▶ ½ cup sugar
- ▶ ½ cup distilled water
- ▶ Dry and liquid measuring cups and spoons
- ▶ 3-quart saucepan
- ▶ Two sturdy spatulas
- ▶ Waxed paper
- ▶ One medium ceramic or stainless-steel mixing bowl
- ▶ One 9-volt battery
- ▶ Two wire leads with alligator clips on each end
- ▶ 3-to-5-watt component LED bulbs in a variety of colors

WEEKEND

10

Wood Glue Just Got Tougher

Gorilla Products Promise:

- Incredible Strength
- Maximum Performance

Made in  USA

Welcome to Tough...



www.GorillaTough.com • 1-800-966-3458

Scan to Learn More

An American Original!



STRONG • STICKY • WATERPROOF

Trust Duck® brand duct tape to deliver the quality and strength needed for every project.



Get the Duck to do it.

800.321.0253



DuckBrand.com

©ShurTech Brands, LLC 2012/50314



Digital Clinic

BY RACHEL Z. ARNDT

PHOTOGRAPH BY JOSHUA SIMPSON

TV on the Small Screen

How can I record TV on my computer? Is it legal?



What kind of TV do you have in mind? The type of equipment and software you'll need depends on whether you'd like to replicate cable or regular over-the-air (OTA) TV. Assuming you get decent reception, you can view and record the broadcast channels in your area using a USB-based TV tuner and antenna, such as Hauppauge's WinTV-HVR-950Q (\$79) for PCs or the PCTV for Mac HD Mini Stick (\$120) for Macs, plus software that can play and record those signals—we recommend EyeTV (\$80). These devices can also tune cable channels directly from a coaxial cable, but there's a bit of a catch: You can pick up only unencrypted clear QAM (quadrature amplitude modulation) channels—the ones the Federal Communications Commission considers to be in the basic tier of service.

These options are fairly limited compared with a typical cable subscription with a DVR, which lets you watch and record multiple shows at once. To get that kind of flexibility on your computer, you need a cable-TV tuner, such as SiliconDust's HDHomeRun Prime (\$250) or Hauppauge's WinTV-DCR-2650 (\$149), and a CableCARD that goes inside the adapter to decode the encrypted cable signals (as with a cable box, you can rent a CableCARD from your provider). After you connect the Hauppauge device to both the cable and your computer, recording files to your hard drive works the same way as with OTA devices. The HDHomeRun Prime goes a step further: It plugs into your router, then streams TV over your home network so it can be watched on multiple devices simultaneously.

As to the second part of the question: Is this legal? Assuming you aren't file sharing, recording TV streams is all perfectly aboveboard.



**SILICONDUST'S
HDHOMERUN
PRIME (\$250)**
captures TV
signals and
beams them over
a home network.



According to Mitch Stoltz, a staff attorney at the Electronic Frontier Foundation, "Personal recording was essentially declared to be legal by the Supreme Court in the 1984 Betamax case." Cable companies don't seem too enthusiastic about the idea, but they're not actively trying to stop it either.

When a Fan Flames Out The fan in my laptop stopped working. What can I do to prevent my computer from overheating?

Before anything, you should clean the fan to make sure it actually is broken—caked-on dirt can cause an otherwise good fan to fail. Open your laptop case (make sure to keep track of all the tiny screws) and spray compressed air on the fan blades. Close everything, turn on your machine, and listen. If you don't hear your fan spinning and your computer is hotter than usual or shutting down without warning, you have a broken fan that needs to be replaced. Look for a new fan (which shouldn't be too pricey) on laptopbattery-usa.com for PCs or ifixit.com for Macs. To install it, first remove the broken fan. If your fan is easy to access (some aren't) and you can find where it plugs into the motherboard, disconnect it from the board. Then put the new one in its place and plug it in.

If your fan still doesn't work, you have a deeper electronics issue that's probably not worth fixing. You can keep using your computer, but sooner or later unexpected shutdowns are bound to convince you to get a whole new machine.

Stereoscopic Solution

I have a PlayStation 3 and just got a new TV that supports 3D. I'd like to use the PS3 to play 3D content, but it's hooked into my old surround-sound receiver, which I assume doesn't support 3D. Is

THUNDERBOLT VS USB 3



Thunderbolt ports are finally appearing on PCs, and Apple has given up fighting the USB 3.0 standard and is putting the port on its newest laptops. Thunderbolt is supposed to transfer data at up to 10 gigabits per second, while USB 3 reaches 4.8—but Thunderbolt has worked only marginally faster in our tests. It's also more expensive and found in fewer peripherals.

So when shopping hard drives, which option should you pursue? If you've got a pre-USB 3.0 Mac, then a Thunderbolt drive such as LaCie's Little Big Disk (\$200 for 1 terabyte) is your speediest option. But if you work cross-platform or on PCs only, USB 3 is the way to go [a typical 1 TB drive from Western Digital sells for \$96], especially because the port is backward compatible with USB 2 ports. Can't decide? Then try Buffalo's Mini-Station (left; \$264 for 1 TB), which supports both standards.

there any way to get a 3D signal from my PS3 to my TV without losing surround sound?

The PlayStation 3 can indeed support 3D, and to get it to your TV, you'll need an HDMI cable (in fact, HDMI 1.3 or better), because no other video connection has the bandwidth to carry a digital 3D signal. The great thing about HDMI is that it is also a one-cable solution for both video and multichannel audio. So if you have an AV receiver with HDMI inputs, you can route one cable from each of your devices (PS3, cable box, Roku, etc.) into the receiver, then route a single cable from the receiver to the TV. The receiver separates out the multichannel audio and acts as a switch between video sources. The problem is most receivers more than two

years old won't pass a 3D signal to your new TV. But there is a work-around.

The PS3 allows you to split the audio and the video signal—sending the video directly to the TV over HDMI and sending multichannel audio to your receiver over a fiberoptic (sometimes called Toslink)

cable. After you set up the cable, go into the PS3's Settings menu. Under Video Settings, leave the HDMI as your output. In Audio Settings select Digital Out (Optical). (Don't turn on the multiaudio-output feature found in the main audio settings menu—enabling it downgrades and locks the digital output sampling rate to 44.1 kHz.) You'll have to change the inputs on your TV and receiver to watch a movie or play a game on the PS3, but the upside is surround sound and 3D without a new audio system. **PopMech**

GLOSSARY

QUADRATURE AMPLITUDE MODULATION (QAM)

Whether traveling through the air or over a wire, TV signals must be broadcast at certain frequencies. QAM is the format cable companies use to differentiate, say, HBO from Bravo, with channels ranging from 57 MHz to 999 MHz.



GOT A TECHNOLOGY PROBLEM? ASK RACHEL ABOUT IT. Send your questions to amdigitalclinic@hearsst.com. While we can't answer questions individually, problems of general interest will be discussed in the column.

The perfect woodshed keeps rain off the stack yet allows plenty of cross ventilation for the wood to season. PM's shed does both and provides access from the front and back.



HIGH AND DRY

Home

- FIX A LEANING CHIMNEY
- BUILD SQUISHY CIRCUITS
- BRUSHLESS DRILL DRIVERS TESTED



BY ROY BERENDSOHN

BUILD A SHACK FOR YOUR FIREWOOD STACK. BY GEORGE RETSECK

For me, heating with firewood is more about feeling self-sufficient than it is about lowering my utility bills. I also like cutting and splitting logs. It's good exercise and the source of my wife's wry nickname for me, the Saturday Lumberjack. But storing and keeping the wood dry is a hassle. Tarps can trap moisture, promote rot, and be difficult to remove after a snowfall. And stacking the wood inside is a poor choice, unless you enjoy the company of insects and mice.

The solution is a simple shed. I designed the one you see above, which involves basic post-and-beam carpentry, to create an attractive storage unit for more than a cord. It keeps the wood from getting soggy and leaves the critters out in the cold, just where the Saturday Lumberjack likes them to be.

W

WEEKEND

diy



UNIVERSAL FIT™ SYSTEM

Sonicrafter®

ACCESSORIES
FIT ALL TOOLS

Rockwell's unique Universal Fit System allows Sonicrafter accessories to fit tightly on all oscillating tools. It doesn't matter the brand, the model or the year purchased. No more paying too much or driving across town to get the right blade.

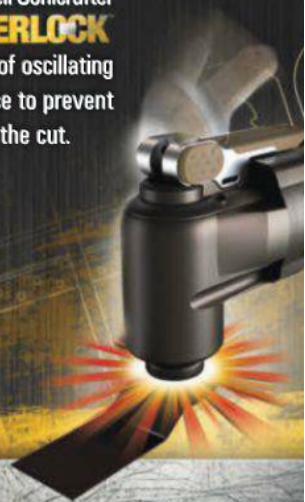
TOOL **ACCEPTS**
ALL BLADES

The Universal Fit System on the New Rockwell Sonicrafter accepts every blade out there. The **HYPERLOCK** tool-less blade change clamps any brand of oscillating tool accessory with 1-ton of clamping force to prevent slipping or stopping no matter how tough the cut.



ROCKWELL®

ROCKWELLTOOLS.COM



**BUILD THE
SIDE PANELS**

Crosscut the cedar slats and side supports to the lengths shown in the plans (page 96). Of the two supports on each side, the top one is shorter than the bottom one. This provides clearance to affix the beam.

Next, notch the posts to receive the beam. Using a circular saw, make a shoulder cut and a series of cuts parallel to the shoulder, then remove the scored wood with a wide chisel [1]. Smooth the notch's face with a rasp.

To assemble the walls, place the cross supports on a flat surface, bore pilot holes, and attach the cross supports to the posts [2]. Then place the slats in position, apply a glob of construction adhesive, and screw the slats to the supports [3].

**SET THE FOOTINGS
AND RAISE THE WALLS**

It's important to accurately place the footings, or piers—it makes the build quicker and easier by preventing constant remeasuring and adjustment. We set the four corner piers in rough position and brought them into alignment with a string line [4]. Then we used a tape measure to check the diagonals of this rectangle and to position the fifth and sixth piers relative to the perimeter. Using a string level, we adjusted the height of the piers. Next, we placed the plastic end caps on the bottom of the posts and raised each wall on its piers [5]. We plumbed the walls and braced them diagonally to a stake driven into the ground [6].



1



2



3



4



5



6

**ADD JOISTS, BEAMS,
AND POSTS**

Measure the distance between the walls, then crosscut the long joists and bolt them to the posts. Do the same

with the beams. It's infinitely easier—and more fun—to complete a build of this size with a friend. I'm in the blue shirt; the guy in the hat is Roy Berendsohn, *POPULAR MECHANICS'* home senior editor. We're using a level, a clamp, and a 2 x 4 to hold a post position prior to bolting it in place [left].

with the beams.

Measure the height from the center piers to their respective beams to determine the position of the shoulder cut on the center posts. Notch the two center posts, set them on their piers, plumb them, and bolt them into position [7].

Crosscut the remaining joists and fasten them, as noted in the diagram, with joist hangers, joist hanger nails, 16d com-

mon nails, or 3½-inch deck screws. Crosscut the floor pieces and screw them to the long and short joists. Make yourself a small jig from scrap lumber to speed accurate spacing between each piece of flooring. Even better, make two. Place one at the front and another at the rear of each deck piece. Fasten the deck pieces with the jig in place. Lift the jigs out, position the next piece of decking, and repeat.



8 9



10

The process of notching and attaching the rafters requires patience and precision. Working with the chisel to get the notches just right lends the project a pleasing old-school feel.

After fastening the rafters, climb up onto the roof and have a friend hand you the panels. Screw them to the skip sheathing, watching your step as you move along and complete the roof install.

rafters to length.

Place the rafter on sawhorses and clamp it firmly in place. Make the vertical cut with a circular saw, use a chisel to notch the horizontal cut where the rafter rests on the beam, then turn the rafter back upright and finish the shallow horizontal notch with a chisel.

Test-fit the pattern rafter and adjust its notches. When it fits accurately all along the beams, use it to mark and cut the remaining rafters. First, cut all the rafters to length. Then clamp together all the rafter stock, including the pattern rafter, edge up. Mark and cut all of the notches to match the pattern rafter. Use a chisel to finish each notch [8].

Mark the position of the rafters along the beams at 16-inch centers and carefully nail them in place [9]. We even went so far as to set each nailhead to firmly pinch the raf-

ter down against the beam. We nailed the front fascia in place and moved on to the skip sheathing for the roofing. Note that two pieces of sheathing are nailed on at the peak and at the base. The rest are spaced evenly between them.

INSTALL THE ROOF AND ADD FIREWOOD

After crosscutting the steel roof panels, we fastened them to the skip sheathing using self-tapping screws with a rubber gasket under the head [10]. We drove the screws with an 18-volt drill and a socket wrench attachment, but we'd advise using a more sturdy nut driver because penetrating the roofing requires a fair amount of force. Finally, we screwed the diagonal braces to the posts.

The last part was the most fun—stacking a nice, neat pile of freshly split firewood in our new shed.

ADD THE RAFTERS

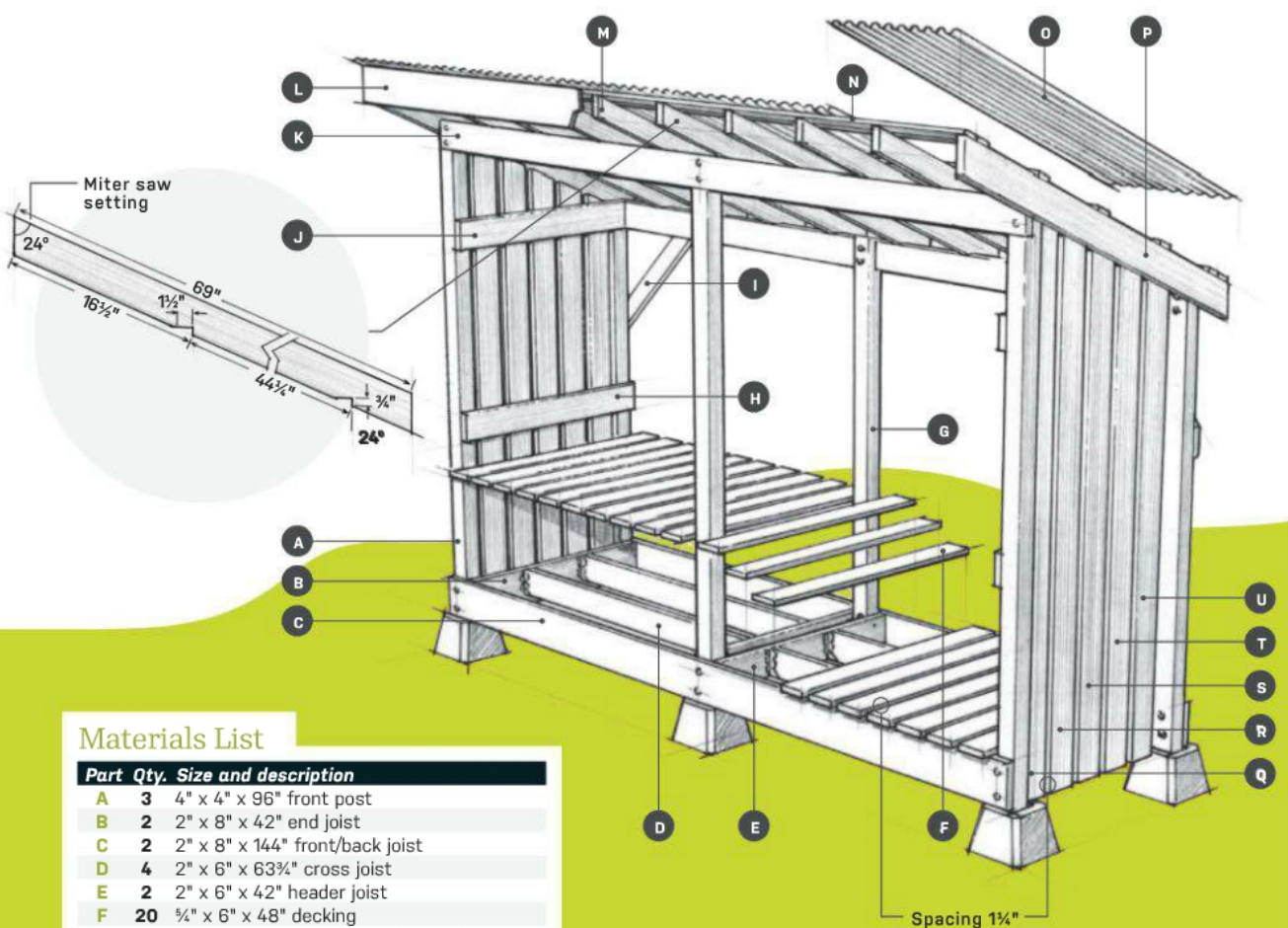
To begin, make a pattern rafter from the best 2 x 4 on hand. Mark the angled plumb cuts at the top and bottom of the rafter and the position of the bird's-

mouth cuts (the notch where the rafter meets the beams). Clamp the rafter on top of the beams, check that the lines drawn are accurate, and adjust the lines as needed. Cut the



WHAT MAKES WOOD GOOD

Wood's Btu content and density are linked. Hardwoods that are dense have more wood fiber per unit volume and thus a higher Btu content than species that are lighter. So you get more Btus for your buck if you buy (or cut) a cord of wood with a high percentage of dense hardwoods—oak, birch, hickory, locust, Osage orange, or even prunings from an apple orchard, for example—rather than lighter species such as basswood or poplar. The tradeoff: Dense hardwoods are tough to cut and split.



Materials List

Part	Qty.	Size and description
A	3	4" x 4" x 96" front post
B	2	2" x 8" x 42" end joist
C	2	2" x 8" x 144" front/back joist
D	4	2" x 6" x 63 3/4" cross joist
E	2	2" x 6" x 42" header joist
F	20	5/8" x 6" x 48" decking
G	3	4" x 4" x 78" rear post
H	2	2" x 6" x 42" cross brace
I	2	2" x 4" x 40" angle brace
J	2	2" x 6" x 40 1/2" upper cross brace
K	2	2" x 6" x 144" beam
L	1	1" x 8" x 147" fascia
M	8	2" x 4" x 69" rafter
N	7	1" x 8" x 147" skip sheathing
O	4	2' x 72" steel roofing
P	2	2" x 6" x 69" end rafter
Q*	2	1" x 6" x 92 3/8" side panel
R*	2	1" x 6" x 89 3/8" side panel
S*	2	1" x 6" x 86 3/8" side panel
T*	2	1" x 6" x 83 3/8" side panel
U*	2	1" x 6" x 80 3/8" side panel

* Dimension is maximum length measured from base to peak of angled top.

Fastener Schedule

Part C to A	6" carriage bolt (two per location)
Part K to A	5" carriage bolt (two per location)
Parts Q, U to B, H, J	1 1/2" SS screw (two per location)
Part M to K	16d common nail (two per location)
Part P to A, G	3" EXT screw (two per location)
Part N to M	2" 6d screw-shank nail (two per location)
Part L to M	1 1/2" SS screw (two per location)
Parts H, J to A, G	3" EXT screw (two per location)
Part B to A, G	3" EXT screw (three per location)
Part E to A, G	3" EXT screw (two per location)
Part F to B, C, D, E	2 1/2" EXT screw (two per location)
Part I to G	3" EXT screw (two per location)

Shopping list ▶ one 2" x 4" x 8' (brace I) • four 2" x 4" x 12' (rafter M) • three 2" x 6" x 8' (joist E, braces H, J) • five 2" x 6" x 12' (beam K, rafter P, joist D) • one 2" x 8" x 8' (joist B) • two 2" x 8" x 12' (joist C) • six 4" x 4" x 8' (posts A, G) • fourteen 1" x 4" x 8' (sheathing N) • ten 1" x 6" x 8' (side panels Q, R, S, T, U) • ten 5/8" x 6" x 8' (decking F) • one 5/8" x 8" x 16' (fascia L) • six precast concrete piers • six composite base blocks for 4" x 4" posts • four 2' x 12' HDG corrugated roof panels • one 1-lb box self-tapping roofing screws with neoprene washers • twelve 3/8" x 6" HDG carriage bolts, nuts, washers • twelve 3/8" x 5" HDG carriage bolts, nuts, washers • eight HDG joist hangers for 2" x 6" • one 1-lb box of N10HDG joist hanger nails • one 1-lb box No. 8 2 1/2-in. CT EXT screws • one 1-lb box No. 10 3-in. CT EXT screws • two 1-lb boxes No. 8 1 1/2-in. CT SS screws • two 1-lb boxes 6d 2 1/2-in. HDG screw-shank nails • one 1-lb box 16d HDG common nails • two 10-oz cartridges Liquid Nails Heavy Duty Construction Adhesive **Notes:** SS = stainless steel; CT = coarse thread; EXT = exterior; HDG = hot-dipped galvanized. All lumber pressure-treated except cedar panels Q to U.



Tool Test

DRILLS & DRIVERS

BRUSHLESS MOTORS GO MAINSTREAM WITH THE CURRENT CROP OF POWER TOOLS. BY ROY BERENDSOHN

C

an cordless tools get any better? The short answer is there's always room for improvement. Swap the motor's carbon brush and commutator assembly for a microprocessor circuit and you dramatically cut power loss and friction—and increase performance. Brushless motors hit the market several years ago but were limited to a few impact driver and rotary hammer models. Now you find them in hammer drills and drill drivers and in a growing number of impact drivers. We tested the group below on construction lumber and concrete blocks and learned that this new breed of power tool provides more than enough performance to handle homeowner needs. Here's our report.

HAMMER-DRILL DRIVERS

IMPACT DRIVERS

HITACHI
DV18DBL

RANKING ★★★★★

Price: \$300

Voltage: 18

Battery: Li-ion,
3 amp-hours3-in. drywall
screws into
pressure-treated
4 x 4: 6361-in. holes
with spade bit
through 2 x 8:
62¾-in. holes
through 3% in.
of concrete: 74Likes: Four
speed-limit
settings and a
two-range (Hi
and Low) selec-
tor switch allow
very precise
control of drill-
ing and driving.

Dislikes: None.

MILWAUKEE
2604-22

RANKING ★★★★★

Price: \$300

Voltage: 18

Battery: Li-ion,
3 amp-hours3-in. drywall
screws into
pressure-treated
4 x 4: 6671-in. holes
with spade bit
through 2 x 8:
124¾-in. holes
through 3% in.
of concrete: 106Likes: Torque to
spare. It doesn't
just bore holes,
it blasts them.

Dislikes: None.

DEWALT
DCF895L2

RANKING ★★★★★

Price: \$350

Voltage: 20

Battery: Li-ion,
3 amp-hours¾ x 3-in. lag
screws into
pressure-treated
4 x 4: 172Chuck: One-hand
insert, one-hand
release.Likes: Light,
tough, stubby,
powerful. With
three speed-
limit ranges, it's
also precise.Dislikes: Minor
complaint—
sometimes we
had to tap a
bit with a ham-
mer in order to
remove the bit
from the chuck.HITACHI
18DBDL

RANKING ★★★★★

Price: \$300

Voltage: 18

Battery: Li-ion,
3 amp-hours¾ x 3-in. lag
screws into
pressure-treated
4 x 4: 137Chuck: Two-
hand insert,
two-hand
release.Likes: Four
speed-limit
ranges and two-
speed impact
settings make
it the most
precise impact
driver in our
test.Dislikes: Same
hammer-tap
issue as with
the DeWalt.MAKITA
LXDT01

RANKING ★★★★★

Price: \$300

Voltage: 18

Battery: Li-ion,
3 amp-hours¾ x 3-in. lag
screws into
pressure-treated
4 x 4: 122Chuck: One-hand
insert, two-hand
release.Likes: Big Mak
was the only
tool here that
consistently
released the bit
from the chuck,
no matter how
severe a beat-
ing the bit took.
Three speed-
limit ranges
make it a pre-
cise driver.Dislikes:
None.MILWAUKEE
2653-22

RANKING ★★★★★

Price: \$300

Voltage: 18

Battery: Li-ion,
3 amp-hours¾ x 3-in. lag
screws into
pressure-treated
4 x 4: 130Chuck: One-hand
insert, two-hand
release.Likes: Perfectly
balanced and
powerful; with
three speed-limit
settings, reason-
ably precise.Dislikes: Chuck
ring is some-
what small and
slippery.Best
Overall

WEEKEND



HOME SENIOR EDITOR ROY BERENDSOHN ON IMPACT VS DRILL DRIVERS

Choose an impact driver if you're planning to drive big lag screws to build a deck, a wood retaining wall, or any other large wood structure. Use a drill driver for everything else.

Home Clinic

BY
ROY BERENDSOHN

Q

+

A

A curving chimney needs to be inspected by a certified chimney sweep. With the inspection report in hand, a homeowner can set things straight.



Chimneys lean for a variety of reasons. Weather erodes the mortar joints, a TV antenna (remember those?) catches wind and stresses the masonry, and sulfurous chemicals from fuel oil or coal exhaust attack the mortar and the flue. The latter is especially likely if the chimney lacks a ceramic flue liner.

Regardless of what put a kink in your chimney, I'm sorry to say that I don't have a single answer to the problem.

Your best bet is to have the structure inspected inside and out by a licensed and registered chimney sweep (visit the website for the Chimney Safety Institute of America); this is done with a small camera attached to fiber-optic cable. The inspector would also check where the boiler vent joins the chimney—a common trouble spot.

Once you're armed with the inspection report, you can pick the best solution.

Having a masonry contractor restore the chimney is appealing

Chimney Checkup

We have a nice old house with an obvious flaw: The chimney curves. One contractor told us to brace the chimney and convert the home's heating system to a boiler that vents through the sidewall, not through the chimney flue. Taking the chimney out of use seems extreme, as one of its flues serves a fireplace that we use. Others say we should rebuild the curved section, and still others advise installing a stainless-steel liner. What's the best remedy?

GLOSSARY

SMOKE SHELF

A smoke shelf is not a mythical device like a board stretcher. It's a flat projection above the throat of the fireplace, right behind the damper, so it's out of plain sight. It prevents a downdraft from traveling through the flue and into the firebox.



because it would preserve the house's architecture, but it's not a complete fix—more about that in a moment. The procedure, though, is pretty straightforward. The contractor disassembles the chimney right down to the roof flashing and then rebuilds it, complete with new flashing.

Because rebuilding the section above the roofline does nothing to address hidden problems such as a crumbling flue, my guess is that you need a combination of solutions that take into account both the repair above the roof and the condition of the flue.

You might consider putting in a full stainless-steel lining. Still another option is to put an inflatable form down the chimney and surround it with an insulating, grout-like material. (The latter costs thousands of dollars but would provide both safety and a lasting solution.)

Regardless of which path you take, check with the town about building permits and certification of the flue. That's important because improperly documented work can hang up the sale of the house should you ever decide to move.



GOT A HOME-MAINTENANCE OR REPAIR PROBLEM? ASK ROY ABOUT IT.

Send your questions to pmhomeclinic@hearst.com or to Home Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



PH ALERT
Chimney Scams

How to Smoke Out a Sweep Who Has Bad Intentions

As you look to get your chimney serviced this fall, be wary of dishonest sweeps who try to dupe homeowners into unnecessary or shoddy work.

"There are some bad actors in the business," says Ashley Eldridge, director of education at the Chimney Safety Institute of America (CSIA). "They typically will hire unscrupulous people who are being paid a commission; it's in these people's interest to diagnose huge problems, regardless of whether they exist."

There's no reason for you to settle for a substandard sweep. You can locate a certified sweep at the CSIA website. And certi-

fication is no small deal. Eldridge says it requires passing a rigorous exam, including testing about the international residential code, as well as best-practice tools and techniques.

So how do you separate the pros from the pretenders? There are several easy ways. An obvious bad sign is a sweep in an unmarked van or one who requests payment via a check made out to "cash."

Here are three other warning signs:

Lowball Bid

The most common red flag is an extremely low estimate. Often a scammer will go door to door, offering a "promotional price" of as little as \$20 for an inspection. "Once they get in there, they invariably recommend expensive repairs," Eldridge says. Don't take the bait. Ask

for a written estimate and say you'd like to get a second opinion; this may send a scammer scurrying.

Cold Caller

Another ruse is the cold call. Scammers will talk as if they already have an appointment or say they've serviced other chimneys in your neighborhood and then try to pressure you into inviting them to do an inspection or cleaning. Ask the caller's name and phone number—no honest sweep would refuse to give this info.

Time Pressure

The sweep offers a price that is conditional on your making a decision on the spot.

Above all, Eldridge says, trust your gut reaction. "If you don't feel comfortable with this person, then don't do business with them," he says.

— STEVE ROUSSEAU



Winter Grill Storage

I know you guys have written about gas-grill maintenance, especially what to do at the end of the season and at the beginning. Can you give that to me again, please?

Sure, but I wouldn't rush to put away your grill for the season. Many people find that cooking outside on a nice winter day beats even summer grilling. In any case, if you're storing a gas grill in a garage or shed, the first rule is to leave the propane tank outside in a sheltered location. If you keep the grill outside, wrap it securely in a tarp to keep out mice and squirrels. A grill makes a good winter home for them, and they have a nasty habit of chewing on gas regulators, hoses, and other parts. Also, insects can build nests inside the grill's gas plumbing, leaving a blockage that creates a fire hazard.

Prestorage cleaning and maintenance is a must. Pull the grill into the garage and replace weather-beaten or cracked knobs, or the piezoelectric igniter that's on the fritz, or even the gas valve that gave you trouble. Replacement parts are easy to find on grill manufacturers' websites. Spray cleaner, some rags, and a few hand tools are all you need for this end-of-season ritual.

Once you've spruced up your grill, you've got something to look forward to in the spring. And, hey, you never know: Getting your grill sparkling clean and into good working order might inspire you to do a little midwinter outdoor cooking. **PopMech**

Science



BY MARY BETH GRIGGS

MOBILE MICROVERSE

ARMED WITH A SMARTPHONE OR A TABLET AND 15 BUCKS IN SUPPLIES, ANYONE CAN ZOOM IN ON A SMALLER REALM.

Microscope photography used to be a high-priced craft—and for high magnifications it still is. Hall Davidson, a former math teacher who works for Discovery Education, has come up with an easy project that uses an iPad or mobile-phone camera to create a 45x- or 60x-magnification device. That's ideal for looking at details of plant and insect anatomies or at the surface of anything from rocks to computer chips. "I went to the hardware store and bought every possible thing to attach it," Davidson says. Eventually, he settled on a rubber grommet and a jeweler's mini microscope glued to an iPad. We've modified the plan so that the hardware attaches to a case instead—because not everyone wants to mess with a \$500 device. Commercial versions of this project are coming on the market, but ours is less expensive and more versatile. **PopMech**



SUPPLIES

- A. Case: Look for a thin, hard case for your device. iPad cases are available online for as little as \$5.
- B. Half-inch rubber grommet: available in hardware stores for under \$1.
- C. Jeweler's mini microscope: Also known as a currency microscope, this tool is commonly used to detect imperfections in jewelry. Look for a unit that incorporates an LED; the cheapest ones cost around \$4.
- D. Superglue

INSTRUCTIONS

1. Before gluing, center the grommet on the case over the camera lens opening.
2. Got the position right? Apply glue to half the grommet and attach it. Assuming you're using an iPad, the glued part of the grommet should be opposite the curved edge of the device. (The grommet will not be completely flush.)
3. Once the glue dries, insert the eyepiece into the grommet.
4. Open the camera app and turn on the scope's LED to start exploring the microverse.

TIP: Zoom from inside the app, and also adjust the view by sliding the eyepiece in and out of the grommet.

10

WEEKEND

diy

HARBOR FREIGHT TOOLS

Quality Tools at Ridiculously Low Prices

LIFETIME WARRANTY
ON ALL HAND TOOLS!

FACTORY DIRECT TO YOU!

How does Harbor Freight Tools sell high quality tools at such ridiculously low prices? We buy direct from the factories who also supply the major brands and sell direct to you. It's just that simple! See for yourself at one of our 400 Stores Nationwide and use this 20% Off Coupon on one of our 7,000 products*, plus pick up a Free 7 Function Digital Multimeter, a \$9.99 value. We stock Shop Equipment, Hand Tools, Tarps, Compressors, Air & Power Tools, Woodworking Tools, Welders, Tool Boxes, Generators, and much more.

- Over 20 Million Satisfied Customers!
- 1 Year Competitor's Low Price Guarantee
- No Hassle Return Policy!
- 100% Satisfaction Guaranteed!

**Nobody Beats Our Quality,
Service and Price!**

SUPER COUPON!

Item 90899 shown

ITEM 90899/98025/69096

FREE!
WITH MINIMUM PURCHASE OF \$9.99

CENTECH

7 FUNCTION DIGITAL MULTIMETER

REG. PRICE \$9.99

HARBOR FREIGHT TOOLS - LIMIT 1 Only available with qualifying minimum purchase (excludes gift value). Cannot be used with other discount, coupon or prior purchase. Offer good while supplies last. Shipping & handling charges may apply if not picked up in-store. Original coupon must be presented. Non-transferable. Valid through 1/11/13. Limit one coupon per customer per day.

30640618

SUPER COUPON!

20% OFF

ANY SINGLE ITEM!

HARBOR FREIGHT TOOLS - LIMIT 1 Save 20% on any one item purchased at our store. *Cannot be used with other discount, coupon, gift cards, Inside Track Club membership, extended service plans or on any of the following: compressors, generators, tool storage or carts, welders, floor jacks, Campbell Hausfeld products, open box items, in-store event or parking lot sale items. Not valid on prior purchases after 30 days from original purchase date with original receipt. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

91623678

SUPER COUPON!

PITTSBURGH

12" RATCHET BAR CLAMP/SPREADER

LOT NO. 46807/68975/69221/69222

Item 46807 shown

\$1.99

SAVE 63%

REG. PRICE \$5.49

HARBOR FREIGHT TOOLS - LIMIT 8 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

30640618

SUPER COUPON!

CENTECH

AUTOMATIC BATTERY FLOAT CHARGER

Item 42292 shown

LOT NO. 42292/69594/69955

\$4.99

SAVE 61%

REG. PRICE \$12.99

HARBOR FREIGHT TOOLS - LIMIT 8 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

91623678

SUPER COUPON!

HaulMaster

MOVER'S DOLLY

LOT NO. 93888

Item 46807 shown

\$7.99

SAVE 46%

REG. PRICE \$14.99

HARBOR FREIGHT TOOLS - LIMIT 8 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

30640618

SUPER COUPON!

drillmaster

1500 WATT DUAL TEMPERATURE HEAT GUN (572°/1112°)

LOT NO. 96289

Item 42292 shown

\$7.99

SAVE 60%

REG. PRICE \$19.99

HARBOR FREIGHT TOOLS - LIMIT 8 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

91623678

SUPER COUPON!

drillmaster

18 VOLT CORDLESS 3/8" DRILL/DRIVER AND FLASHLIGHT KIT

LOT NO. 68287/69652

Item 93068 shown

\$19.99

SAVE 50%

REG. PRICE \$39.99

HARBOR FREIGHT TOOLS - LIMIT 3 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

30640618

SUPER COUPON!

CENTRALPNEUMATIC

3 GALLON, 100 PSI OILLESS AIR COMPRESSOR

LOT NO. 97080/69269

Item 97080 shown

\$39.99

SAVE 50%

REG. PRICE \$79.99

HARBOR FREIGHT TOOLS - LIMIT 4 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

91623678

SUPER COUPON!

HaulMaster

2 PIECE STEEL LOADING RAMPS

LOT NO. 44649/69591/69646

Item 44649 shown

\$39.99

SAVE 50%

REG. PRICE \$79.99

HARBOR FREIGHT TOOLS - LIMIT 4 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

30640618

SUPER COUPON!

US • GENERAL

30", 11 DRAWER ROLLER CABINET

LOT NO. 67421

\$149.99

SAVE \$150

REG. PRICE \$299.99

HARBOR FREIGHT TOOLS - LIMIT 5 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

91623678

SUPER COUPON!

PITTSBURGH

RAPID PUMP® 3 TON HEAVY DUTY STEEL FLOOR JACK

Item 68048 shown

LOT NO. 68048/69227

\$69.99

SAVE \$70

REG. PRICE \$139.99

HARBOR FREIGHT TOOLS - LIMIT 5 Good at our stores or website or by phone. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 1/11/13. Limit one coupon per customer per day.

30640618

400 Stores Nationwide

Order Online at HarborFreight.com and We'll Ship Your Order FedEx.

diy

Auto

- BAD VIBRATIONS
- LAZY TEMP



DEGREE OF DIFFICULTY 9/10

BY BEN WOJDYLA

Vehicles should be positioned so their center of gravity is aligned with the two upright posts. This rear-engine Volkswagen poses no challenge to our newly installed lift.

GIMME A LIFT

AUTO LIFTS ARE NOW WITHIN REACH OF HOME MECHANICS. YOU CAN EVEN INSTALL ONE YOURSELF.

of the advanced do-it-yourselfer. Global competition has driven down the cost of a very serious, good-quality, entry-level lift to under \$1500—totally affordable. Innovative manufacturers have also developed a variety of lifts to match every garage and skill level. We're going to show you how to stop crawling around under the car and start working on your feet.

Like Gearhead Christmas

There are several types of lifts to choose from (pick yours with help from the "Choose Wisely" sidebar). For the new POPULAR MECHANICS garage in Ferndale, Mich., we installed a 9000-pound two-post 12-inch symmetrical lift with a 220-volt hydraulic pump (we

Auto lifts make every project easier—no more jacks and jackstands, bending over, or squeezing under a car for service. So why doesn't everyone have one? What used to be expensive, impossible to fit in most garages, hard to install, and dangerous to work with is now within reach

W

WEEKEND

never know what vehicles are going to roll in). A two-poster is one of the most versatile kinds of lifts and the one most people choose.

The first order of business is receiving and unboxing. Lifts aren't exactly feather-light, and they are shipped in big wooden crates—so make sure the shipper sends a truck-mounted crane or forklift to do the unloading. Also, have four furniture dollies (trust me, it'll be worth it) to drop it onto and roll the crate into the garage. Then tear open the box and sit down to read the instructions. No, really, actually read them.

The individual installation steps aren't hard (well, most of them), but pay careful attention to detail. We are talking about a potentially dangerous machine, so take your time.



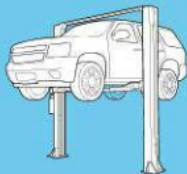
STAGE 1 ASSEMBLE THE METAL FRAME

Keep individual components square and in alignment with each other. Tighten all bolts by hand and check for alignment and basic range of motion, then finish by torquing all bolts to spec.

UPLIFTING OPTIONS

Researching and selecting the right lift is the challenging first step of the process. Balancing multiple priorities and technical restrictions while keeping an eye on the budget is tricky. What will you be doing with a lift? Do you need full access to the underside of the car or just enough to do brake jobs and tire rotations? Doing restorations or just regular maintenance? Would an extra parking spot in your garage be nice? How big are the cars you'll work on?

What about the shop? What's the width, depth, and height? What is the electrical service? How thick is the concrete slab; is it cracked, overly coarse, out of level? Think all this through, then match the lift to your shop and needs.



TWO-POST LIFT

Two-posts use two hydraulic cylinders to power four arms to lift the car in a compact space. These lifts have a wide range of capacities, install easily, and leave all the car's mechanical systems accessible. There are several types. Base-plates run safety cables and hydraulic lines at floor level, and their shorter posts fit in lower garages. Overheads run those features in a brace tying the posts together at the top for more stability but require more clearance. Symmetrical lifts have equal-length arms and carry heavier loads, but car doors hit the posts. Asymmetrical lifts use unequal-length arms so car doors miss the posts. Floors must be well-cured, crack-free concrete, 4 inches minimum (6 is better) for anchors.



FOUR-POST LIFT

Surprise—this type of lift uses four posts, one in each corner, to support service and storage. Force comes from a single hydraulic cylinder driving a maze of high-strength steel cable guided by pulleys. These lifts are excellent for powertrain and exhaust work but difficult for suspension maintenance. Vehicles are driven onto the lift and serviced without the suspension being decompressed. A four-post lift is expensive but can be used on floors with surface-quality and thickness problems, since the load is distributed more evenly and doesn't have to be anchored down. Optional accessories include casters that allow the lift to be moved and jacks to raise the car off its suspension for complete service.



MIDRISE/SCISSOR LIFT

The least expensive of the group (entry models start at under \$1200) and the least versatile, the scissor lift, or midrise lift, packs the machinery in its center, so there's no reliable way to work on the underside of the car. It is the easiest to install though, normally requiring only 120-volt power, 3 inches of solid concrete, and minimal overhead clearance. This lift works by using hydraulics to open a scissor mechanism, and the car rests atop two platforms that fit inside its wheelbase. If all you want is an easy time of lifting a vehicle off all four wheels or of getting it up to a comfortable working height for brake, tire, suspension, or body work, the scissor-type lift is a good choice.



STAGE 2

INSTALL THE FUNCTIONAL HARDWARE

⊖ Balancing cables, safety locks, and hydraulic systems can all be hooked up while the lift is still on the ground. The cables serve to keep each lifting carriage at equal levels so the car doesn't rise unevenly. These are mounted with a bolt end, nut, and lock nut and should be run through the pulley system as directed. Tension the cables lightly to keep them in place.

Mechanical locking mechanisms increase safety and the life of cylinders, hoses, and fittings by transferring weight off the hydraulic system and onto pins that move a car's weight to the posts. A lever, pins, springs, and a thin cable running through the top plate connect both sides.

Auto-lift hydraulics have only one high-pressure line (no return line as on tractors). Pressure to the hydraulic cylinders lifts the car, and its weight provides the force to compress the cylinders and lower the car. Attach the hydraulic lines at the cylinder bases, then mount the pump and fluid reservoir. Connect the pump outlet to the hose and tighten all joints.



STAGE 3 RAISE THE LIFT

⊖ With the lift mostly assembled and ready to go up, mark the floor for placement. Use a plumb bob, a measuring tape, a chalk line, and a permanent marker to draw out the end positions of the columns. Remember to account for the car approaching the lift, so keep turns or corners in mind when orienting the layout.

Raising the lift is serious business. Invite at least six strong friends over to help. Overwhelming manpower and coordination are key. Work together to raise the lift into position, and be careful not to let its inertia tip it over onto the other side. Once it's upright it'll stay up all by itself. Use a mallet to tap the columns into exact position.

Rent or borrow an SDS Max rotary hammer (standard 3/4-inch chuck size) to do the hole-making, along with a masonry bit. Drill through the mounting-plate holes to prevent alignment issues and stay as vertical as possible. Drill all the way through the concrete and wear safety gear, keeping the powdered concrete clear of the hole. Three-quarter-inch wedge anchors are almost universally recommended for auto lifts—concrete will fail before these pull out. Put a nut on the anchor just flush with the end and pound the bolt down to the mounting plate. If the anchor is damaged, you can drive it down into the dirt and set an undamaged one on top of it. Torque all the nuts to spec. Check the columns for plumb—they should be at 90 degrees vertical in all directions; if they aren't, level with the included shims. Unbolt the anchors, add a few shims, torque the anchors, and measure again.

See the full installation on YouTube.



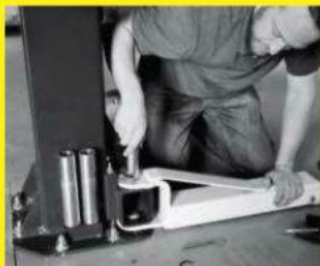


STAGE 4

WRAP IT UP AND GET TO WORK

Finishing includes hiring a qualified electrician to install power to the pump and a plug at the column so that 220-volt power is nearby for a welder. Have a friend help by positioning the base of the lift arm with the holes in the lifting carriage while you drop the huge pins through the holes; jiggle the arm until the pin seats. Install the retaining clips and the mounting pads. Your lift is now physically complete.

Fill the hydraulic reservoir and cycle the cylinders while the system is unladen. This clears air in the hoses, which can cause choppy, uneven lifting. Check that the safety mechanisms work properly—go over every nut and bolt and inspect for hydraulic leaks. Park the lift arms on the ground and tension the control cables as directed by the installation manual. Test the lift with your least-loved car. Bring it off the ground until the first lock engages and release hydraulic pressure. The car should settle evenly; if it doesn't, you need to adjust the control cables. Shake the car back and forth and watch the columns to make sure they're stable. If it checks out, take the vehicle up to the top and begin working on its nagging problems.



ASSOCIATE AUTO EDITOR BEN WOJCYLA

takes to the really small screen to demonstrate this project and other fixes and upgrades on the *Saturday Mechanic* show, presented by the Car and Driver Channel on YouTube. Want to get in on the Internet automotive action? Submit car-related questions to popularmechanics.com/cdchannel and Ben may save you time, money, and needless frustration when your ride goes awry.



W

WEEKEND

J•R CIGAR

THE WORLD'S LARGEST CIGAR STORE!

AN ASSORTMENT OF 10 PREMIUM CIGARS

Limited time offer



BELICOSO BUNDLE

for \$29⁹⁵

MSRP
\$84⁷⁰

+ \$5.00

Standard Shipping

NC customers add appropriate sales tax
Limit one per customer Not available to minors

Surgeon General's Warning: Cigars
are not a safe alternative to cigarettes.

GRAB THIS DEAL ONLINE:

www.JRCigars.com/P3

order by phone

800-JR-CIGAR

800-572-4427

mention offer P3

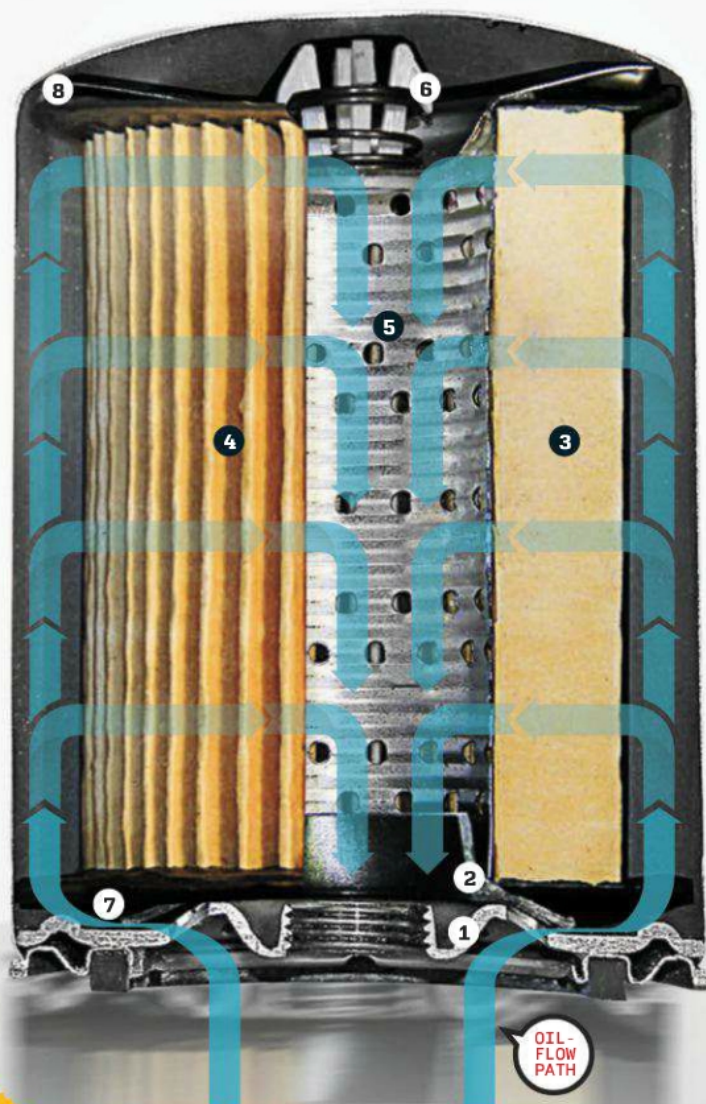
Offer expires 10-31-12



HOW IT WORKS

OIL FILTER

CLEAN OIL IS ESSENTIAL FOR A HEALTHY ENGINE, MAKING THE OIL FILTER AN INDISPENSABLE ORGAN. HERE WE EXPLORE THE VARIOUS PARTS OF A FRAM EXTRA GUARD OIL FILTER INTENDED FOR CARS AND TRUCKS. BY ANDREW DEL-COLLE

**1. TAPPING PLATE**

This serves as the entry and exit point for oil. Small holes around the edge facilitate the free flow of oil into the container. The threaded center hole is where the oil flows out and also how the container attaches to the engine.

2. ANTIDRAINBACK VALVE

Because the oil filter is typically located toward the middle or bottom of an engine, this rubber valve has a flap that blocks oil from draining back into the filter when the engine is off.

3. FILTER MEDIUM

The porous filter medium consists primarily of microscopic cellulose fibers along with synthetic fibers such as glass and polyester, which increase filtering efficiency and durability. The medium is also saturated with resin to give it strength and stiffness. Higher-grade filters have more synthetic fibers.

4. PLEATS

Folding the filter medium creates a greater total surface area. The number of pleats depends on the medium's thickness.

5. CENTER STEEL TUBE

The center tube provides structure and lets filtered oil return to the engine. The number, size, and position of the holes is key to ensuring that the oil flow is not restricted.

6. RELIEF VALVE

On a cold startup, oil can be too thick to filter. To prevent the engine from starving, the relief valve opens when the pressure builds enough to force the calibrated spring downward, allowing unfiltered oil into the center tube through the top.

7. END DISC

To keep unfiltered oil from leaking into the center tube, a fiber or metal end disc is bonded to each end of the filter medium. Some brands forgo discs and use a sealant to create solid ends.

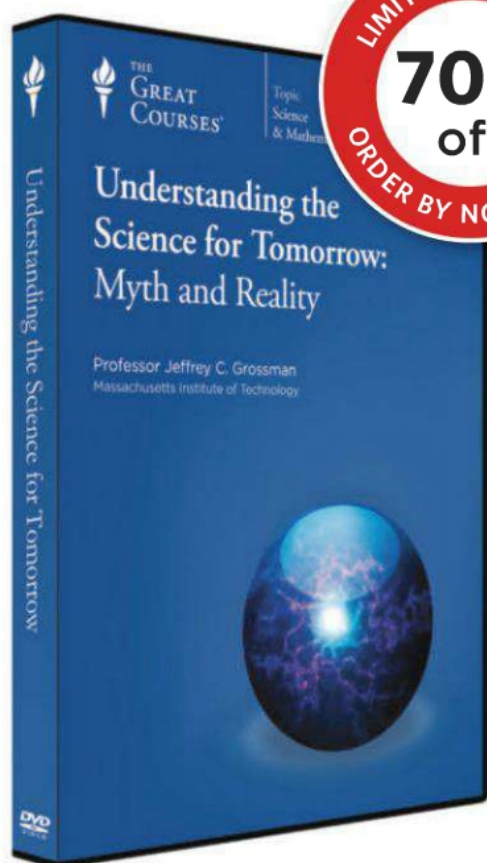
8. RETAINER

A thin bit of metal that acts as a leaf spring, the retainer keeps the filter medium and end disc tight against the tapping plate.



GARY BILSKI, CHIEF ENGINEER AT FRAM GROUP

"When a vehicle's idling, the oil filter receives roughly 1 to 2 gallons a minute, but at 4000 to 5000 rpm the gallons per minute can hit 5 to 10."



Explore the Science of Tomorrow's World

Science and technology are, without a doubt, two forces that will change the way you live your life in the coming months, years, and decades. Nanotechnology, quantum computing, genetic engineering; these and other fascinating fields will revolutionize how you eat, communicate, travel—even how long you live.

Explore what your future may look like with **Understanding the Science for Tomorrow: Myth and Reality**. This scientifically accurate and enlightening survey of today's most advanced research in fields such as engineering, biology, chemistry, and theoretical physics is delivered by Professor Jeffrey C. Grossman of the Massachusetts Institute of Technology. His 24 lectures offer you an accessible look at biofuels, nuclear fusion, nanorobots, artificial intelligence, and other fascinating real-world subjects.

Offer expires 11/20/12

1-800-832-2412

WWW.THEGREATCOURSES.COM/4PRM

Understanding the Science for Tomorrow: Myth and Reality

Taught by Professor Jeffrey C. Grossman
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LECTURE TITLES

1. Changing the Game
2. Magnetism—The Science of Attractions
3. Transportation—The Science of How We Move
4. Computers—Trillions of Bits per Second
5. Artificial Intelligence—Thinking Machines
6. Robotics—Living with Machines
7. Microscopes—The Power of Seeing It All
8. Nanotechnology—The New Science of Small
9. Nanotechnology—Changing Everything
10. Genetic Engineering—Life's Building Blocks
11. Synthetic Life—Making Life from Scratch
12. The Brain—Your Body's Supercomputer
13. Cancer and Aging—Can They Be Defeated?
14. Powerful Viruses—Future Friend or Foe?
15. Food or Famine—Science Holds the Key
16. Water—The Currency of the Next Century
17. Biofuels—The Fuel of the Future?
18. Solar Cells—Electricity from the Sun
19. Batteries—Storing Energy Chemically
20. The Hydrogen Economy—Fact or Fiction?
21. Nuclear Energy—Harnessing Star Power
22. Prediction—From Storms to Stocks
23. Communication—Transcending Time and Space
24. Science in the Future

Understanding the Science for Tomorrow: Myth and Reality

Course no. 1391 | 24 lectures (30 minutes/lecture)

SAVE \$185

DVD ~~\$254.95~~ NOW \$69.95

+ \$10 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 65686

Designed to meet the demand for lifelong learning, The Great Courses is a highly popular series of audio and video lectures led by top professors and experts. Each of our more than 400 courses is an intellectually engaging experience that will change how you think about the world. Since 1990, over 10 million courses have been sold.

*In the amount of time it takes
to do this, you could have
installed a Premium K&N Air
Filter Designed to Improve
Engine Performance.*



*Easily installs in just 5 minutes
and never needs to be replaced*

A K&N Million Mile Air Filter is incredibly easy to install. Just unclip the lid on the factory airbox, remove the old filter, replace it with a K&N, fasten the clips back on, and drive off knowing you will never need to replace another air filter. And since they flow more air than a standard paper air filter, they can help your car run better too.



Find yours today at
KNFILTERS.COM/PM
800-871-0560



© 2012 K&N Engineering, Inc.

PHOTOGRAPHS BY NICK FERRARI



Car Clinic

BY
BEN WOJDYLA

Speed Wobble

Lately my 1995 Accord is acting weird around corners. When I take left curves at higher speeds, I feel vibrations from the right rear tire. No such issue with right curves. I'm wondering if there's something wrong with my suspension.

The good news is you probably don't have a suspension problem. The bad news is you probably need a new wheel bearing at the right rear corner. Wheel bearings are just like any other roller bearing you find in machines—two rings of hardened and finely machined steel separated by a rolling element such as small metal spheres or cylindrical rods, all kept happy with a thick coating of grease. Older cars (think 20-plus years) used inner and outer wheel bearings that didn't last as long but were exceedingly easy to service. The majority of new cars



come with sealed bearings that last longer and perform much better but that are pressed into place with mechanical force, staying put by way of an interference fit (the bearing housing is slightly too big for the hole it fits in). That lopsided vibration you feel comes from those rolling elements inside the bearing starting to fail. In a sweeping left turn, the right rear wheel (at the outside of the curve) is loaded up with force so the bearing is under higher stress, amplifying the vibration. When you turn to the right, the right rear wheel is on the inside of the turn and under much lower force, so the vibration more or less goes away. Pay close attention while driving on flat, straight, smooth roads—you'll notice a faint vibration. Watch the rearview mirror to see if the image vibrates with a consistent frequency.

Now the question becomes one of replacement. Whenever something like a bearing fails, it's a good idea to swap its sibling on the other side of the car too, because it's only a matter of time before that one will fail as well. For the Accord, the bearings are most easily replaced by purchasing a new hub and bearing assembly with the bearing already pressed in. A full disassembly of the rear corners and a replacement of the knuckles will ensure another pile of miles before any trouble arises. If you have the time and the talent, you can pull off the repair with basic shop tools. Remember, it's important to take the car in for an alignment afterward, since the whole suspension corner has been taken apart. New, smooth bearings will get rid of the vibration, but improper alignment will invite a host of other problems.

Temperature Tantrum

I have a 2011 Buick Lucerne CXL with an ambient temperature readout on the dash. In a typical day I might drive 8 miles around town and make five short trips, but the readout never changes. Our Kansas summers sometimes

see differences of 30 degrees from morning to afternoon. The dealer says it's normal. I "fixed" the problem by sticking a piece of tape over the display, but what can I do to make the thermometer more accurate?

This was a new one to me, so I contacted GM for an answer. Your issue lies partly with how the car works and partly in the way you're driving it. The Lucerne's computer reads the outside air with a temperature sensor, which is normal for pretty much all cars with this feature. However, with the Lucerne the sensor is close enough to the engine that the vehicle needs to be turned off for at least 2 hours before the current temperature reading is displayed on startup. This time delay is in place to allow the engine to cool so the heat radiating from it

Make Money In Metal Art

- Make Artistic Projects and Mechanical Parts
- Includes Industry-Leading Software
- Simple to Operate - Runs Off Your Computer

"PlasmaCAM is a well thought-out tool. The software is incredible. I can quickly go from concept to a finished part. I haven't seen anything we can't do with this machine. It has saved us so much time and effort, it's just incredible!"

-Jim, Custom Turbo Engineering

PO Box 19818 • 5112 Graneros Rd.
Colorado City, CO 81019
www.plasmacam.com
(719) 676-2700 • fax (719) 676-2710

Plasma
CAM

TOUGHEST ON THE BLOCK



If you're looking for a tough solution for basement water problems, **DRYLOK® Extreme** is the answer. Its toughness shows with an enhanced biocide to resist mildew growth. It can also stop 12 psi, which is greater than a wall of water 26 feet high. DRYLOK Extreme is made to last which is why it features a fully transferable 15-year warranty. Apply it on interior, exterior, above or below grade masonry surfaces.



Bright White Smooth Finish
Mildew Resistant
Guaranteed to Stop Water

Just ask your neighbors – **DRYLOK®** is the most proven waterproofer on the market.

For a dealer near you call 1-800-272-3235 or visit www.ugl.com



DIY AUTO / CAR CLINIC

Back to Basics

GET A PARTS BIN

The hardest learned lesson in auto repair is that the big parts aren't what slow you down—it's the little fiddly bits. I've been to a hardware store two and three times to

get the right nut-and-bolt combo for a hidden electrical connection. Small bolts, circlips, and cotter pins reliably break at the exact moment all hardware stores close. Usu-

ally, more time is burned running back and forth to the store than in actually making the repair. Save yourself a lot of gas and get a parts bin like this. It's easily stored and it holds loads of common nuts and bolts, roll pins, connectors, and the like. You can even buy these things prefilled—everything you need but didn't know you needed. While you're at it, nab a good thread-and-fastener-identification setup like our kit from Parker (foreground). For a few bucks you'll never have to guess grade, bolt size, thread pitch, or thread count again. Work smarter, not harder, right?



doesn't influence the temperature of the sensor and by extension what shows on the readout. Your series of short trips means the engine is probably never off for 2 hours at a time. Further complicating matters, the car skews this wait time based on how fast you're driving. High speeds push more air over the sensor, cooling it quickly, so an accurate reading of the temperature can be made sooner. Cruising around town never overcomes the speed threshold for a real-time readout. I think you should do some experiments with the car to confirm this, though. Next time you're out around town, go off your beaten path and onto the highway for some higher-speed driving. Check to see if the readout is working. Likewise, try waiting over 2 hours after a shutoff to see if the readout is accurate. Given your driving

POPULAR MECHANICS (ISSN 0032-4558) is published monthly, 12 times a year, by Hearst Communications, Inc., 300 West 57th Street, New York, NY 10019 U.S.A. Frank A. Bennack, Jr., Executive Vice Chairman & Chief Executive Officer; Catherine A. Bastron, Secretary; Ronald J. Doerfler, Senior Vice President and Treasurer; Steven R. Swartz, Executive Vice President and Chief Operating Officer; Hearst Magazines Division: David Carey, President; John P. Laughlin, Executive Vice President and General Manager; John A. Rahan, Jr., Senior Vice President, Finance. © 2012 by Hearst Communications, Inc. All rights reserved. **POPULAR MECHANICS** is a registered trademark of Hearst Communications, Inc. Periodicals postage paid at N.Y., N.Y., and additional entry post offices. Canada Post International Publications mail product (Canadian distribution) sales agreement no. 40012489. CANADA BN NBR 10231 0943 RT. POSTMASTER: Send address changes to **POPULAR MECHANICS**, P.O. Box 6000, Harlan, IA 51593. Printed in U.S.A.

EDITORIAL AND ADVERTISING OFFICES: 300 West 57th Street, New York, NY 10019-3797.

SUBSCRIPTION SERVICES: **POPULAR MECHANICS** will, upon receipt of a complete subscription order, undertake fulfillment of that order so as to provide the first copy for delivery by the Postal Service or alternate carrier within 4 to 6 weeks.

>>> Subscription prices: United States and possessions \$24.00 for one year. Canada and all other countries \$40.00 for one year.

>>> Should you have any problem with your subscription, please visit service.popularmechanics.com or write to Customer

Service Department, **POPULAR MECHANICS**, P.O. Box 6000, Harlan, IA 51593. Please enclose your mailing label when writing to us or renewing your subscription.

>>> **POPULAR MECHANICS** is not responsible for unsolicited manuscripts or art. None will be returned unless accompanied by a self-addressed stamped envelope.

MAILING LISTS: From time to time we make our subscriber list available to companies who sell goods and services by mail that we believe would interest our readers. If you would rather not receive such mailings, please send your current mailing label or

exact copy to **POPULAR MECHANICS**, Mail Preference Service, P.O. Box 6000, Harlan, IA 51593.

AS A SERVICE TO READERS,

POPULAR MECHANICS publishes newsworthy products, techniques, and scientific and technological developments. Because of possible variance in the quality and condition of materials and workmanship, **POPULAR MECHANICS** cannot assume responsibility for proper application of techniques or proper and safe functioning of manufactured products or reader-built projects resulting from information published in this magazine.



habits, the blackout tape may be the best solution.

Shocking Ride

Lately I've noticed that my car has developed a surprisingly harsh ride. Small bumps in the road result in teeth-clenching hits through the seat. It's gotten to the point where I don't even want to drive it anymore. What's going on?

It's not uncommon for ride comfort to degrade as a car ages. Rubber parts and springs wear out, which changes how the suspension absorbs road imperfections. But before you go blaming your suspension, check your tire pressure. Low pressure or really high pressure will result in a jarring ride. If the pressure is normal, then it's time for a simple test of your shocks. Go to the front bumper and quickly press down with your body weight, then immediately release it and watch what the suspension does. A properly functioning suspension should react with about a bounce and a half, like a basketball a little down on air. If the car bounces beyond that (two oscillations or more), you probably need new shocks. Another possibility, although less likely, is that the springs have begun to slouch. A lower car will hit the suspension limit sooner and that means nasty bumps are directly transmitted to the frame. Have a mechanic compare the free-spring length against factory specs to see if you need new ones. **PopMech**

WEEKEND



**GOT A CAR PROBLEM?
ASK BEN ABOUT IT.**

Send your questions to pmautoclinic@hearst.com or over Twitter at twitter.com/PopMechAuto or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we can't answer questions individually, problems of general interest will be discussed in the column.

THE STEALTH WAR

Continued from page 73

"There's a real risk that a lot of the high-tech investments are going toward things our adversaries want us to invest in, because they can neutralize them—and spend far less money to do so," Sharp says.

In his essay in *Proceedings*, Greenert suggests the way to keep U.S. aircraft safe is to make smarter choices in equipping them. Instead of investing massive amounts of money in airplanes that can defeat every new threat, he advocates purchasing weapons that existing aircraft can fire from longer ranges, safely away from radar. He also suggests adopting UAVs and missiles that can jam enemy radar before manned aircraft even arrive. "We need more numerous electronic warfare and cyber payloads to thwart detection and targeting," he wrote. "U.S. forces can . . . employ long-range sensor, weapon, and unmanned vehicle payloads instead of using only stealth platforms to reach targets."

The drones, cruise missiles, and decoys may lead an attack, spewing radar beams and flooding computer networks with viruses. But they will have to be built to defeat powerful radar networks and fast missiles with can't-miss seekers.

Years of fighting low-tech insurgencies have increased military reliance on UAVs that are easily spotted on radar. "We've got to start planning to build systems and to field capabilities to fight in a contested environment again," the Air Force's new military deputy for acquisition, Lt. Gen. Charles Davis, said in a recent interview with the *Air Force Times*. So, in one form or another, the duel will continue.

As of now, no S-300 surface-to-air weapon has ever been fired at a target in anger. The Lightning II is still in testing, and the debut of its style of networked warfare is years away. Their matchup awaits. Only then will the war of words between detractors, engineers, salesmen, and journalists be settled—in combat, with lives at stake and history in the balance. **PopMech**

Crutchfield's totally redesigned Catalog



**Interested in the latest
audio/video gear?**

We've got you covered

Check out an all-new Catalog for a look at new stereo gear and helpful A/V tips

Visit us online for more

See expert evaluations and chat with one of our advisors



For your free Catalog or to
talk to a Crutchfield expert, call:

1-800-317-9722

visit:

www.crutchfield.com/mechanic

scan:



CRUTCHFIELD
Trusted since 1974

GEAR If you already have rock-climbing equipment, Potter says, putting up a slackline is as simple as setting a top rope. Otherwise, buy a kit from a company such as Gibbon Slacklines. For around \$75, you can get a ratcheting device and 2-inch-wide webbing custom-made for the sport.



SETUP Wrap the line around one tree and connect it to the ratchet system, which should be anchored to another tree up to 20 feet away. "You want it nice and low, maybe a foot off the ground," says Greenwood, who is a member of Gibbon's pro team, "and keep it short" to minimize bounce while you learn.

TREE CARE When the anchors are snug but not tight, work carpet remnants or blankets beneath the webbing to protect the tree's bark.

TENSION The line should remain just under knee height as you bounce on it. The webbing will stretch during your first session; adjust it with the ratchet.

FIRST STEPS Potter suggests slightly elevating a short section of line between two boxes, or between one box and a tree. This reduces wobble. "Practice standing on one foot, then the other foot, then both feet," he says. "Once you can stand with both feet, taking a step is a lot easier."

BALANCE TIPS

First, don't look down. "Empty your head and just focus on your breath and watch the anchor point," says Potter. Second, balance by making an upturned U shape with your arms. Finally, use your unweighted foot as another balancing aid. "You can use that foot as a way to catch yourself," Greenwood says. "You're walking, start to wobble, and if you take one foot off, you'll be able to stop the wobble." **PopMech**

Adventure



BY MICHAEL FRANK

YOU WALK THE LINE

SET UP A SLACKLINE IN YOUR CAMPSITE OR YARD—AND JUMP INTO AN ADDICTIVE BALANCE TUNEUP.

Slacklining started in the late 1970s as a rainy-day pastime for rock climbers in California's Yosemite Valley. Unlike tightrope or high-wire walking, slacklining is done without using a pole and, as the name would imply, on a stretch of nylon webbing that has some give. Dean Potter, originally famous for soloing some of the hardest climbs in the world without the aid or the protection of a rope, learned to slackline a few decades ago from one of the sport's founders, Chongo Tucker. Today Potter is probably just as renowned for having stretched lines 2600 feet over Yosemite Falls and for walking without the reassurance of a tether that would save his life if he fell. But along with **Josh Greenwood**, a professional slackliner who taught Madonna the sport, Potter says that it's a fascinating challenge close to the ground as well. And Greenwood, a former gymnast, recommends slacklining as a full-body workout. Here are both experts' tips for getting started.

Unclog Drains

with Your Pressure Washer

100 Ft. Sewer Jetter Only \$129



Free Guide

ClogHog.com

Or Call 877-992-5644

\$10 OFF

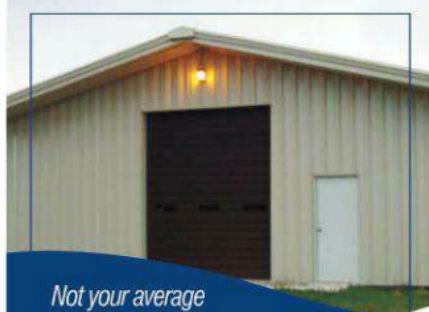
WEB COUPON PM92



FIVE MINUTE FENCE STAIN

Stain 100 feet of fence in just 5 minutes! Sprayer attaches directly to garden hose. No masking, simply hose off over-spray. One quart covers 600 square feet. Select from three natural wood tones; Natural Cedar, Dark Cedar or Redwood.

www.FiveMinuteFence.com



Not your average
TROPHY CASE.

Whatever your game, display it in a metal building from Heritage. Call us today for a building that will protect and showcase your prized possessions.

HERITAGE BUILDING SYSTEMS.
Established 1979

1.800.643.5555

HeritageBuildings.com



KINEKT GEAR RING™
moving gears you can wear

888-600-8494
watch our video at
www.kinektdesign.com

TerraTrike
PART OF THE SOLUTION

World's Most Comfortable Ride

Starting at \$799

WWW.TERRATRIKE.COM
FREE CATALOG 800-945-9910

JumpSport FITNESS TRAMPOLINE

#1 Rated New Fitness Innovation!



NASA Confirms ~ "The most efficient, effective form of exercise yet devised by man."

"I suffered from low back pain for over 20 years. The JumpSport strengthens all the core muscles and ended all the pain."

Bill E. — Big Springs, TX

"It has a lot more give, a lot easier on the knees, and you can definitely tell you get a better workout in your glutes, your hamstrings, and your quads."

Dr. Rob, Chiropractor — Burbank, CA

"Cardio is never fun, but now it is. I get a good sweat and elevated heart rate pretty quickly with this product and I found myself enjoying the process."

Richard T. — Amazon Review

"Your joints, lungs, and athleticism will love it!"
Curt L. — Sarasota, FL



See the new tech behind this American innovation at:

www.Fit-Man.com

1.877.214.9773



FREE SHIPPING
For a Limited Time

CLEAR ACRES OF LEAVES
While You Ride!

The DR® LEAF and LAWN VACUUM turns your riding mower into a powerful yard clean-up machine!

VACUUMS leaves, grass clippings, and other debris from your lawn using an incredible 85 mph suction force!

SHREDS most everything it vacuums. Reduces the volume of leaves by 90%.

DUMPS OR BAGS collected material.

CHIPS fallen tree branches and prunings up to 2" thick with a built-in chipper.

WALK-BEHIND MODELS AVAILABLE!

LIMITED-TIME OFFER
1*YEAR TRIAL

Call for a FREE DVD & Catalog!



TOLL-FREE

800-462-1032

DRleafvac.com

Makes Glass INVISIBLE

America's #1 selling automotive glass cleaner

Leaves no streaks, haze, or residue

"It's like driving with no windows"

Cleans home & work glass too

1-888-STONER3

InvisibleGlass.com

Invisible Glass
Premium Glass Cleaner

LOWE'S

Orally

Advance

PERFORMANCE

AutoZone

DOLLAR GENERAL

Walmart

TARGET

VPM6R

To Reach 9 Million 9 Million Prospects each month

or for additional advertising information, call Kathleen Gleason at 708-352-2487, or e-mail: klassmark@aol.com.
THANK YOU for choosing Popular Mechanics Classified Advertising, 512 West Burlington Ave., LaGrange IL 60525.
 For subscription questions, visit service.popularmechanics.com.

ARTS, CRAFTS, SUPPLIES

WHOLESALE PRICES ON JEWELRY CRAFT ITEMS,

Beads & Beading Supplies,
 Rockhound Supplies, Belt Buckles,
 Clock Movements.

Free 122 page catalog:

Eloxite: Dept. 45,

Box 729, Wheatland, WY 82201,

Ph.: 307-322-3050

Web: www.eloxite.com

AUTOMOTIVE

AMSOIL, SYNTHETIC LUBRICANTS.

Buy Direct, Register to

Buy Wholesale.

Free Catalog. 1-888-450-2658.

www.synthoils.com

BICYCLES

GOLDEN EAGLE BICYCLE ENGINES

2 & 4 Cycle Geared Belt 25 - 40cc

517-410-2793 bikeengines.com

BOATS, OUTBOARDS, TRAILERS

BOAT KITS - PLANS - PATTERNS - SUPPLIES

Catalog \$5.00,
 Clarkcraft, 16-6 Aqualane, Tonawanda, NY 14150. 716-873-2640.

www.clarkcraft.com

AS SEEN ON NCIS!

BUILD YOUR OWN BOAT -

Send \$9.95 for Book of Designs,
 includes free plans.

Glen-L, 9152 Rosecrans/PM,

Bellflower, CA 90706,

888-700-5007

WWW.SMALLBOATPLANS4U.COM

BOOKS AND PUBLICATIONS

**IF CHRISTIANS ARE "WRONG"...
 THEIR "INVESTMENTS" ARE
 SMALL...BUT IF THEY ARE RIGHT...
 WHERE WILL "YOU" SPEND
 ETERNITY?!? DELIGHT IN BOOKS...
 "IN SEARCH OF AN EARTHLY
 SANCTUARY WITH FODDER",...
 AND "FLOCKS FEED FEAST".
 GO TO WWW.AMAZON.COM
 TO PURCHASE.**

BUSINESS OPPORTUNITIES

CONCRETE CHARLIE™ Says:

Claim your piece of the \$100 Billion
 waterproofing industry and become
 a foundation crack repair specialist.

Most Complete Training
 in the Industry! Don't Wait!

Territories available NOW!

Or, buy a kit and fix **your** cracks!

www.concretecharlie.com

Enter Pop. Mech Promo Code: 971208

PROCESS MAIL FROM HOME!

Excellent weekly income.

For free information send S.A.S.E.:

Mailers-PM, P.O. Box 458,

New Britain, CT 06050-0458

BECOME A HOME INSPECTOR!

Make \$50,000+ per year.

Free information at

www.HomeInspectionBook.com

DO-IT-YOURSELF

HYDRAULIC JACK REPAIR

Manual and catalog: \$15.00

620-594-2247,

Hydraulic Parts Supply,

P.O. BOX 97-PM, Sawyer, KS 67134.

ELECTRONICS

CONDUCTIVE PAINT, EPOXY

From \$12. Silver or carbon paint.

Silver epoxy. Carbon tapes.

Custom formulas available.

www.semsupplies.com

301-975-9798 (M-F).

PRINTED CIRCUIT BOARD DESIGN

Schematic, Layout, Packaging,

Fabrication and Assembly.

Reverse Engineering.

Prototypes to Production.

Your one stop solution!

www.PCB3D.com

FINANCIAL

RARE COIN INVESTMENTS.

Our clients **DON'T LOSE** money!

FREE brochure.

DENKO 1-877-777-1754.

FREE

SOON THE GOVERNMENT

will enforce the

MARK OF THE BEAST

as CHURCH AND STATE unite!

Let THE BIBLE identify him.

FREE BOOKS/DVDs

The Bible Says, P.O.B. 99,

Lenoir City, TN 37771

thebiblesaystruth@yahoo.com

1-888-211-1715.

HEALTH AND FITNESS

LEGAL STEROIDS -

Build Muscle Fast! Safe & Effective!

1-866-309-4590

www.SWESSPHARMA.com

HEARING AIDS

DIGITAL HEARING AID SALE

16 channel bands, any size, any type
 or BTE \$339.95

Options: touchtone, twin mics,
 custom molded - \$50.00

**New! Open Fit Technology -
 most brands - big discounts**

Repairs \$77.00 (since 1981)

Free brochure & mold kit

Hearing One

1-800-249-4163

100 Main Street, Marty SD 57361

HEARING AIDS

TROUBLE WITH YOUR HEARING AID?

Lilli Electronics is a full service
 hearing aid repair lab. We can
 quickly return most hearing aids
 to perfect, working condition.
 Serving the U.S. and beyond since
 1967. Call: 1-800-653-8882 or
 visit us at: **lillielelectronics.com**.

HEARING AIDS - GUARANTEED

LOWEST PRICES! No huge

commissions. Home trial, terms.

All makes. We're the oldest,
 biggest, best. Custom instrument
 specialists. Free information,

1-800-323-4212. Lloyds-PMC

HEARING AIDS

FREE HEARING AID CATALOG! PRICES START AT \$249.00 !

Lowest Prices ! Huge Discounts !
All Makes ! Trial Period !
Monroe Hearing Aid Corporation
P.O. Box A-3976, Chicago, Illinois
60690 **1-800-462-5778**

HELP WANTED

\$400 WEEKLY ASSEMBLING

Electronic Circuit Boards/

Products. Rush S.A.S.E.:

Home Assembly - PM,

P.O. Box 450,

New Britain, CT 06050-0450

INVENTORS

INVENTORS: Free information
tells how to offer your invention
for sale or license.

Kessler Corporation, 52+ years
800-537-1133, ext. 25,
www.kesslercorp.com

**PROTECT YOUR IDEA! Write
Your Own Patent Application
PatentPro® Software
www.patentpro.us**

JEWELRY

.....WITH MOTION IN MIND..... KINEKT DESIGN GEAR RING:

Interactive jewelry
for men & women.

Turn the outer rims of the ring &
see the gears move (watch our
video!). Lifetime Warranty &
Free Shipping. Order online or
call 1-888-600-8494.

www.kinekttdesign.com

LAKES & PONDS

LAKE OR POND?

Aeration - 1st Step towards
improved water quality.

Complete Systems \$169 - \$329
11,000 Gal. Per Hour Water
Fall Pump only 3.6 amps!
Just \$399.95

www.fishpondaerator.com

608-254-2735 Ext. 3

OF INTEREST TO ALL

FREE CATALOG by mail.

Meet nice singles, women, men.
Photos. Profiles. All ages.
Since 1981. Box 310, Allardt, TN
38504 Call 931-879-4625.

OF INTEREST TO MEN

LITEROTICA - Adult Videos,

Pictures & Over 100,000
FREE Stories! Free Adult Cams!
Personals & Friendship ads!
Over 1,000,000 visitors daily.

WWW.LITEROTICA.COM

MEET SEXY WOMEN

Listen to Ads & Reply..FREE!

FREE Code 7840, 18+

1-888-634-2628

www.MegaMates.com

ASIAN BRIDES! Worldwide!

Free Details/Photos!

PIC, Box 4601-PM,
T.O., CA 91362. 805-492-8040.

www.pacisl.com

SEXY BABES WANT YOU!!!

To Call NOW...Wild and Waiting....

Call Now **1-800-615-6869**

V/MC/AMEX 18+

FREE PARTY LINE

Lots a babes No charges!

Party as long as you like

1-712-432-7900

Reg. phones rates apply

FREE FREE FREE,

Non Stop Party!!!

No Charges! Party from your cell.

1-712-432-7962

Reg. phone rates apply.

PARTY GIRLS LIVE, UNCENSORED, ENTHUSIASTIC.

From \$1.65 per min. -

No Connection Fees.

614-263-2633.

TALK TO LADIES NATIONWIDE!

Housewives, Working Girls
and Students waiting just for you.

1-800-921-TALK

only .69¢ per minute 18+.

SEXY LOCAL LADIES, WANT TO HOOK UP NOW!

CALL AND TRY IT FREE!

1-800-996-8444. 18+.

RADIO CONTROLLED

WAREHOUSE HOBBIES

Innovators of gasoline radio
controlled model boats
since 1982, We manufacture ready
to run gas model boats,
engines & all components.

Made in USA. Get Your fun on!

www.whobbies.com

1-800-444-1995.

RENEWABLE ENERGY

HIGH QUALITY SOLAR PANEL SALE.

230 Watt - \$345.00 280 Watt -

\$420.00 25 Year Warranty

Dynamo Power Systems

800-230-4016. SATELLITE SYSTEM

SATELLITE SYSTEM

COMPLETE DIGITAL SATELLITE TV

Dish System / Free Channels

No Contract or Monthly Bill,

Watch FREE 200+ Channels

Call 574-233-3053 for

FREE Satellite Chart and

Information Package.

www.rcdst.com

SNOW GUARDS

Stop Snow Slides

on Metal Roofs!

Practically Invisible,

Easy Installation,

Online Estimator. Fast Shipping

www.snojax.com

STEEL BUILDINGS

STEEL BUILDINGS,

designed for the do it yourselfer.

Buy direct from the factory

& SAVE THOUSANDS.

Worldwide Steel Buildings

www.wsbnow

800-825-0316.

TREASURE FINDERS

BURIED TREASURE -

Sensitive equipment allows
locating from distance.

Brochure free.

Simmons, Box 10057-MA,

Wilmington, NC 28404

www.simmonsscintificproducts.com

WANTED TO BUY

BUYING GOLD, SILVER, PLATINUM - ANY FORM

60 years experience.

Free pricing quotes.

Top payment.

1-800-932-1010

www.preciousmetalsreclaiming.com

WINE/BEER MAKING

WINEMAKERS - BEERMAKERS.

Free Catalog. (800)841-7404.

Kraus, 7850-L,

Independence, Missouri 64054.

www.eckraus.com/offers/L.asp

A BRIEF HISTORY OF THE ...

Chain Saw

We trace the chain of events that made this tool a hit among weekend warriors, in horror movies, and beyond. BY AMANDA GREEN

Start here!

1785

A chain handsaw model appears in John Aitken's *Principles of Midwifery, or Puerperal Medicine*. The fine serrated chain is used to remove diseased bone.

1926

Andreas Stihl patents two-person saws: a 116-pound electric model, and a 139-pound gas one in 1929. U.S. troops bring them home from Europe in 1941 to be imitated.

2011 Canadian Ian Stewart breaks the Guinness World Record when he makes 94 catches while juggling three running chain saws. Stihl's MSA 160 C-BQ lithium-ion saw debuts; it can run for 35 minutes. You've cut a long way, baby.

2000

Eminem opens shows wielding a chain saw. But the real Slim Shady is just imitating—the chain is left off.

2011

Stihl's Wood Boss slices, dices, and produces 50 percent fewer emissions.

1980

Husqvarna debuts the 40, which has a crankcase made of light-weight composite materials. In '83 the company introduces the 154, which has multiple plastic parts.

1974

The Texas Chain Saw Massacre is "inspired by a true story" that didn't involve Texas, chain saws, or massacres.

1973

Husqvarna creates the automatic chain break—a lever that stops the chain after kickback, literally saving faces.

1964

Stihl introduces its first antivibration handle, which uses buffer elements to absorb vibrations coming from the engine and chain. Two years later, "Good Vibrations" by the Beach Boys is a No. 1 hit. (It's not about chain saws.)

1949

McCulloch Motors Corp. debuts the world's lightest chain saw, the 25-pound Model 3-25.

1947

Inspired by timber beetle larvae, which chew both across and with wood grain, Joseph Buford Cox invents the Cox Chipper Chain.

1945 Chain saws before the end of World War II are heavy, often wheeled, two-person devices (above). The development of aluminum alloys and forged steel parts leads to one-person saws.

— INDIVIDUALLY SEALED —
FLAWLESSLY PRESERVED



PARTAGAS[®] MACANUDO[®] EXCALIBUR[®] PUNCH[®]

Introducing the biggest innovation in handmade cigars since the humidor – the NEW Freshness Pack. Available for Macanudo, America's #1 selling premium cigar, as well as Partagas, Punch and Excalibur. Now wherever you go you can enjoy the best-selling premium cigars in the U.S. – individually wrapped straight from the factory.

Look for our premium brands in Freshness Packaging at a store near you!

SURGEON GENERAL WARNING:
Tobacco Use Increases The Risk
Of Infertility, Stillbirth And Low Birth Weight.



You can't fake fast.

Fast is a 200-hp turbocharged engine, sport suspension, and an available DSG® transmission with Tiptronic®, tuned to perfection right off the assembly line. All the fluorescent paint, graphics, air scoops, and spoilers in the world can't change that, because fast is more than flash, it's a total performance package. And it's just waiting to make you take a second look at what performance is all about — the Volkswagen Jetta GLI. **That's the Power of German Engineering.**



Das Auto.



3 Years or 36,000 Miles of No-Charge Scheduled Maintenance.
Whichever occurs first. Some restrictions. See dealer or program for details.

vw.com/performance

Obey all speed and traffic laws. ©2012 Volkswagen of America, Inc.