

★ **Special Report:** FIXING DEADLY U.S. COAL MINES

10 WILD BACKYARD INVENTIONS

Popular Mechanics

WE TEST
3D TV!

SCIENCE TECHNOLOGY AUTOMOTIVE HOME OUTDOORS

RADICAL VEHICLES

INSIDE THE RACE TO BUILD THE 100-MPG CAR

FROM LEFT: FVT RACING eVARO, LI-ION MOTORS EVI WAVE II, EDISON2 VERY LIGHT CAR



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A close-up, high-angle shot of the front interior of a 2011 Jeep Grand Cherokee. The image shows the driver's side seat and the center console. The seats are upholstered in a rich, tan-colored leather with visible stitching. The center console is black with a silver gear shifter and handbrake. A red parking brake lever is visible on the side of the console. The door panel on the left features a silver handle and a wood-grain trim strip. The background shows a glimpse of the exterior through the window, with green foliage visible.

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2010

Sept.

PM FEATURES

VOL. 187 NO. 9

62 The X Factor

With \$10 million at stake, 22 teams from around the world are scrambling to design and build the best production-ready, 100-mpg vehicle—and win one of the most grueling automotive competitions ever staged. PM lifts the hood on the top contenders.

BY JOHN PEARLEY HUFFMAN

80 3D TV: An Early Adopter's Guide

Do stereoscopic televisions have a place in your home? Our experts slap on shutter glasses and test the market's first 3D sets to bring you the basics on the newest dimension in TV tech.

BY GLENN DERENE

74 Danger Below

Working with high-voltage electricity, 35-ton machines and explosive methane is just part of a day's work for coal miners. But the high rate of safety violations has made many mines accidents waiting to happen. So why hasn't the industry adopted tougher safety rules? A PM special report.

BY CHRISTOPHER MAAG

84 Backyard Genius

In our third annual salute to DIY inventions, we profile tinkerers who use serious brainpower to create gadgets that are totally optional—and irresistibly ingenious.

BY DAVIN COBURN

Look, Ma—no spokes! Nick Tsouris spins on a radical revision that he and eight other Yale students built for a mechanical engineering class.



ON THE COVER

Vehicles competing for the \$10 million Progressive Insurance Automotive X Prize—which challenges teams to create a new generation of fuel-efficient cars—stand ready for test runs at the Michigan International Speedway in Brooklyn, Mich. Photographs taken by Joe Pugliese on May 7 and 8.

Popular Mechanics

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The all-new Nissan Juke revs up its very sporty intentions. **PLUS** Inside the world's cheapest car; we test drive Hyundai's first hybrid; can your vehicle's computer be hacked?

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PRODUCTION

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POPULARMECHANICS.COM

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PROJECT ASSISTANTS

Alyson Sheppard, R. Scott Wells

INTERNS

Tarah Knaresboro, Brian Resnick, Andrew Sawyer,
Anneliese Sendax

Contributing Photographers & Illustrators:

Burcu Avsar, Levi Brown, Leandro Castelao,
Zach DeSart, Dogo, Christopher Griffith, Chad Hunt,
Scott Jones, Dennis Kleiman, Andres Rivera,
Axel de Roy, Dan Saelinger, Gabriel Silveira,
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WHAT THEY'RE DOING



× DAVID E. COLE

With car companies stabilizing and making room for growth, Center for Automotive Research chairman David Cole is preparing for a new kind of industry workforce—one requiring employees with more education and the capabilities to adjust to a continuously changing technological landscape. Cole plans to educate politicians and the public on this new environment with a program to be called This Is Auto.





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PM LETTERS

Energy Debate

I receive hundreds of newsletters, journals and magazines each month, and was thinking of eliminating a couple, including *POPULAR MECHANICS*. Then just before I sent a grant proposal to the National Renewable Energy Laboratory, your July issue arrived, with its story "Energyland," about energy issues and myths, including nuclear, algae and clean coal. The story was excellent, and covered a number of the issues I am trying to tackle. As you can imagine, I'll be keeping my subscription.

JIM CROWELL
PORTLAND, OR

I found your July story on 10 energy myths interesting and informative. But I was disappointed you didn't mention fusion and natural gas, which is supposedly available in huge quantities and easy to extract—or is that a myth? The former is of course very experimental, but that's even more reason to bring your readers up to date.

STEPHEN ROBISON
BLOCK ISLAND, RI

July

ISSUE

07 / 10

= =

✕
Readers responded to our stories on energy myths, inventing and the dangers of helicopter emergency medical services.

From Napkin to Market

Thank you for the "Inventor's Handbook" story. I have been a patent attorney for over 20 years and have worked with many independent inventors. From my experience, the author's advice is dead-on. It is important for an independent inventor to understand that the inventing is not the end of the work. Even for the best ideas, there is a long and difficult road from the "back of the napkin" stage to market (and profit).

RUSS CULBERTSON
AUSTIN, TX

Risky Flights

I just read your story, "Critical Condition," on helicopter emergency medical service (HEMS) safety. I'm a helicopter pilot who has flown some HEMS flights, and I found your story very accurate and on point. One issue that you didn't

discuss was standard operating procedures (SOPs) under poor weather conditions.

When the weather gets truly bad, a dispatcher will frequently "shop around" for a pilot who will accept the flight. All the safety equipment in the world won't do a bit of good if a pilot accepts this risk. The system needs SOPs, and pilots must adhere to them. Airlines and the military have

exemplary safety records because pilots strictly adhere to SOPs. For the most part, the civilian world doesn't, and the safety record reflects it. Thanks for the article.

BOB LANCASTER
WILMINGTON, DE

Lock, Shock and Wheel

I read your Abusive Lab Test on padlocks with great interest and was surprised at the results. But you left out one good test: cutting through the locks in just a few seconds with a small cutoff wheel for steel, which is available at any hardware store. I think it would be a burglar's first choice—quiet, fast and sure.

NORBERT ZESCHKE
THORNDALE, TX

CORRECTION: *August's DIY Home, "Wood Chopper's Ball," should have listed the Jonsered CS2159's engine at 59 cc.*

what
do you
think?



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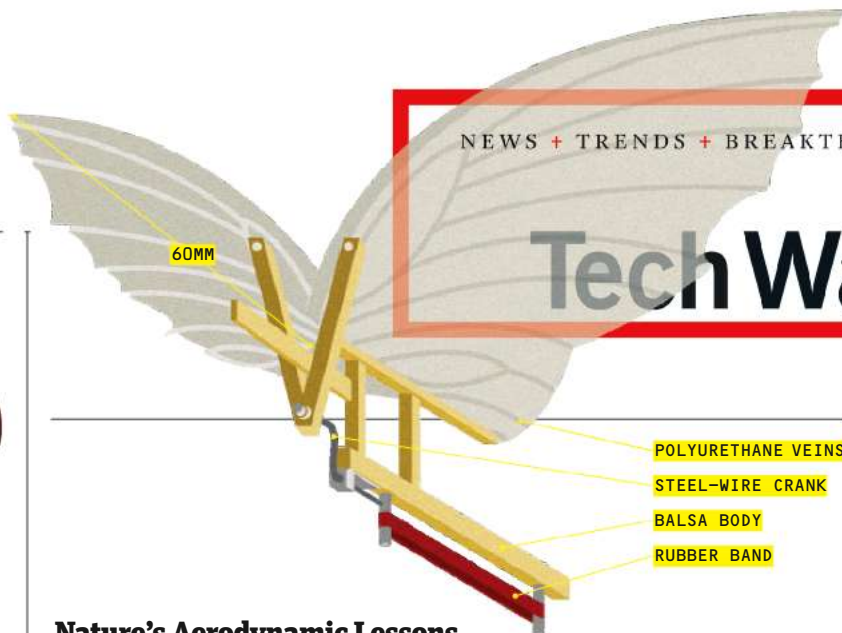
Tech Watch

• ALIEN WORLDS



Methane Eaters on Mars?

A team of researchers working with the SETI Institute has found creatures in a desolate Arctic spring whose existence hints at a new kind of life that could possibly thrive on Mars. The water of Lost Hammer, a spring on Canada's Axel Heiberg Island, contains bubbles of methane that steadily rise to the surface. While searching in the frozen pool for organisms that emit methane, the researchers instead found anaerobic bacteria that utilize methane as a source of energy and carbon. The spring's mix of methane and ice mirrors past conditions on Mars, leading the team to speculate that similar life forms could have evolved there.



Nature's Aerodynamic Lessons

Unlike most flying insects, swallowtail butterflies do not change the shape and angle of their wings when they fly, and stay aloft only by flapping them. Researchers at the University of Tokyo and Harvard built a tiny butterfly model that reproduces swallowtail biomechanics, then changed aspects of the insect's "body" to determine what influences its airworthiness. They found that the model's wings generated quadruple the aerodynamic lift when stiffened with veins, as found in nature. The data could aid the design of small, unmanned aerial vehicles and high-endurance aircraft.

• FAST FLIGHT



Making History at 1700 Miles per Second

The X-51A Waverider, part of an experimental American missile program, made its first successful test flight this May off the coast of California. The unmanned vehicle, launched from under the wing of a B-52 Stratofortress, used a solid rocket booster to reach Mach 4.8, then fired a supersonic combustion ramjet (or scramjet) engine to reach Mach 5. The Waverider runs on JP-7 jet fuel, making the air-breathing engine's 200-second burn the first use of a practical hydrocarbon-powered scramjet. More test flights are planned for fall. The Pentagon's goal is to create a missile that can strike a target anywhere in the world within 2 hours.

—ALEX HUTCHINSON

• WEATHER MAKERS

Punching Rain From Clouds Findings from the National Center for Atmospheric Research show that airplanes can trigger rain or snow simply by flying through clouds composed of supercooled water droplets. As the droplets pass over propellers or wings and into the cooler wake, they freeze and fall to the ground, creating distinctive "hole punch" clouds that are sometimes seen in the sky.

• TOOL FROM BATMAN'S BELT

Rapid Hands-Free Climbing

Atlas Devices has created a climbing aid for the Navy that can hoist up to 500 pounds with the press of a button. Personnel can use the Power Ascender to quickly scale the hulls of vessels during boarding operations or to drop from helicopters without rescue booms. The rope weaves through the Ascender between rollers on a spindle: Rotate the spindle one way and the climber ascends; a button changes its direction for the descent. Rock climbers, look elsewhere—Atlas is only marketing the device to the military and to civilian first responders.



• EFFICIENT ARCHITECTURE



Need Smarter Air Conditioning? Try Ice.

Public buildings in Glendale, Calif., are using ice to keep cool, part of a pilot program aimed at sparing the electrical grid from high demand during the day. The Southern California Public Power Authority (SCPPA), in a multiyear project, will retrofit 1500 municipal buildings with 6000 rooftop units that each use a high-efficiency compressor to freeze 450 gallons of water at night, when demand for power is low. Around noon each building shuts off its regular air conditioner and pipes a stream of cool water from the slowly melting ice to an evaporator coil. Once the ice has completely melted, the air conditioner returns to normal operation. The utility says the system could cut power usage during peak hours by up to 95 percent. The manufacturer, Colorado-based Ice Energy, began to sell and install units in 2005, but the SCPPA program is the first utility-scale rollout of a distributed energy-storage project. — ALEX HUTCHINSON

• HOMELAND SECURITY

A Boat for New York's Bravest

New York City's fire department—including its fleet of fireboats—must be prepared for unthinkable emergencies. (Fireboat pumps, due to infrastructure damage, were responders' only available source of water during the terrorist attacks in 2001.) This year, FDNY fielded two \$27 million vessels, mostly paid for by the U.S. Department of Homeland Security, that can operate in areas tainted by chemical, biological or nuclear agents. The crew, protected by an air-purification system and a network of air locks, can effectively respond from inside the vessel. — JOE PAPPALARDO

NAME Fireboat Three Forty-Three

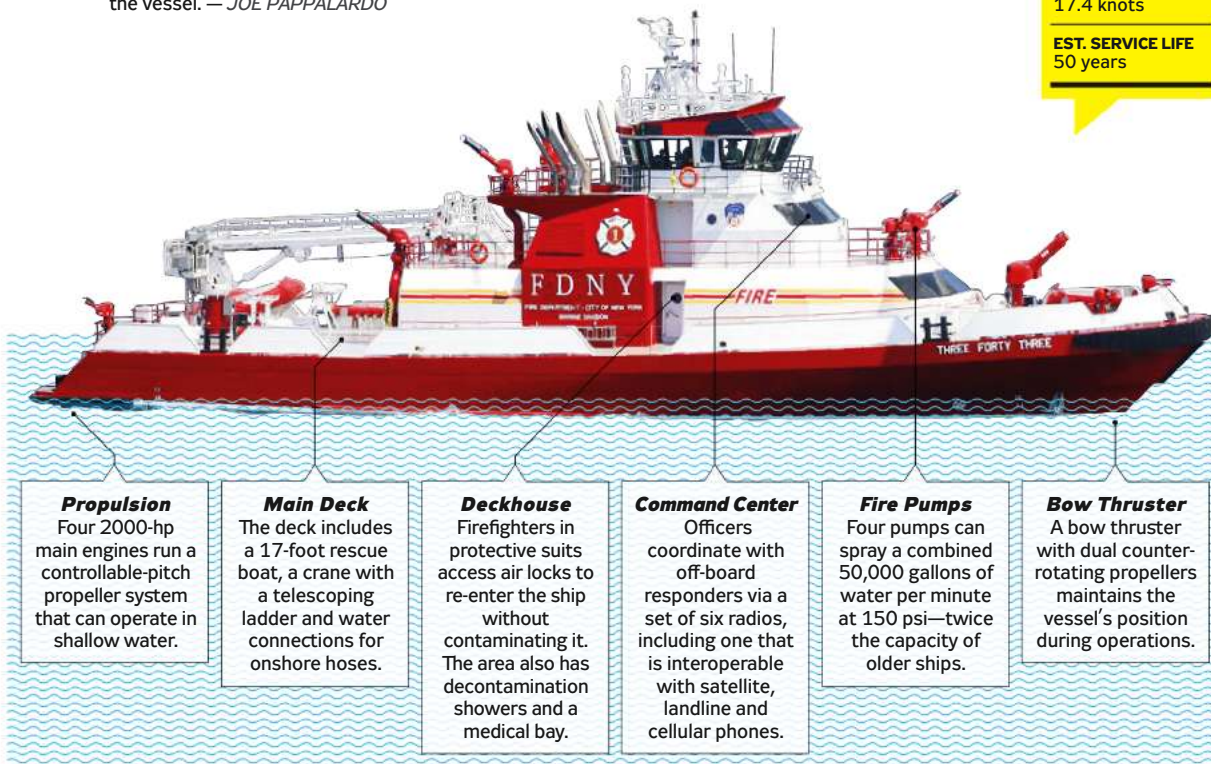
LENGTH 140 feet

WEIGHT 500 tons

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Four 2000-hp main engines run a 17-foot rescue boat, a crane with a telescoping ladder and water connections for onshore hoses.

Main Deck

Firefighters in protective suits access air locks to re-enter the ship without contaminating it. The area also has decontamination showers and a medical bay.

Deckhouse

Officers coordinate with off-board responders via a set of six radios, including one that is interoperable with satellite, landline and cellular phones.

Command Center

Four pumps can spray a combined 50,000 gallons of water per minute at 150 psi—twice the capacity of older ships.

Fire Pumps

A bow thruster with dual counter-rotating propellers maintains the vessel's position during operations.

Bow Thruster

PROGRESSIVE AUTOMOTIVE X PRIZE

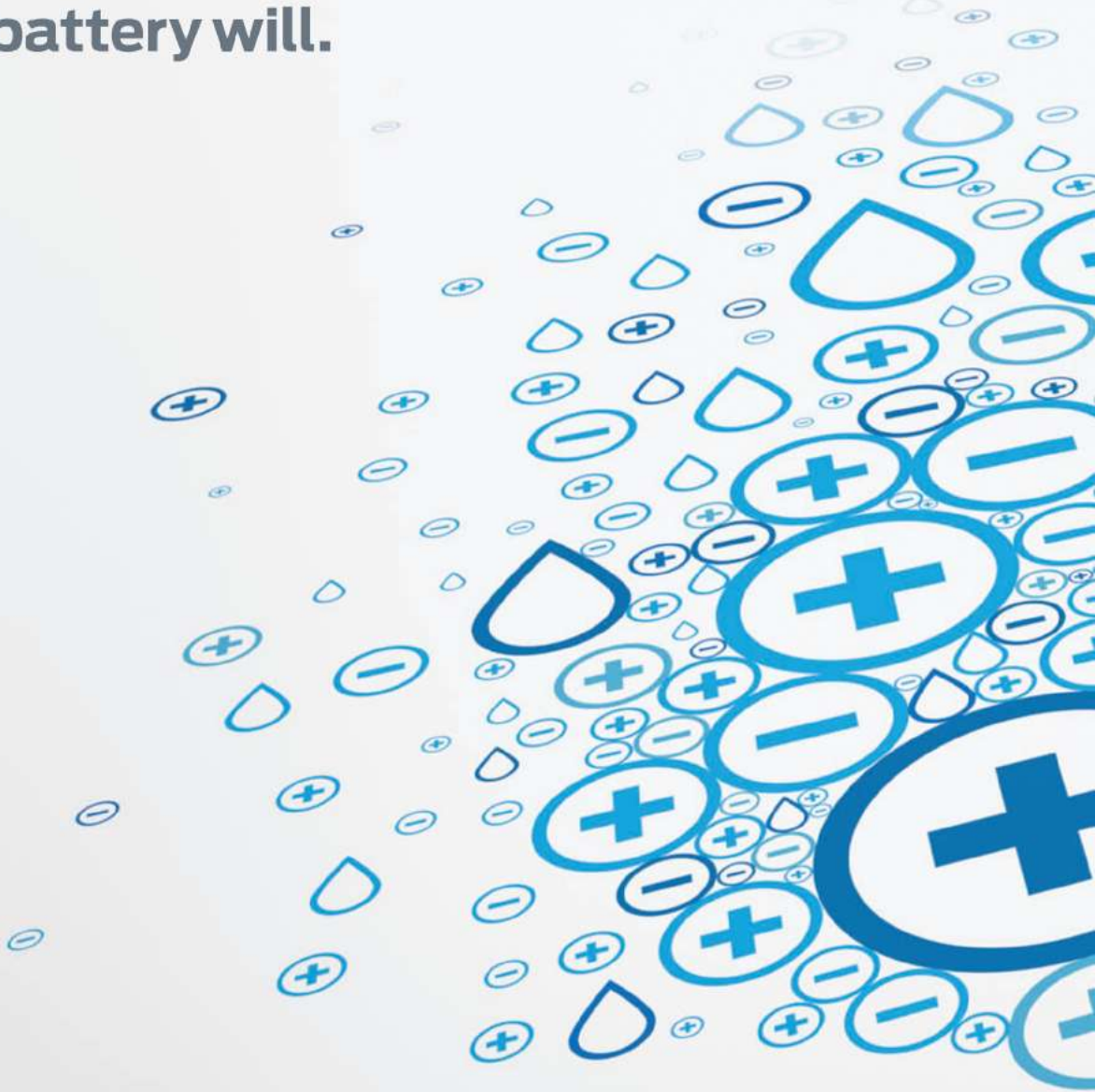
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• SURVEILLANCE SOCIETY

Eye Spy

M

anufacturers of eye scanners that identify people by their irises tout the technology as the 21st-century equivalent of fingerprint analysis. But scanners have been limited by their 6-inch range, as well as their sensitivity to movement and obstructions (such as stray lashes). Now Honeywell has built a Combined Face and Iris Recognition System (CFAIRS), which extends the range of iris scans to 16 feet.

CFAIRS shoots a high-resolution video image of the iris, then cross-references it with biometric databases. "The software flattens the iris, unfolding it into a two-dimensional speckle pattern that looks like a standard bar code," says Dan Sheflin, Honeywell's vice president of advanced technology for automation and control solutions. At an airport, the 2.5-foot-tall machine would pan and tilt 120 degrees to survey travelers filing into customs. "This looks through masks and glasses, scans at off-angles and captures people who are moving," Sheflin says. "You can be walking down a corridor and not even know it's being done."

Local and federal law enforcement agencies are creating standards for collecting biometric data. For now, the tool's utility is limited by the depth of the databases. — HARRY SAWYERS

• CHEATING DISASTER

The New Wave of Tsunami Prediction

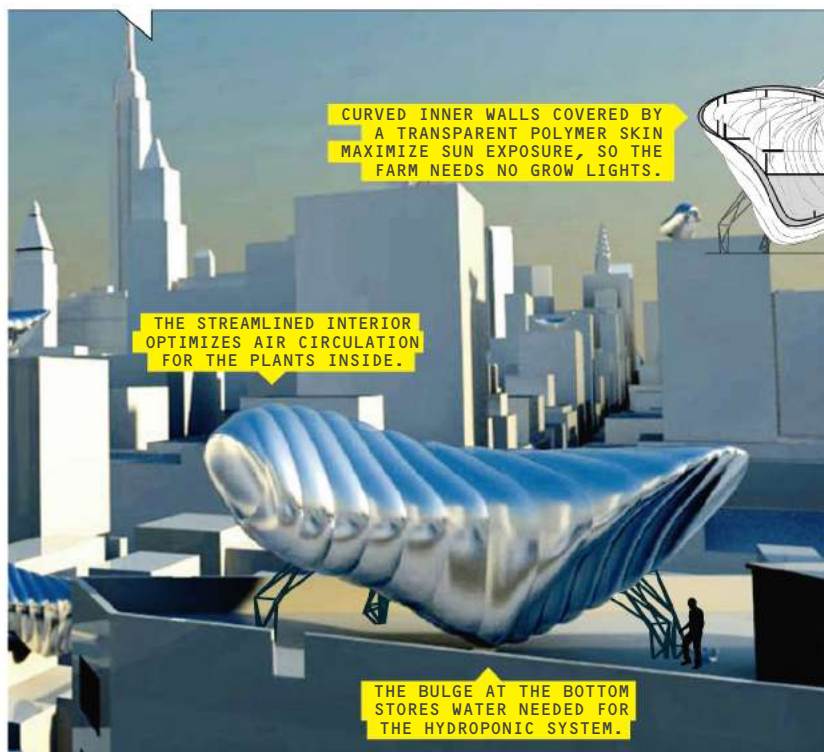
Researchers at NASA's Jet Propulsion Laboratory (JPL) have devised a new system that could predict the size of tsunami waves more quickly and accurately than current methods. The prototype got a real-life trial after

the 8.8 earthquake that struck Chile on Feb. 27. Using data from JPL's Global Differential GPS network—which measures ground movement, down to a few centimeters, from hundreds of regional and local GPS sites every second—scientists

estimated the amount of energy the undersea earthquake transferred to the ocean. Their model accurately predicted a moderate, 12-inch local tsunami with minimal effects in the Pacific; the result was confirmed using sea surface

height measurements from altimetry satellites. The existing tsunami-prediction system, which relies on 49 pressure sensors on the ocean floor and readings from sea-level gauges in ports, initially predicted a 6-foot wave and prompted

an evacuation of Hawaii's coastal areas. By delivering better, faster data, the new system could determine when it isn't necessary to flee to higher ground—or give people in the line of fire more time to get there. — ERIN MCCARTHY



Architectural Symbiosis

Natalie Jeremijenko, an engineer and environmental health professor at New York University, has developed a rooftop greenhouse that taps into the systems of the building below. Taking a cue from mutually supporting organisms in nature, Jeremijenko's design circulates oxygen from plants to the people inside and routes carbon dioxide to the plants. The greenhouse reuses the building's graywater—water that drains from bathroom sinks and drinking fountains—for irrigation. Some plants can also filter harmful fumes, such as formaldehyde from gas stoves and pressed wood products, that can accumulate in buildings. Many roofs can't take the weight of a greenhouse, so the rooftop structure uses steel stilts to distribute the extra pounds directly to the building's load-bearing walls. — ROBERT GOODIER

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• CRY FOR HELP

Hundreds Respond to Coast Guard Plea for Cleanup Tech

The sinking of the Deepwater Horizon oil rig in the Gulf of Mexico, and the subsequent gush of millions of gallons of petroleum, exposed a startling lack of tools for cleaning extensive spills. A month after the explosion on the BP-leased rig, the United States Coast Guard issued a call for new technologies that could help control the catastrophe.

The request detailed five “technology gap areas” related to oil-spill response, including methods to cap rogue wellheads, better skimming vessels, next-generation oil dispersants and fresh methods to detect and track spreading oil. The public has not held back: Within two weeks, the Coast Guard screened more than 420

submissions and had over 1000 yet to be evaluated. While Coast Guard officials would not release details about individual proposals, officials say that at least a handful of the ideas in the white papers will eventually be tested, although none has been fast-tracked to the gulf.

The Coast Guard’s outreach is a direct response to the lack of feedback BP offered for ideas that flooded the company after it solicited input from the public, says Coast Guard Lt. Cmdr. C.T. O’Neil. This experience, he says, unlike that one, will “provide a process by which people will know whether their idea can help in the current fight against the oil.”

Many firms, large and small, see an opportunity in the aftermath of the spill. “After the *Exxon Valdez*, the entire industry transitioned to double-hulled tankers,” says Glenn Rink, the founder of startup AbTech Industries, whose Smart Sponge polymer has now attracted interest from BP after years of rejection by energy firms. “The question is, what sweeping changes will come from this disaster?” — ERIK SOFGE



Skimming ships and relief well drilling crews respond to the spill.

• THE AFTERMATH

The Future of Spilled Oil

WHAT WILL HAPPEN TO THE MILLIONS OF GALLONS OF CRUDE POURING INTO THE GULF OF MEXICO? — AMBER ANGELLE AND CASSIE RODENBERG

1 WEEK Waves and wind mix oil with water to form a substance resembling chocolate mousse. Up to 40 percent of the surface oil evaporates, leaving behind more viscous compounds. Plumes of crude deep below the waterline are not broken down by sunlight, and they spread with undersea currents.

1 MONTH Pellet-size balls form on the surface as the oily mousse breaks up. Plankton absorb the oil/water mix and excrete tainted metabolites that settle to the bottom, damaging larval shrimp, crab and fish. On beaches, oil starves plants of nutrients and kills emerging shoots.

1 YEAR The surface oil has broken into hydrocarbon components that allow water and carbon dioxide to re-form. In the wetlands, small creatures that depend on dead plant material for nutrients have exhausted that supply. Numbers of crab and shrimp plummet.

5 YEARS Beaches and wetlands appear rehabilitated, but asphaltene—oil residue mixed with sediments—lingers beneath the sand and in pools in the bayous. Invasive plant species have taken root; the annual loss of wetlands accelerates from 25 square miles to up to 40 square miles.

10 YEARS Underwater oil plumes still persist. Bacteria feasting on the oil consume oxygen, creating a shortage that suffocates life. Squid, sperm whales and whale sharks decline. The plumes may eventually drift into the Atlantic, where they threaten coral reefs.

20 YEARS Caches of oil, trapped in underground pockets, linger on shore. These do little harm unless unearthed by storms, animal activity or man-made disruptions. Aboveground, wildlife has returned but species’ life cycles have been altered.

• 21ST-CENTURY DOGFIGHTS **New Eyes for an Old Airplane**



The Air Force this year deployed F-15C Golden Eagle warplanes with new **active electronically scanned arrays (AESA)** that can track more targets with precision and can guide several missiles at once. AESA's digital beams, which replace radar that turns mechanically, are agile enough to spot cruise missiles and enable the F-15C to shoot them down with air-to-air missiles. (The Air Force is now testing a system that enables the F-15Cs, built in the late 1970s, to shoot down ballistic missiles as well.) The radar upgrade will also change dogfighting strategies. Although engineers designed the targeting radars of the F-22 Raptor stealth airplane to be hard to detect, there is always a chance other crafts' sensors could spot the Raptor's electromagnetic emissions. To guarantee a Raptor can shoot and remain unseen, an F-15C can do the targeting for it, using AESA to track an opposing airplane from outside the enemy's radar range while the Raptor closes in for the kill. The F-15C then beams the targeting data to the Raptor, which takes the shot with a heat-seeking missile. —JOE PAPPALARDO

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Upgrade

Turning the Tables

In concept, a portable turntable may seem fairly ridiculous. But for vinyl devotees looking to bring their LPs on the road or simply acquire a retro desktop centerpiece, the

Crosley Revolution turntable (\$150) may prove irresistible. It runs on batteries, pumps out music through a headphone jack or built-in speakers and is just slightly bigger than the record it's playing. A USB connection makes the Revolution a convenient tool for digitizing a vinyl collection. — SETH PORGES

Are They Worth It?

→ Sure, \$1150 is an insane amount of money to spend on a pair of earbuds. But the world of audiophile tech is filled with such insanities. So what do JH Audio's custom-molded, eight-driver **JH16 Pro in-ear headphones** sound like? The custom molding almost completely blocks out ambient noise, letting you focus on the music at much lower volumes (there's no cranking the dial to drown out trains and planes), and the audio fidelity over almost the entire frequency range is astonishing. So are they 38 times better than a \$30 set of iPhone headphones? Maybe not, but consumers can still get all the advantages of custom molding with JH Audio's relatively cheaper \$400 dual-driver JH5 Pro, which may actually be 13.3 times as good as stock iPhone earbuds.

Y

Eye in the Sky →

You don't need to be the Pentagon to own a video camera crammed into a remote-control aircraft. Like a pint-size Predator UAV, the foam **Air Hogs R/C Hawk Eye (\$65)** flies around the house snapping up still shots and videos. A few hundred photos or up to 5 minutes of footage can be stored before being off-loaded to a computer.



Small Game → We've always been skeptical of so-called edutainment games for kids—which tend to pass off a shooting game with some shoehorned math or spelling problems as a learning product. But we're impressed with the **LeapFrog Leapster Explorer (\$60)**,

a portable gaming system that handles some of the best-made children's games around, along with the company's curated online community. And no more lending out your Kindle—the Explorer is designed to double as a kid-friendly e-book reader.



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ABUSIVE LAB TEST

Ruggedized Cameras

The allure of a ruggedized camera is obvious—after all, who hasn't lost a point-and-shoot to a toilet or a tumble? To see how well these models hold up, we put three of them—including one Flip-style mini-camcorder—through a battery of tests. **BY SETH PORGES**



Casio EX-G1 (\$230)

Kodak PlaySport (\$150)

Olympus Stylus Tough-8010 (\$400)



Grime Test

We sealed the cameras in a container full of dirt, sand and dust for three days, regularly shaking the package.

CASIO: The bits of dirt that got into the camera's doors and crevices were nothing a Q-tip couldn't handle.

KODAK: The Kodak saw the least dirt seep in, if only because its monolithic frame had the fewest nooks and crannies.

OLYMPUS: A few pieces of sand worked their way into various hinges and crevices, and some particles seemed to interfere with the flip-up lens cover.

WINNER: Kodak.

Water Test

We submerged the powered-on cameras in a tank of water for three days, occasionally taking photos.

CASIO: What's a bit of water? The camera proved to be truly waterproof.

KODAK: The camera emerged from the three-day swim completely unharmed.

OLYMPUS: Yep—survived it.

WINNER: Three-way tie.

Drop & Smash Test

To test for drop-proofness, we released the cameras from incrementally increasing heights. We then laid them on concrete and smashed them with a metal baseball bat until they broke.

CASIO: Casio claims its camera can survive 7-foot drops. Ours breezed through a 10-foot ceiling-height fall unscathed. After one hard bat smash, the screen was a cracked mess, but the camera still worked. One more hit and it was over.

KODAK: This camera's claim to resist 2.5-foot drops was far too modest—the PlaySport took our 10-foot fall like a champ. The baseball bat was another story: One hit broke a hinge and cracked the screen beyond use.

OLYMPUS: The claim: 6.6-foot-drop survival. The reality: A 10-foot fall was no problem. But one hard hit from a baseball bat left us with a dead camera.

WINNER: Casio.

BOTTOM LINE

All three cameras proved exceptional at withstanding grime, water and drops. And while the Casio's ability to withstand a hard hit from a bat was particularly impressive, all of them can handle most common calamities.

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Sniper Sniper

→ Two years ago, two snipers from the Army Marksmanship Unit approached Leatherman with an idea: Combine a standard pliers and knife with specialized tools for maintaining M-16 and AR-15 rifles. The company responded with the **Leatherman MUT Military Utility Tool (\$170)**, which contains a bolt-override tool to clear jams, a bronze scraper to remove carbon deposits and a 1/8-inch steel punch for disassembly. The tool has already been tested by Marines in Iraq and Afghanistan.

CLEAR JAMS, DISASSEMBLE M-16S, STAB INSURGENTS—THE MUT IS A GO-TO TOOL FOR WEAPON MAINTENANCE IN THE FIELD.



A Free-er Phone

It's difficult to call the modern mobile phone world a free market. After all, just about any phone worth its salt is tied to a particular carrier for months—or even years (iPhone, we're looking at you)—after its launch, forcing many would-be buyers to either forgo a purchase or suffer a hefty fee for ditching their mobile contract early. The **Samsung Galaxy S (price not set)** line of phones is an exception—over the course of the summer, the Android-powered handset is being released on all four major mobile carriers, with only subtle variations between the models.

Plunge Taker

→ The fact that it can make a plunge cut—that is, a cut beginning in the middle of a workpiece, used when routing a groove or carving a mortise—signals that the **Dremel Trio (\$100)** goes beyond the typical lightweight hobbyist's rotary tool. Using proprietary 3/16-inch shank bits, the 12-volt lithium-ion tool cuts laminate flooring or galvanized

ductwork, sands molding edges and routs holes in drywall for electrical boxes. The bit spins at up to 20,000 rpm; the head articulates in a 90-degree elbow pivot, and, on a dusty day in our test labs, we successfully Trio-ed every material listed above.





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Photo Courtesy of Andrea Paquette

UPGRADE

Fourth-Coming

→ Internet leaks may have siphoned off some of the surprise, but the

Apple iPhone 4 (\$200 to \$300)

is still the iconic device's most dramatic upgrade since the original launched four years ago.

New to the features list:

a front-facing camera for video calls, the ability to shoot and edit 720p hi-def video, an LED flash-

augmented 5-megapixel camera and a ridiculously high-resolution 960 x 400

pixel screen (previous iPhone screens were 480 x 320). Still,

with other carriers already releasing 4G phones, it's harder than ever to ignore the

weaknesses in AT&T's troubled 3G network.



Controller-Free Gaming

→ We've been following this gesture-command system for the Xbox 360 since it was announced as Project Natal more than a year ago.

But now that the **Microsoft Kinect (price not set)** is here, we still can't help but feel a bit giddy. The system uses depth-perceiving cameras to fulfill the dreams of full-body

video-game immersion we've been harboring since we first saw *Tron*. (The player controls the game by waving his limbs through the air.) When Microsoft builds this tech into Windows—and, believe us, it will—well, that could be the day we ditch our computer mouse for good.



STANDARD



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✓Yes



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New Cars



Attention Seeker

The all-new five-passenger Juke joins Nissan's lineup as the Rogue's rambunctious little brother. It trades the bigger crossover's spacious interior for

a taut, rally-inspired body with sporty intentions. A new turbocharged 1.6-liter four-cylinder fueled by direct injection sends over 180 hp to either the front or all four wheels. Befitting this hatchback's mission, a six-speed manual is an alternative to the standard CVT. Driving a prototype near L.A., we found the Juke eagerly dove into corners with little body roll and hung on like a hot hatchback. The fun continues inside with attractive glossy red panels and a g meter that measures lateral and longitudinal acceleration. — *BASEM WASEF*



RISK TAKER

Coupes are typically the more outwardly attractive versions of practical four-door sedans. So looks matter. On a recent drive of the first CTS Coupe (\$38,990), opinions varied on the success of the car's unique body. Most loved it, but some thought it looked too much like a hatchback—that's the kind of split reaction that often follows good but risky design. Cadillac, it seems, is keen to make some waves. Appearance aside, the Coupe drove as brilliantly as the sedan, with the same 304-hp V6 and planted chassis. The interior is handsome. All-wheel-drive is available, and later this year a hot-rod V version debuts.

— BEN STEWART

TRACK STEED

The Hog Pen is a notoriously tricky downhill right-hander at Virginia International Raceway and an ideal proving ground for the improved Ford Shelby GT500. Lighter by 184 pounds—thanks in part to an aluminum engine block—and shoed with a revised suspension and grippier new Goodyears, the fastest Mustang charged into

the Pen and blasted out like a greased hog. With 550 hp—10 more than last year—the supercharged V8 and six-speed transmission then made quick work of the ensuing straightaway. The \$53,645 convertible version is likewise improved with extra body stiffening, but for track work, stick to the stiffer, less expensive \$48,645 hardtop.

— LARRY WEBSTER

Mini Fighter

If fuel prices someday zoom skyward, Audi will be ready with the new not-yet-sold-in-the-U.S. A1. Sized about equal to the Mini, the A1 shares its platform with the VW Polo and offers a wide range of fuel-sipping engines, including a diesel. The sportiest version employs a turbo 1.4-liter motor that has plenty of spunk yet still returns over 40 mpg. A miniaturized version of the A8's interior proves that small cars don't have to feel cheap—there's even a decent-size cargo area. Audi says that a U.S. version is at least a few years away—a pity, since the A1's upscale duds and frugal energy use would suit many urban drivers. — ANDREW ENGLISH

2011
Cadillac
CTS Coupe



2011
Ford Mustang
GT500



2011
Audi A1

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2011
Mazda2



ZOOM BOX

Mazda developed its subcompact car for the European market and took World Car of the Year honors in 2008. This year, the third-generation Mazda2 legitimizes the title by finally entering the U.S. market. The smiley-faced little five-door hatchback's 1.5-liter four-cylinder engine routes 100 hp to

its front wheels through a four-speed automatic or a five-speed manual, for 33 to 35 mpg on the highway. Trouble is, Ford's Fiesta gets up to 40 mpg while pumping 120 hp through a six-speed dual-clutch gearbox. That sort of takes the wind out of Mazda's "zoom-zoom" ads. Still, despite the

inevitable comparisons to its corporate cousin, the Mazda2 has a lot to offer for its \$14,730 base price, including ABS, dynamic stability control and side-curtain airbags. And it's quiet inside. Maybe *too* quiet.

— KEVIN A. WILSON

5

2010
Honda VFR



Dual Shifter

Honda's new VFR 1200F offers an automated dual-clutch gearbox that either shifts on its own or by a driver-operated handlebar switch. It's coupled to a compact 170-hp 1.2-liter V4. Upshifts are nearly seamless, and the computer executes perfect, rev-matched downshifts. With antilock brakes, the VFR is one of the easiest bikes to seriously blur the scenery. Plus, there's a concerted mechanical sense to the bike, lending excellent levels of refinement. The only downside is the stiff \$17,499 price tag. — BARRY WINFIELD

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1



2011
Porsche Cayenne
S Hybrid

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↑ Cayenne Peppier

Next year, Porsche joins the eco-conscious crowd with the Cayenne S Hybrid. With a nickel-metal-hydride battery pack and a 47-hp electric motor assisting a 3.0-liter blown V6 engine, there's 333 hp and more torque—428 lb-ft—than the V8 model. Yet this SUV uses less fuel than the V8, with an estimated mid-20s combined EPA figure. Thanks to a clutch between the engine and EV motor, this hybrid can operate in EV-only mode up to 40 mph and when cruising. — JAMES TATE

2



2011
Chevy
Silverado HD

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↑

HEAVY HITTERS

While the 2011 Chevrolet Silverado Heavy Duty pickup shares most sheet metal with the 1500, there's a whole new truck underneath. The fully boxed frame is five times stiffer, torsionally, than the previous model, which improves ride quality and hauling capability. The 17,000-pound

towing capacity (21,700 with a fifth-wheel rig) is best-in-class. The revamped 6.6-liter Duramax V8 diesel develops 397 hp and a stunning 765 lb-ft of torque. And it's quieter. A base rear-drive Silverado 2500HD starts under \$29,000, but a loaded dually diesel 3500HD pushes \$60,000.

— KEVIN A. WILSON

HYUNDAI'S FIRST HYBRID

The Sonata Hybrid, on sale late this year as a 2011 model, eschews the torque converter in its six-speed automatic in favor of an electronically controlled clutch and 30-kilowatt motor. The new lithium-polymer battery pack is 35 percent lighter,

40 percent smaller and 10 percent more efficient than the nickel-metal-hydride batteries in the Ford and Toyota hybrids (which run two motors). The Sonata's single motor and 2.4-liter four-cylinder unit produce 209 hp and 195 lb-ft of torque. Hyundai claims the car will achieve up to

39 mpg on the highway and get to 62 mph in 9.2 seconds. It can even drive on electric power alone for up to 10 miles. After a quick spin, we can report that the clutch does a credible job of managing torque transfers, and it's fun to drive. Pricing will likely start at around \$26,000.

— JOHN STEWART

↓

3



2011
Hyundai
Sonata Hybrid

++

**FIRST
ALSO HAS
A FRONT
CAMERA.**

2011
Saab 9-5



Reborn From Jets

"The 9-5 demonstrates we're alive and kicking," said Victor Muller, Saab's new CEO, after GM unloaded the Swedish brand. Developed on GM's Epsilon II platform—which underpins the Buick LaCrosse—the Saab 9-5 Aero XWD (\$49,165) is Saab's first new product in years. Unique tuning for the GM turbo 2.8-liter V6 produces 300 hp and 295 lb-ft, which gets the Aero XWD to 62 mph in 6.9 seconds. While driving the car at speed, we found that the 9-5 exhibits very little wind noise, bumps are nicely absorbed, the engine is quiet, corners don't slow you down and downshifts are virtually undetectable. In other words, it's alive and kicking. — WES SILER

COST CUTTER

For just \$2500, the Tata Nano has both air conditioning and a radio. These are unexpected luxuries in a car that's meant to put India's—and the rest of the developing world's—middle class on wheels. Befitting markets where the average wage is less

than 10 bucks a day, the Nano is a study in cost containment. A decent amount of interior room has been carved from a car that's about the same size as a Mini. But pile in four people, as we did during a recent test drive in Germany, and the tiny, rear-mounted 33-hp two-cylinder feels

overtaxed. Directional stability registers on the negative scale, but compared with the Nano's competition—rickshaws, bicycles covered by tarps—it's like a Cadillac. Tata says an EV version heads to Europe next year. Someday, a modified model may hit the U.S. — J.T.



2011
Tata Nano CX



Carhacked!

As cars head toward full electronic control, are they vulnerable to cyber attack?

BY GLENN DERENE



Last November, on a closed airport runway north of Seattle, researchers from the University of Washington and the University of California–San Diego performed an ominous experiment on a late-model sedan. With a chase car driving on a parallel runway, they sped the test vehicle up to 40 mph, then turned off the brakes—via Wi-Fi. “Even though we knew what was going to happen, it’s a very unsettling feeling to

have a loss of control,” says Alexei Czeskis, the researcher who was driving the test car. “You get full resistance from the brake pedal, but no matter how hard you press, nothing happens.”

The test sedan had a laptop hooked into its OBD II diagnostic port. On the computer was a custom-coded application, called CarShark, which analyzes and rewrites automobile software. That laptop was linked via a wireless connection to

another laptop in the chase car. In addition to temporarily rendering the test car brakeless, the setup also allowed the team to remotely turn off the vehicle’s headlights and brake lights, turn on the wipers, honk the horn, pop the trunk, rev the engine, disable specific cylinders, engage individual brakes and completely shut down the vehicle while in motion.

Although the make and model of the test sedan are easily identifiable from

photos in the team’s published report, the researchers chose not to identify the car, because in their view the experiment could have been done on any number of late-model vehicles.

Reports like this could easily be sensationalized to make it appear as if our cars have a potentially dangerous electronic vulnerability. But computer-security pros have seen no evidence of sophisticated criminal networks of car hackers. Besides, most drivers would notice if a laptop was jacked into the underside of their dashboards.

But the threat is not purely theoretical. In March, 20-year-old Omar Ramos-Lopez, a disgruntled former employee of Texas Auto Center in Austin, remotely disabled more than 100 cars owned by customers by hijacking the dealership’s vehicle-immobilization system. The controversial system is a product of Pay Technologies, which produces remotely addressable black boxes that dealers can install under the dashboards of drivers with high-risk loans. If a customer stops making car payments, the GPS-enabled boxes can provide the location of the vehicle, shut it down and honk the horn to make repossession easier.

Ramos-Lopez’s simple hijacking of the Pay Technologies system was hardly an involved electronic breach, but it highlights how much damage a dedicated attacker or

disgruntled insider can do in a vehicle in which almost every mechanical system is computer-controlled. The threat of digital vehicle takeover seems to have come out of nowhere, but the technological shifts that have made it possible have been advancing in fits and starts for decades. Onboard vehicle computers date back to the late 1960s and have evolved into complex networks of electronic control units (ECUs) that are highly intercon-

nected and often interdependent.

For years, aftermarket performance tuners have been reverse engineering ECUs to tweak fuel mixing, ignition and valve timing, among other variables. "It's not easy, for sure," says Mike Wesley, president of the tuning shop DiabloSport. "In a typical engine ECU there may be 5000 things we can change that affect how the engine performs." Tuners reprogram to improve performance, but according to Wesley, any changes in code must be done carefully or unintended consequences can arise.

"Powertrain controls are becoming very complex and interrelated," he says. "If you change certain things in the engine ECU, for example, this can have an effect on how the throttle body reacts. It may open unexpectedly."

So either by accident or by malevolent intent, a few damaged data packets can have a disastrous effect. The potential for mayhem has recently been amplified thanks to the increase of in-vehicle wireless systems. The most widespread of these systems is OnStar, a subscription cellular service that interfaces with equipment on most GM vehicles. OnStar has access to vehicle diagnostic information as well as many component-control systems. OnStar advertises a feature called Stolen Vehicle Assistance, which can, in cooperation with law enforcement, remotely locate a vehicle, then slow it to a stop.

OnStar, however, is hardly the only system using wireless technology. Ford's newest Sync system can turn its vehicles into Wi-Fi hotspots, and both GM and Ford are encouraging third-party software developers to design apps that integrate smartphone software (such as Pandora and Google Maps) with vehicle-telematics systems.

According to OnStar representative Jim Kobus, the company's service has never been compromised, and there are multiple security protocols built into the OnStar system. The University of Washington and UC San Diego researchers did not break through any embedded wireless systems, but according to team leader Professor Yoshi Kohno, compromising such a system isn't out of the realm of possibility.

Computer-security pros agree that there is little reason for drivers to worry



In a recent experiment, researchers controlled a car via a laptop connected to the OBD II port and sent a message (below) to the dash.



today, since the chances of random hackers killing your brakes on the interstate are slim to none. Yet now is the time, they say, for the auto industry to start concentrating on cyber security. "We should learn from infamous examples in the general computer industry of what not to do," says Tiffany Rad, a

lawyer, hacker and lead evangelist for the OpenOtto project, which aims to promote open-source code for automobile ECUs. "If cars are going to communicate with each other or be able to access the Internet, information-security professionals should be working with the mechanical and electrical engineers in designing the software and hardware for cars from the first line of code to the last."

PM

FIRST CAPTURES THE ACTION AND REACTION.



Auto Exotica

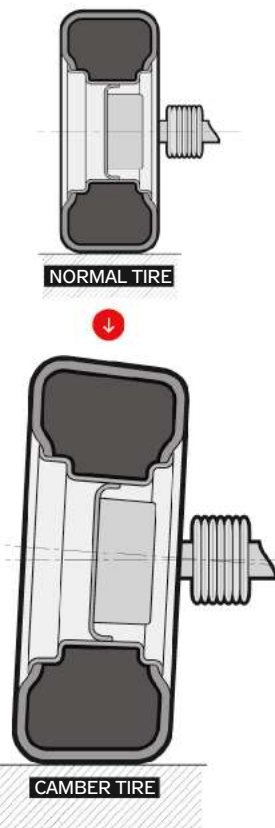
While the following collection of automotive components may seem unusual now, in a few short years, these incremental advances could represent the norm.

EMERGENCY STEER ASSIST

A step in the apparent march toward autonomous cars is a system called Emergency Steer Assist (ESA). Developed by Continental, **ESA helps a driver avoid a possible impact by varying the power-steering-assist level.** Here's how it works: When ESA determines (via radar sensors) that a crash is imminent and you need to swerve to avoid an impact, it alters the steering effort to make it hard to turn the wheel right, for example, but easy to turn it left. The system then works with stability control to further manage the aftereffects of the swerve. As yet, no carmaker has implemented ESA, but that, too, could change course quickly. — J.T.

OPTIMA SPORTS CAMBER TIRE

Tire technology typically evolves slowly, which makes the Camber Tire from Optima Sports noteworthy. **The Camber Tire's inner sidewall is shorter than the outboard, which tilts the top of the tire inward, toward the car.** This increases the tire's negative camber, an alignment specification that car racers use to enhance grip while cornering. On the highway, however, too much negative camber puts only the inner portion of the tread in contact with the road, resulting in uneven wear and dicey straight-line stability. The Camber Tire maintains its tilt while keeping the tread flat on the tarmac. The company hopes to have production versions in a couple of years. — L.W.



CONTINENTAL INTELLIGENT TIRE SYSTEM

Continental's latest tire sensor goes way beyond simply gauging pressure. It also measures the tire's temperature, load and acceleration forces—information that can be put to a variety of uses. For example, based on the data, the car's computer can tell the driver when the tires are worn out or suggest a higher tire pressure to compensate for extreme cornering behavior or high loads. And why not remind the driver that it's time to switch to snow tires? Plus, these new sensors are approximately the size of a bottle cap and are easy to install because they affix to the tire, not to the valve stem, like the units in use today. The technology will appear on high-end luxury cars first, probably by 2013, and migrate to mainstream models as the cost comes down.

— JAMES TATE



INFINITI ECO PEDAL

Pedal Pusher

We've long known that driving behavior has a significant impact on fuel economy, which is why Infiniti's new Eco Pedal makes so much sense. When switched on with a console-mounted dial, **this pedal gently resists quick or long dabs of the throttle pedal, encouraging more prudent acceleration.** The driver can easily override the feedback, but it's a constant and effective reminder of good hypermiling techniques, and as a bonus it helps erratic drivers smooth their driving style. Infiniti says that the pedal increases real-world fuel economy by between 5 and 10 percent. Currently only on the new M sedans; expect more Nissan products to get this feature in the near future. — LARRY WEBSTER

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The American-made Ace motorcycle set speed records that remained unbroken for years.

WHEN AMERICA ACED MOTORCYCLES

> BY JAY LENO

> PHOTOGRAPH BY JOHN LAMM

W

WHEN I RIDE MY RESTORED 1924 ACE MOTORCYCLE

to places where motorcyclists go, like the Rock Store, a tavern on Mulholland Highway near Malibu, it always gets attention. That's probably because it still looks like a superbike, like something special. Other riders give you the thumbs-up. Even non-motorcyclists say, "Wow. What is that?" But it's a tricky machine to master because other than the twist-grip throttle, the controls are completely foreign.

The Ace has twin external-contracting rear brakes, so it's got a brake pedal at each footboard.

Two long hand levers sprout upward from the left floorboard—one works the shifter, the other the clutch, which also operates with a foot pedal. You can use either one.

In some ways, riding the Ace is more like driving a car. To start, you disengage the clutch with the foot pedal, slide the shift lever with your hand into first gear, put your hand back on the handlebars and then slowly release the clutch to pull away. You have to remove your hand from the bars for every shift. As you're rolling toward a stop sign, you try and find neutral and put the clutch in. In a panic situation, you use the hand clutch so both feet are free to operate the brakes, which is tricky because

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JAY LENO'S GARAGE/// THE ACE MOTORCYCLE

the left-side brake is at the rear of the floorboard, but the other one is at the front. As I was learning to ride the Ace, a number of times I sailed right through red lights. "Scuse me! Thank you! 'Scuse meee!" I guess that's the downside, but having to think so much connects you to the machine.

At least the Ace starts on the first kick and settles into a nice idle, thanks to its high-quality magneto ignition that always sparks. And there's plenty of torque, so you can slow *waaaaayyyy* down in top gear, roll on the throttle and chug away. These days, performance is about zero to 60, but back in the day, whether it was a 16-cylinder Cadillac or a big motorcycle, it was about how slow you could go in third and then accelerate smoothly. The Ace is a wonderfully relaxed and refined bike because it's got a big 78-cubic-inch four-cylinder. This bike can go 100 mph, but good luck stopping from that speed.

We have William G. Henderson to thank for both the company that bore his name and the Ace. He founded the American Henderson Motorcycle Company in Detroit in 1911 and offered a 7-hp cycle with an inline four-cylinder. Ignaz Schwinn—yes, *that* Schwinn—bought the business in 1917. Two years later Henderson exited the company because his new backers insisted on bigger, heavier bikes that he despised. So he simply set up another company—Ace Motor Corporation—in Philadelphia to design bikes the way he wanted.

His new bikes were superior to his earlier effort—relatively light, fast and reliable. Compared to the small and finicky European motorcycles of that time, the Ace had a big 1300-cc engine, with an inlet-over-exhaust valvetrain, a giant magneto and a big, old-fashioned generator. It was made to cover great distances. In 1922 Cannonball Baker rode an Ace 3332 miles from Los Angeles to New York in just six days, 22 hours and 52 minutes! He averaged 48 mpg. No wonder the cops used Aces.

After Henderson was killed in a motorcycle accident in late 1922, his successor, Arthur O. Lemon, refined the Ace even more, and it became one of the world's finest motorcycles. There were a few foreign motorcycles with four cylinders in that era, like the FN from Belgium, and England's Ariel Square Four and the Brough Superior. But the American fours were superior in power and reliability, and the Ace continued to set records.

In 1923, riding a lightweight Ace, Red Wolverton made back-to-back timed runs on a section of Pennsylvania highway, averaging 129 mph. Then they bolted on a sidecar, and he posted a sidecar record of 106 mph. The Ace Motor Corporation was so confident, they offered a \$10,000 cash prize for anyone who could beat that speed. There were no takers.

better oil circulation.

Modern "fixes on fixes" often do more harm than good. Some people want to convert an antique bike from 6 volts to 12 volts. But if you just restore it to the way its designers intended, you'll have a fast, reliable motorcycle. That's what we did. And that's why the bike starts on the first or second kick.

When I was 16, I went into a Triumph dealership and looked at a new Bonneville. There was a sticker on the tank that read, "For the Expert Rider." I thought, "That's me; I just got my license." The Bonnie was considered one of the fastest bikes you could buy, but it still couldn't do what the Ace did in terms of top speed back in 1923.

Sadly, over the years, the Ace heritage has fallen by the wayside. Young

This bike can go 100 mph, but good luck stopping from that speed.

The reason you don't see many Ace motorcycles is that they were all ridden hard and poorly maintained. They were beaten to death. It's a well-engineered but complicated motorcycle. The previous owners of my Ace made modification after modification. It had been "professionally restored" by someone who didn't know what he was doing. It would run, but after 2 or 3 miles the engine would heat up and "soft-seize." Originally, there were oil dippers on the connecting rods, designed to splash oil where it was needed. These dippers had all been shortened, supposedly because they had been hitting the insides of the crankcase. We lengthened and drilled them for

guys like European bikes because the only American bike they've ever heard of is the Harley. When you tell them about the Ace, and the Henderson, and the early Indian wins at the Isle of Man TT in 1911, they're stunned. We led the world. It's inspiring to me to read about men like Henderson and Lemon who, cost be damned, decided to build the best bike they could.

It reminds me of the Mercer Raceabout, the best sports car of its day and one of the greatest cars of all time. There's nothing on the Mercer that wasn't needed. It wasn't about style; it was about form following function. That's why it's a classic.

Just like the Ace.

PM



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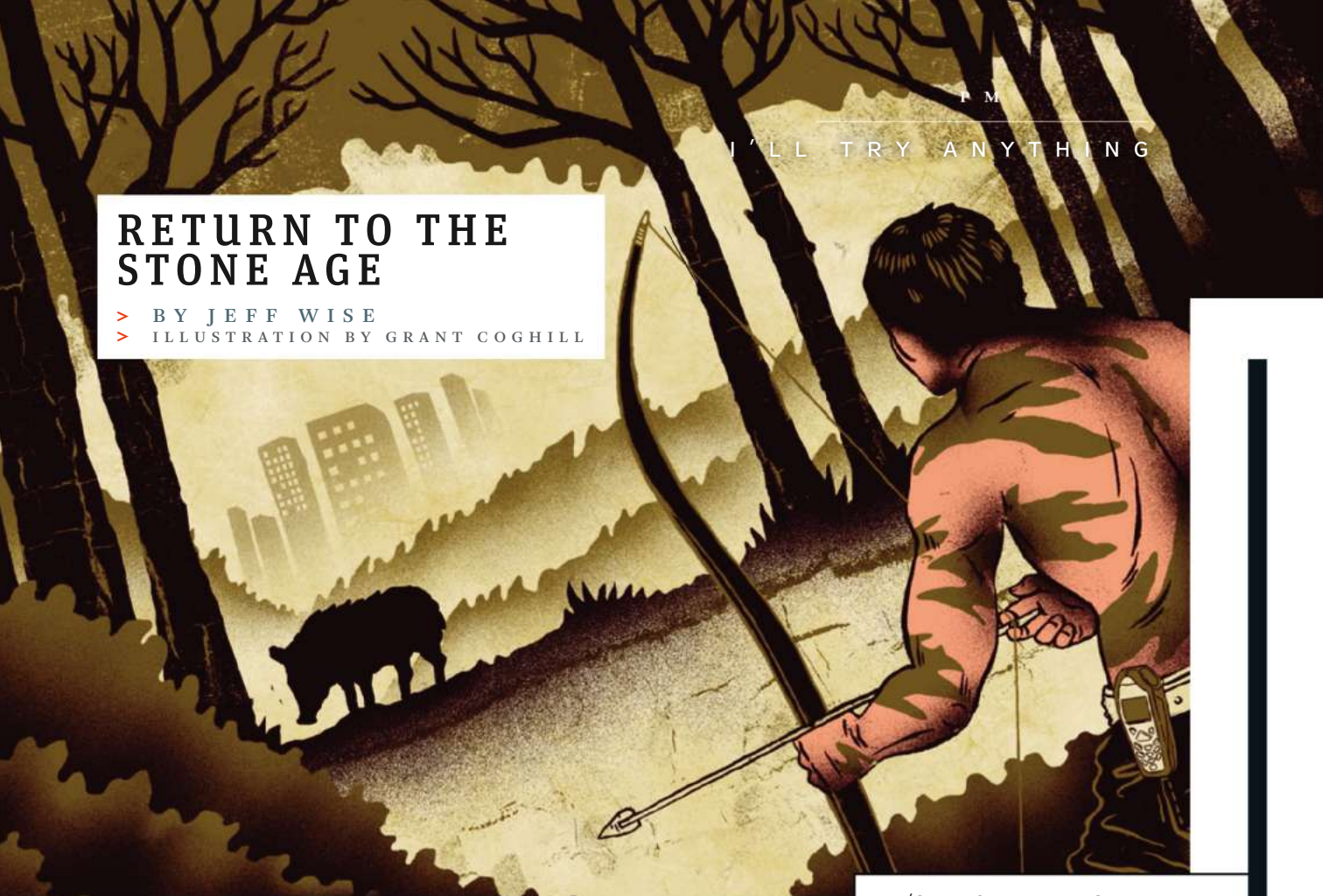
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RETURN TO THE STONE AGE

> BY JEFF WISE
> ILLUSTRATION BY GRANT COGHILL

P M
I'LL TRY ANYTHING



PM'S REPORTER FINDS
THAT PRIMITIVE HUNTERS
NEEDED MORE THAN SKILL
TO BAG A MEAL.

A

MIST HANGS IN THE FORESTED VALLEY AS dawn approaches. Somewhere a lone bird calls. I sit on my haunches, listening. There are wild pigs in this forest, somewhere. Daylight might draw them up through this thicket to the ridgeline behind me. My quarry is a razor-tusked beast that can weigh several hundred pounds and is famous for exacting violent revenge on hunters. I check my weapons—a wooden bow and a single stone-tipped arrow—and find myself wondering: Is this really a great idea?

Ahead of me, a rustling in the bushes. I sink lower. There's the sound again, the *scritch-scritch* of an animal rooting through leaf litter. Whatever it is, it's close, no more than 4 or 5 yards ahead through the undergrowth. The noise moves closer. Is it a pig? If so, I'll have just one chance to inflict a mortal wound.

The rustling grows closer, then stops. I catch my breath. The Santa Cruz Mountains are home to more than pigs. There are mountain lions, too. Judging from the racket, this thing is big. I'm not packing a gun or even a knife. My God, I think. What have I gotten myself into?

The *scritch-scritch* moves closer still. I strain my eyes trying to peer into the undergrowth. At last, a flicker of motion, and it emerges. It's...

A robin.

I've survived this close call, but my struggle is far from over. I'm in Northern California to participate in a ritual that many assume has been extinct since the frontier days. My guide, 30-year-old Cliff Hodges, is one of a few dozen people in the country who hunt pig, bear and other big game with weapons made only of natural materials—wood, flint and feathers.

Hodges grew up near Silicon Valley and earned a master's degree in electrical engineering from MIT, but then realized that what really spoke to him was the great outdoors. He turned his back on high tech and started a wilderness-skills school, Adventure Out. Primitive toolmaking, he says, is a way to feel closer to the natural world. "We rarely get to experience our food as living things," he says. "Only when you see an animal

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I'LL TRY ANYTHING/// STONE AGE HUNTING

moving in its environment can you understand its sacrifice.”

Primitive-skills hunting is incredibly difficult. Each bow requires weeks of work, as a rough stave is gradually whittled and sculpted to a sinewy, springy arc. Even so, the end product has a lethal range of just about 15 yards. To take out a pig, a hunter has to get close and set up a shot from just the right angle, so the arrow passes

The finished piece is lightweight and surprisingly sharp. This is the original human technology; our ancestors began using sharpened rocks 2 million years ago. With time, techniques became more sophisticated, so that eventually distinct cultures could be identified by the unique patterns of their stonework. Archaeologists can tell how modern humans moved into Europe around 30,000 years ago by the way dainty Aurignacian blades replaced the more bludgeon-like Mousterian hand axes of the Neanderthals. Flint knapping is an art, but it

plausibly lethal-looking.

The next morning, we drive up winding roads in the predawn darkness to a 200-acre parcel of private land. Hodges has scouted it only once, which puts us at a disadvantage: What indigenous hunters lack in firepower, they make up for in patience, skill and cunning. They have to know the land intimately to understand the habits of their prey. As newcomers, we'll be relying to a large extent on luck.

We settle in just below a ridgeline, 100 yards apart, then move slowly down the slopes. After my run-in with the robin, I break free of thick underbrush and find myself on the edge of a grassy glade, alone, the morning sunlight filtering through the oaks. Now I understand the appeal of hunting: It's a great excuse to go into the wilderness and just sit.

Hodges once spent a week hunting a single buck, learning its habits so that he could position himself within firing range. Another time he went bear hunting, and on the first morning a 450-pound black bear appeared within feet of where he was sitting. He spun, drew and fired in one motion, sending an arrow through its rib cage. It was, he believes, the first bear killed in California by a stone-tipped weapon in over 100 years.

That kind of outcome isn't in the offing today. I spend the morning gradually working my way down the ravine. Near the bottom, I again hear a large animal moving through the undergrowth. This time, it's Hodges. By now the sun is high enough that any pigs that might be around are hunckered down for the day.

We hike back to Hodges's truck and retreat to a diner in Felton, a little town tucked amid towering redwoods. One of the things the day has brought home to me is just how demanding primitive technology is. Stone Age hunters had to constantly hone their craft. The price of failure was starvation. Nowadays, cosseted by civilization, we don't have to be nearly as tough or clever.

“We live in an age when so much is done for us,” Hodges says as the waitress sets down steaming plates of bacon and eggs. “And that certainly has its advantages.”

PM



← The author knapping an obsidian biface into an arrowhead.
↓ Cliff Hodges doesn't just hunt with primitive weapons—he also gets into the indigenous spirit, fasting, saying prayers and sitting in sweat lodges before he hunts.

The rustling grows closer, then stops. Judging from the racket, this thing is big. What have I gotten myself into?



through the rib cage behind the shoulder blade. Hodges says he bags a kill on only one out of every 20 attempts.

Before Hodges went on his first hunt, he spent years honing his skills. I'm on a tighter schedule, so he starts me with a one-day primer. He hands me a chunk of obsidian and shows me how to hammer it with a piece of antler to knock razor-sharp chips from its edges. Flake by flake, the piece slowly assumes a rough oval shape, called a biface. Hodges then employs a more precise technique, carefully pressing a small piece of copper against the edge of the stone to flake off chips until the blade reaches its desired form.

also requires a kind of science. “You need a high level of understanding of the physical properties of the rock,” Hodges says. “It's comparable to the fluid dynamics I studied at MIT.”

That evening, Hodges shows me how to fasten the stone to the arrow shaft using a mixture of eggshell and pine resin. This, I hope, will be my fatal implement. I gnaw on strips of dried elk sinew, softening it so that I can use it to lash the stone more tightly to the shaft, and then seal the assemblage with a foul-smelling glue made of boiled hide. Once dried, the result seems surprisingly similar to modern synthetic resin. The finished arrow is



STARE Back

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THE KEY TO COMFORT IS THE RIGHT GEAR. HERE'S A SHORT LIST OF ESSENTIALS THAT WILL MAKE DEER CAMP AN ANNUAL TRADITION, INSTEAD OF A TRIP TO THE MUSTY CABIN OR MOTEL.

SHELTER INVESTMENT

A good tent is as important as your hunting rifle. Go large and make sure you meet the following requirements. First, a cot to sleep on. Second, if your sleeping bag is a 20-year-old mummy bag, consider a spacious replacement. Get an over-sized rectangular bag with plenty of loft and layer it on top of a comfortable pad for the cot.

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SUBSTANCE

Next to staying dry and a good night's sleep, great food is about as basic as it gets. Every deer camp should have a designated cook (ideally, with talent) that all campers should serve like a culinary dignitary. Clean his pots, deliver water and make sure the fire is always ready.

Most cooks are pretty fussy about their gear, but you can help by supplying an extra camp table and an additional camp stove. Newly designed propane stoves light with the push of a switch. They'll boil a pot of coffee within ten minutes, and cost less than \$90.00.

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Your office attire may blend in at work, but in the outdoors it can be a major hindrance to hunting. With a few simple steps, however, you can be well on your way to almost looking like you belong out there.



WHAT YOU'LL NEED:

Yourself
 Mud/moist soil
 Foliage
 Twigs (optional)

INSTRUCTIONS:

- 1) Roll in mud until evenly coated.
- 2) Affix leaves in alternating color patterns as shown.
- 3) Rip sleeves off and knot together, forming bandana (Fig. 1).
- 4) Use shirt pockets, belt loops, and "sleeve bandana" to attach additional twigs, branches to self.



Fig. 1

Brought to you by



WARNING: In the event of skin irritation or rash, discontinue and go to Gander Mountain.

ULTIMATE SPORTSMAN'S GUIDE



Another perennial favorite is a designated Dutch oven attendant that accrues the responsibility of desserts from the pit of the fire. Ideally, he'll take a deer on the first day and you can put him to work.

COOKING TENT

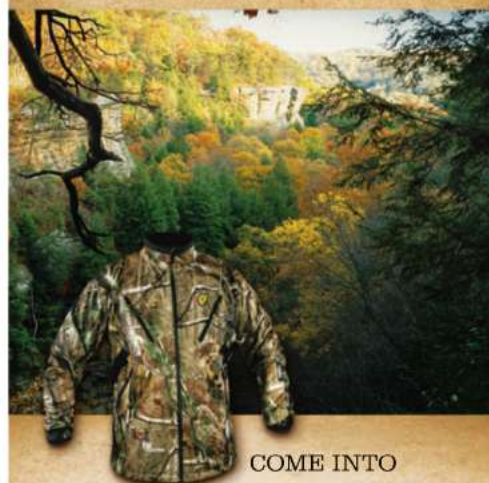
A dry prep area is a wise investment. Consider a canopy or what are often called "party shelters" to provide cover for stoves and a cooking table. If the weather doesn't cooperate, it will really mean the difference between everyone having a place to get out of the rain, or being stuck in his tent with a spoon and a can of SpaghettiO's.

CAMP SOLIDARITY

The goal is comfort and space. For deer camp, weight is not much of a factor as long as the tailgate of the truck is close by. Invite your friends and family to split the gear responsibilities. With a quarter of the budget you may have spent on a motel, you can upgrade your deer camp gear substantially and increase the comfort factor impressively.

When you stay warm, sleep well, and eat well, those nights around the campfire will stay etched in your mind even if you don't fill your deer tag. //

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LEARN, PLAN AND EQUIP FOR A MEMORABLE DAY ON THE WATER

The fall is one of the best times to expose a youngster to fishing and boating. A great place to start for all your information is the RBFF (Recreational Boating Fishing Foundation).

The organization is an invaluable resource that can show you how and where to take your family fishing and boating. You can watch videos, buy a license and even find a public place to wet a line.

**FOR MORE INFORMATION,
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Consider picking a shady place where you know a **fish** can be caught no matter what you throw in the water. Pick a time of day when the child has slept and eaten, but bring a snack and some water, just in case.



ULTIMATE SPORTSMAN'S GUIDE



Keep time under control, and be cautious not to push just because the bite is on. If there is any indication they're ready to leave, reel up and head in until they're ready to go out again. Trust us, they will be.

ADAPT

You are there to catch **fish**. However, if playing with worms or catching minnows in the

Then, find a cooperative sun**fish**. It does not matter how small the **fish**, or what kind. Always make it fun, and never wear them out. Who knows? You may be teaching a future angler.

Keep that up and you'll hear your seventeen-year-old son, in-between texting reminisce with laughter, "Dad, remember when I was four and we went **fish**ing and I let all the worms swim free in the river?"

Today, that twenty-year old will be first in the boat just to spend a day with his dad, even in the rain. //

bucket is where the action is, embrace it. Going **fish**ing is great fun to a four-year-old, but so is digging for rocks in the sand.

PITFALLS

Although a lack of **fish** is not ideal, a more prevalent risk is taking more than one child at a time. If at all possible, especially for their first few outings, take one angler. You can focus the attention where needed and not create any competitive feelings from a friend or sibling. It can really backfire if one child notably outperforms the other.

One of the hallmark mistakes is having the adult **fish**. The child knows you can catch a big one, and you don't want to compete with them. If you have to help get a **fish** at the end of the line, do your level best to make them think they caught it, not you.

If events or the weather turn, or it's just a not an ideal time, go do something else and try again another day.

KEEP IT SIMPLE

Small anglers are not ready to become fly **fishermen** or use skilled casting gear. Get a simple pushbutton reel, a bobber and a worm.

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ULTIMATE SPORTSMAN'S GUIDE



PICKING THE RIGHT UTV

SIDE-BY-SIDES OR UTV'S, ARE ECLIPSING TRADITIONAL ATV'S IN SALES, AND THE SELECTION KEEPS EXPANDING. BUYERS ARE REALIZING UTV'S OFFER A SWEETER RIDE, MORE LAND-MOVING ACCESSORIES AND, OF COURSE, THE ALL-IMPORTANT...POWER. SO, LET'S LOOK AT THE BASICS AND IDENTIFY THE RIGHT SIDE-BY-SIDE FOR YOUR USE.

RUNNING HORSES

Horsepower is always a question, and it's the benchmark of sticker shock. Many UTV's tame power with a governor to cap mph. This limitation is not always a negative, especially when different drivers with various experience levels are allowed to drive.

Power is a necessity when it comes to pushing or pulling heavy amounts of materials. If you're looking to add accessories to a side-by-side, consider investing in larger models over 400 cc's, and fuel injection is a must.

REGULAR OR DIESEL

If diesel fuel is stored on your property and you plan to use your UTV more like a tractor than a trail transport, these small torquey platforms are reliable, long-lasting and strong. However, depending on the make and model, they may not be as quiet, agile or speedy.

THE POWER OF THOR

If electrics have a single Achilles heel, it's

BOBCAT'S 3400 SERIES SIDE-BY-SIDES

Available in five configurations, that including a diesel engine and a six-man crew cab, Bobcat has taken their place in the UTV market seriously.

All units have fuel injection, a smooth independent four-wheel suspension and a switch to select from one-wheel (Turf Mode), to two-wheel or four-wheel drive. When engaged in four-wheel drive, all four wheels receive torque.

The gas engines are remarkably quiet, and the dealer can install a heater to make those nasty winter days a pleasure.

FOR MORE INFORMATION,
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Bobcat

how far they can travel on a length charge. And that's greatly complicated by battery age, charge, temperature and hill grades.

Another consideration is that as the UTV's diminishes charge, it exponentially drops in torque. So that mud hole you breezed through on the way to your deer stand may be a sticky spot on the return trip.

If you can keep an electric parked in a barn or on a charger every night and you drive it less than ten miles each day, then it may be for you. If not...go gas.

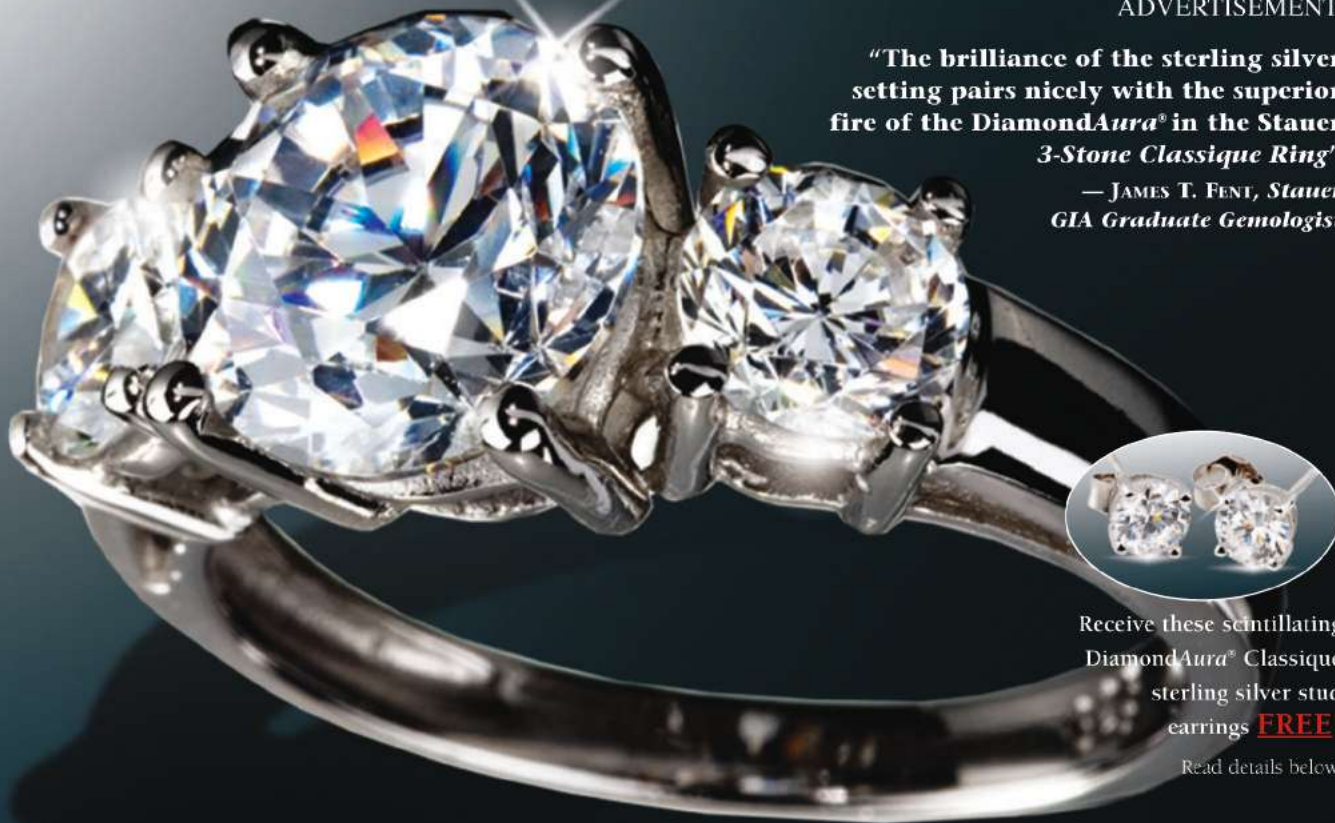
SCOOP, PUSH AND PULL

Accessories for UTV's are one of the primary reasons driving many users to these machines. The sophistication of these add-ons runs the gamut, from being powered by a simple lever and a spring, to winches or hydraulic pumps.

Consider if the working accessory days equal more than ten percent of your total time in the UTV. If so, pass on the less expensive winch-driven tools and go for the hydraulic accessories. //

"The brilliance of the sterling silver setting pairs nicely with the superior fire of the DiamondAura® in the Stauer 3-Stone Classique Ring"

— JAMES T. FENT, Stauer
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Perfection from the laboratory. We named our brilliant cut stones DiamondAura, because, "they dazzle just like natural diamonds but without the outrageous cost." We will not bore you with the incredible details of the scientific

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Color	"D" Colorless	"D" Colorless
Clarity	"IF"	Clear
Dispersion/Fire	0.044	0.066
2 ½ c.t.w. ring	\$60,000+	\$145

process, but will only say that it involves the use of rare minerals heated to an incredibly high temperature of nearly 5000°F. This can only be accomplished inside some very modern and expensive laboratory equipment. After several additional steps, scientists finally created a clear marvel that looks even better than the vast majority of mined diamonds. According to the book *Jewelry and Gems—the Buying Guide*, the technique used in DiamondAura offers, "The best diamond simulation to date, and even some jewelers have mistaken these stones for mined diamonds."

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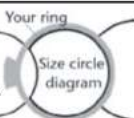
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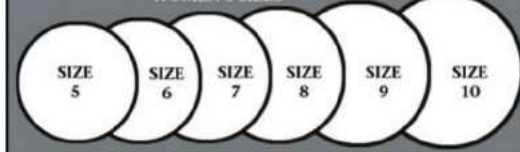
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WOMEN'S SIZES

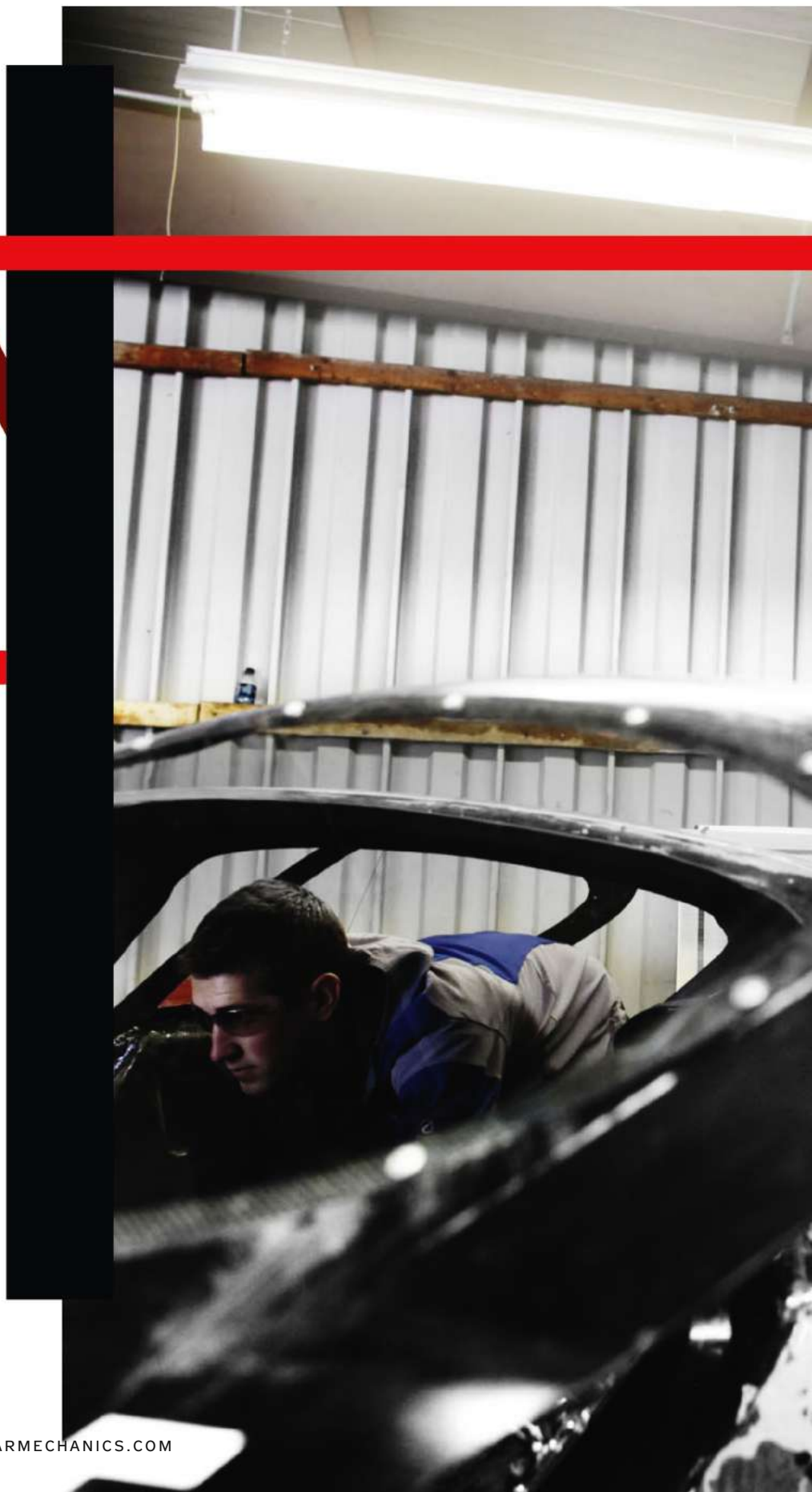


THE



FACTOR

By John Pearley Huffman





PHOTOGRAPH BY MARK PETERSON

With \$10 million at stake, 22 teams struggle to design and build a new generation of fuel-efficient vehicles.

Students from Western Washington University built this carbon-fiber special from scratch and, like so many of the teams, struggled to get it ready for the X Prize.



THERE WERE NO HOSPITALITY SUITES or luxury motor coaches in the infield, and cocktails weren't served. The food came wrapped in plastic and was eaten standing up. Glamour was in short supply, but the Progressive Insurance Automotive X Prize Shakedown sessions were car-geek nirvana. And the teams gathered at the Michigan International Speedway early this past summer were there to make history.

The \$10 million in prizes seemed almost incidental.

Forget the press releases saying the X Prize is about inspiring "a new generation of viable, safe, affordable and super-fuel-efficient vehicles." It's one of the longest and most grueling automotive competitions ever staged.

For Chris Beebe's team, however, the chase was over. Like most of the teams competing for the X Prize, his Team FourSight had spent that beautiful early May day scrambling to get their vehicle through tech inspection and preliminary testing. But now, as the sun set over the empty grandstands, the veteran mechanic was sitting in a lawn chair outside his team's garage sketching technical drawings. He and his exhausted crew were punting—throwing together a last-second appeal to get their just-disqualified TwinSight electric car back into the competition.

"We knew we were way behind," Beebe said as he drew a proposed canopy. "We just thought there would be some leniency, and there's showing to be none."

Mercy isn't part of the Automotive X Prize. It's a stout contest. After all, the technological challenge is monumental—designing production-ready, market-attractive, affordable cars that get the equivalent of 100 mpg (based on a gallon of gas containing 115,000 Btu of energy), meet or beat current emissions regulations and have a range of up to 200 miles. And behind that has to be a solid business plan to produce

**What We
Might Be
Driving in
2020**

FVT Racing

Car: eVaro
Class: Alternative
Drivetrain: Plug-in
serial hybrid
Energy Storage:
Lithium-ion
batteries, gasoline
PM Says: An
aggressive and
outlandish-looking
machine with a
neatly designed
hybrid package.
Odds to Win: 4 to 1

The Future Vehicle Technologies (FVT) three-wheeler is like the upcoming Chevrolet Volt—it runs on batteries most of the time. The gas engine—cribbed from a 1980 Honda GL1100—turns a generator to keep the electrons flowing when the batteries go flat. Shaped like a cross between an F-16 and a hammerhead shark, the car has a small frontal area and low-drag wheels that give it a 125-mile range and a sub-5-second sprint to 60 mph, the Vancouver-based company claims. It handled the Shakedown's challenges almost casually and sure looked like fun.

RaceAbout Association

Car: Electric
RaceAbout
(ERA)
Class: Alternative
Drivetrain: Electric
Energy Storage:
Lithium-ion batteries
PM Says: High
performance
wedged into an
economy run.
Odds to Win:
12 to 1

The ERA comes from the Helsinki Metropolia University of Applied Sciences and was developed by students and faculty advisers over the past nine years. Built with an electric motor for each of its four wheels—totaling 268 hp—and using chassis bits from Audi's R8 sports car, the ERA seems designed for racetracks, not for eking out every last amp of range. Despite the carbon-fiber chassis, the batteries bump the scales to a burly 3700 or so pounds. It's both a rocket and a bulldozer, a complex and fast beast that promises to be expensive to produce.





Edison2

Car: Very Light Car

Class: Mainstream

Drivetrain: Internal combustion engine

Energy Storage: E85

PM Says: A machine optimized for the competition. Can it reach 100 mpg?

Odds to Win: 5 to 1

To Edison2, there are only two absolute virtues: low weight and low aerodynamic drag. Standing 53 inches high with its wheels mounted outboard under fairings, the four-passenger version of Edison2's Very Light Car (VLC) seems incredibly tiny—it's 7 inches shorter than a Honda Fit. The 40 hp from the 250-cc turbo-charged single-cylinder engine is more than enough to push the svelte 800-pound car. Constructed around a steel-tube frame with a stressed skin, the VLC is spartan in the extreme. Would buyers accept that? Or feel comfortable in a car that seems so vulnerable in a world still filled with big trucks? And wouldn't it be ironic if the big-money X Prize went to a car powered by an internal combustion engine?



X-Tracer Team Switzerland

Car: E-Tracer

Class: Alternative

Drivetrain: Electric

Energy Storage: Lithium-ion batteries

PM Says: It's a motorcycle that imitates a car when stopped. But are training wheels enough to make consumers consider it?

Odds to Win: 20 to 1

If there's one vehicle in the competition that provoked controversy, it was the X-Tracer Team Switzerland's E-Tracer. "It's a motorcycle," one competitor says, on condition of anonymity. "I don't care that it has outriggers—it has to be ridden like a motorcycle. It's a motorcycle."

The E-Tracer is an all-electric version of the Swiss-built MonoTracer enclosed two-wheeler (normally powered by a BMW motorcycle engine). It substitutes a relatively small electric motor for the motorcycle engine and adds a 200-pound battery pack to achieve, the

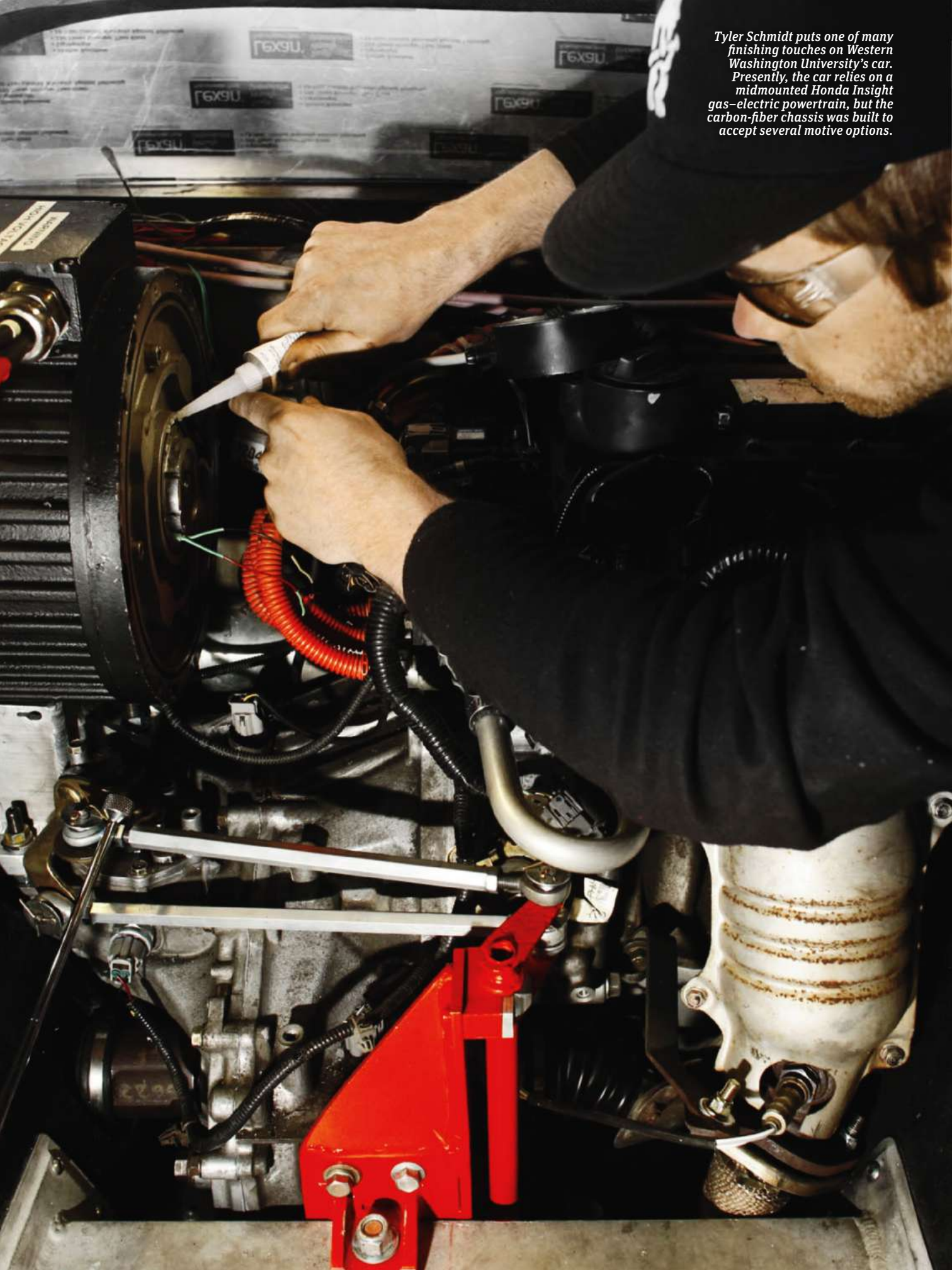
team claims, a range of over 150 miles.

If nothing else, the E-Tracer is great to watch launch. It stands still on two main wheels and two smaller wheels deployed on the outriggers. As it silently gains speed, the outriggers retract and the E-Tracer takes off like a light cycle from *Tron*. It's undeniably

entertaining, and it sailed through the Shakedown tests.

But while the E-Tracer exploits a motorcycle's inherent advantages of a small frontal area and low rolling resistance, is it something your grandmother would be comfortable riding in? And where do you put the groceries?

Tyler Schmidt puts one of many finishing touches on Western Washington University's car. Presently, the car relies on a midmounted Honda Insight gas-electric powertrain, but the carbon-fiber chassis was built to accept several motive options.





Illuminati Motor Works

Car: Seven
Class: Mainstream
Drivetrain: Electric
Energy Storage: Lithium-ion batteries
PM Says: A spirited team running on a shoestring. The car's mass makes a 200-mile range seem very unlikely.
Odds to Win: 100 to 1

"We decided that if you have the ability to do something, then you have the obligation to do it," explains Kevin Smith, the team's founder. "And that's why our motto is *audere est facere*—to dare is to do." Latin motto notwithstanding, Smith and six friends built—in a shed behind Smith's house near Springfield, Ill.—a long, limo-like, gullwing, all-electric car from scratch. It has consumed

Smith's salary from his job as a chemical engineer for two and a half years. The front-drive Seven is a mashup of a Porsche 356, a Tucker Torpedo and a mutant polliwog with a 200-hp motor. "Our drivetrain puts 97 percent of its power to the wheels," Smith says, "and our drag coefficient is about 0.165." If the Illuminati's chances are slim, it's not for lack of audacity.

event in February 2009, 111 teams from around the globe had signed up. By June 2009, 97 of them had submitted proposals for evaluation and qualification. In October, 43 teams were invited to enter the competition.

"There was one team that submitted a 642-page PowerPoint presentation," says Steve Wesoloski, Automotive X Prize director of technical operations. "They pulled in all different areas from grad school and just jammed it into a presentation. They had no real plan to get a vehicle here, let alone go to production. They were eliminated."

Conspicuous in its absence was any major American-market carmaker. GM didn't bring the Chevrolet Volt, Nissan left the Leaf at home, and even Tesla chose to keep its vehicles in their stalls. "The risk/reward equation wasn't right for them," Diamandis explains. "If they competed and lost, that was a black eye. If they won, people would say, 'Why didn't you do this before the competition?'"

THE TEAMS THAT DID ENTER AREN'T from big research labs doing fundamental investigations into new battery materials, far-horizon fuels or *Jetsons*-spec antigravity systems. And they're not jokesters showing up with rubber-band-powered balsa cars or sailboards on skateboard wheels. They're startups like Aptera, small companies like Zap looking to expand their business, educational institutions like Cornell University, and some teams that amount to not much more than a group of friends with a dream, a pole barn and room enough on their credit cards. The one big manufacturer to show up—in a super-low-key way—was India's Tata. They're taking proven technologies like off-the-shelf batteries, electric motors and controllers and pushing them (and often themselves) to the limits.

There are three Automotive X Prize

Edison2

Car: Very Light Car
Class: Alternative
Drivetrain: Internal combustion engine
Energy Storage: E85
PM Says: Built to the rules, it's a very simple design. But it's not a finished product.
Odds to Win: 4 to 1

The Virginia-based Edison2 team is made up mostly of racers and former racers—people good at leveraging a rule book in their favor. So while a four-seat version of their Very Light Car (VLC) competes in the

Mainstream class, two-seat versions—one side-by-side and one tandem—are running under the Alternative rules.

"At Edison2, we are fuel-source agnostic," the team wrote on its blog. "Our X Prize entry is powered by an internal combustion engine running on E85 because we read the rules carefully and want to win the X Prize. Our analyses of weight, drag and efficiency led us away from the significant added weight of batteries toward the simple efficiency of



very low weight and superior aerodynamics." That's how racers think. All of the VLCs use the same minimalist steel-tube chassis, covered wheels and small, turbocharged single-cylinder engine. And if they all work right, Edison2 could drive home with all \$10 million in prize money. That's also how racers think.

10,000 of them before 2014. By comparison, Burt Rutan had it easy: To win the Ansari X Prize in 2004, all he had to do was get his spacecraft into outer space twice in two weeks.

"The X Prize is difficult," says Dr. Peter Diamandis, 49, who started the X Prize Foundation and still leads it. "It's a \$10 million competition. It's what Lindbergh did in crossing the Atlantic."

What Lindbergh chased (and captured in 1927) was the \$25,000 Orteig Prize for a nonstop flight between New York and Paris. Diamandis revived the Orteig Prize's spirit in 1996 with the creation of the \$10 million Ansari X Prize. After Rutan's win, "reinventing the car seemed the next natural challenge," Diamandis says.

When registration closed for the



classes, each with similar rules. Mainstream-class cars are meant to be similar to what we drive today. They must accommodate four people and have at least four wheels and at least 10 cubic feet of cargo space. They must also accelerate to 60 mph in under 15 seconds and pull at least 0.70 g's on a skidpad. The toughest nut to crack, however, is the 200-mile range over a mix of city and highway driving. The winner, if there is one, gets \$5 million.

The Alternative class is looser and divided into two subcategories based on seating position. The side-by-side class positions two passengers conventionally, while the tandem cars seat the passenger behind the driver, fighter-jet style. These cars can have any number of wheels and need a mere 100-mile range.

Each winner of the two Alternative subclasses walks off with a check for \$2.5 million. All the other teams get a set of steak knives. Okay, that was a joke. They don't even get steak knives.

In four rounds of competition spread over five months (this past April through August), the X Prize's ad hoc staff of inspectors and judges evaluated each entry, looking for cars that met the competition's criteria. After objective and subjective judging, the car(s)—if any—that did all of the above most effectively would take home the big check(s).

In late April and early May 2010, the competition began in earnest as most of the qualified teams attended one of two Shakedown rounds at the speedway. This first round wasn't supposed to be a competition. But it was.

"They said this wasn't a knockout round," said one young member of the student-

Li-Ion Motors

Car: EVI Wave II
Class: Alternative
Drivetrain: Electric
Energy Storage: Lithium-ion batteries
PM Says: A simple design that could be rugged and economical. But developmentally it's still teething.
Odds to Win: 30 to 1

The Wave II doesn't look futuristic; it looks alien. It hails from Nascar country—Mooresville, N.C.—where ex-stock-car fabricators built an uncomplicated machine. "It has to be brought to market at an affordable price," Li-Ion's Bill Bratton says. The Lamborghini green two-seater's mild steel-tube frame has Honda Civic front-suspension pieces and rear fabricated swing arms. The 80 lithium-ion battery cells run down the car's spine and energize the front-mounted 58-hp electric motor. Its straightforward engineering makes it a dark-horse contender.

Aptera

Car: 2e
Class: Alternative
Drivetrain: Electric
Energy Storage: Lithium-ion batteries
PM Says: It looks ready for production and is beautifully finished; a true consumer product.
Odds to Win: 3 to 2

The already familiar Aptera 2e three-wheeler's composite body was impeccably smooth, no wiring showed, and the doors shut tight with neat gaps. The Aptera crew was relaxed. All it lacked was a Monroney sticker and a lease deal. "When someone goes to buy an Aptera, for all practical purposes, this is what it's going to look like and function like, and these are the parts and pieces that are going to be on it," says Marques McCammon, Aptera's chief marketing officer. The 2e's 110-hp motor pushed through acceleration tests easily, and the brakes worked well. Tricky three-wheeler handling was apparent in accident-avoidance tests. If the batteries deliver the expected 150-mile range, the Aptera 2e will be tough to beat.





In early testing at the Michigan International Speedway in Brooklyn, Mich., the Edison2 cars didn't wear the silver body wraps—huge decals that take the place of paint—exposing the carbon-fiber bodywork. To further reduce aerodynamic drag, those wheel skirts also cover the compact, in-rim suspension system.

staffed team from Western Washington University at the first Shakedown event. “But they’re all knockout rounds. And I think we’re in trouble.”

On the official X Prize website, the rules specifically state that “The purpose of this first stage is to conduct safety inspections and on-track dynamic safety evaluations of competition vehicles. Teams must submit their cars to on-the-ground challenges for the purpose of shaking out problem areas and preparing their vehicles for the Knockout Qualifying Stage that follows, all without risk of elimination by the judges.”

But the judges were in fact eliminating entries that seemed, to them, hopelessly unprepared or unsafe. And that unexpected pressure to perform had the garages smelling of sweat, solder and slightly moldy Subway foot-longs. Not all the teams were scrambling—the Aptera team almost appeared to be napping—but most had too much work to do and not enough people, and time was running out.

WWU’s entry, for example, is an advanced hybrid two-seater built around a carbon-fiber tub and suspension components. “The big challenge is getting it done,” said Andrew Brady, one of the students slaving away on it. “Six months ago it was a bare chassis. But simply getting to that step was a couple-year process. We also built a prototype car with the same chassis that we use for testing.”

Most of the day, the WWU car was covered in students determined to make sure that the first-generation Honda Insight-based drivetrain was working and that everything was battened down. But the judges had issues. They didn’t think the electrical system was properly grounded. They wanted a more rigid fire-extinguisher mount. And they weren’t pleased that seats were integral to the car’s structure.

Batteries are an efficient, but heavy, energy-storage method.



The Physics of Fuel Economy

THE AUTOMOTIVE X PRIZE IS AN ENERGY-MANAGEMENT CONTEST ON WHEELS, AND THE TEAMS ALL ATTEMPT TO OPTIMIZE FOUR BASIC CHARACTERISTICS.

1. WEIGHT

Low weight is the cornerstone of a fuel-efficient vehicle because the amount of energy required to accelerate a car is directly proportional to its mass. Plus, lightness has a cascading effect. A lightweight body doesn’t require a stout chassis, heavy-duty suspension components or large brakes. And the tires can be smaller, reducing rolling resistance.

2. AERODYNAMIC DRAG

The power—the rate of energy consumption—required to overcome aero drag is a product of the speed and the car’s aerodynamic resistance. Lowering the resistance requires a two-pronged strategy: reducing the frontal area (the product of the car’s height and width minus about 15 percent) and the drag coefficient, which is a measure of how easily the shape glides through the air.

3. MECHANICAL EFFICIENCY

How much of the car’s onboard energy makes it to the road? Electric powertrains are more efficient in this regard but require large and heavy batteries, which hurt overall vehicle efficiency. Internal combustion engines and liquid fuel are lighter but convert only about 30 percent of chemical energy to motion. Hybrids attempt to bridge the gap by capturing normally wasted braking energy.

4. ROLLING RESISTANCE

Drivetrain and bearing friction play a role here, but so does the rolling resistance of the tires. The less rubber on the road, the better, but beware of handling instability. And weight is the enemy of low rolling resistance (see No. 1, above).

“GROUND FAULTS. THAT’S THE BIGGEST thing we’re catching everyone on,” technical director Wesoloski said. “It seems like that’s one item that several teams have been held up on in inspection. If they don’t have safety devices installed properly or have them installed at all, then we’re not allowing them on the track, just because

it’s not a safe situation.”

No one was talking much in the garages; no one was playing music. The most prominent sounds were whirring engines, sparking welders, the clack of laptop keyboards and the occasional empty 5-Hour Energy drink bottle hitting the bottom of a trash can. Screen-printed team T-shirts and



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**Be Car Care Aware**





Zap

Car: Alias

Class: Alternative

Drivetrain: Electric

Energy Storage:

Lithium-ion
batteries

PM Says: A solid
effort from a proven
electric-car builder.

Odds to Win: 4 to 1

Zap's big advantage is that it actually produces electric vehicles. "Our main focus has been the fleet market," company founder Gary Starr says. "We sell trucks to cities, corporations and military bases." The three-wheel Alias mixes a Honda Fit windshield with a Corvette rear window. An electric motor identical to the Aptera's drives the front wheels. Win or lose, Zap plans to offer the \$35,000 Alias, which breezed through the Shakedown tests, for sale in 2011.

\$8 haircuts were the common uniform. However, Zap did bring along Keiko, a leggy model in a skirt and high heels, to accompany its vehicle.

Of the 26 teams that showed up for Shakedowns, 22 of them, fielding 28 cars, passed the inspections and on-track performance tests to proceed to late June's Knockout round, where the competition intensified and more teams were eliminated. WWU snuck through with a "probationary" pass, but Team FourSight's appeal didn't sway the inspectors and it was disqualified, along with three other teams.

Those who survived the Knockout went back to the speedway in July for the Finals round, where they repeated all they had done before and then faced another fresh set of challenges.

These included a "coast-down" test that generated aerodynamic and rolling-resistance data that will be used in the dynamometer-based Validation stage in August at the Argonne National Laboratory in Chicago.

After a month of chewing on the objective data, evaluating the business plans and assessing the consumer attractiveness of the remaining vehicles, the X Prizes will be awarded in September, at an event in Washington, D.C. After that, who knows? At least a couple of these cars—the Aptera, the Zap—will soon be available. But the event has sparked even greater interest in efficient transportation, a result that makes the sweaty late nights, skinned knuckles and fried batteries worthwhile investments. **PM**



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MINING IN DEEP UNDERGROUND CHAMBERS FILLED WITH EXPLOSIVE METHANE AND MASSIVE MACHINES IS DANGEROUS WORK. BUT IT DOESN'T HAVE TO BE DEADLY. PM INVESTIGATES THE REAL PRICE OF COAL.

BY **CHRISTOPHER MAAG**

PHOTOGRAPH BY TIMOTHY HOGAN

TO THE MINERS, THE

fire came as no surprise. On Jan. 19, 2006, around 3:30 pm, Carl White saw haze near a conveyor belt inside Aracoma Alma Mine No. 1 in Logan County, W.Va. At 4:20, White's replacement on the afternoon shift, Bryan Cabell, noticed the haze too. He found that the belt was misaligned, making it rub and smoke.

Cabell was speaking to the foreman about the problem when, shortly after 5 o'clock, he saw red embers beneath the belt. They soon burst into a small blaze, which was detected immediately. But Aracoma Alma had a history of allowing combustible materials, such as coal dust and grease, to accumulate to dangerous levels. The flames quickly grew. Handheld fire extinguishers proved ineffective. When Cabell tried to connect a fire hose, he discovered that the threads of the coupling and the outlet weren't compatible—and then that the water supply had been turned off.

Unaware that a fire was spreading, Don Bragg and Ellery "Elvis" Hatfield





continued to drill roof bolts in 2 Section, the deepest part of the mine. Elsewhere, carbon-monoxide sensors signaled elevated levels of the gas, but almost half an hour passed before the two men received orders to evacuate. They first boarded a diesel-powered mantrip, but the vehicle's route was thick with dense, black smoke. Together, the 12 men working in 2 Section then attempted to exit on foot. Ten escaped; the bodies of Bragg and Hatfield were found two days later, lying 575 feet apart in the mine.

A CENTURY AGO, MAJOR

disasters like the 1907 Monongah explosion in West Virginia, which killed 362 miners, drew attention to the need for a U.S. Bureau of Mines to improve workplace safety. In the 100 years since the agency's founding, a great deal has been learned about how to operate safer mines. Coal mining fatality rates have fallen sharply from the horrific levels of the early 20th century.

"My opinion is that the majority of the industry is always pushing for better safety," says Rick Honaker, chair of the mining engineering program at the University of Kentucky. And regulations governing mine safety have grown progressively stricter, most recently with the 2006 MINER (Mine Improvement and New Emergency Response) Act. Nonetheless, the rate of decline in mining deaths has largely flattened since the mid-1990s. With 40 fatalities recorded by July 1, 2010 is already shaping up to be one of the worst years of the past decade.

Coal mines are inherently dangerous places to work. In the decade ending with 2009, 354 miners died, nearly 90 percent

of them in small accidents that killed in ones and twos, like the fire at Aracoma Alma, rather than in the much larger tragedies that make national news. Most of those deaths were preventable. The Department of Labor's Mine Safety and Health Administration (MSHA) issued 175,000 safety violations and levied \$141.2 million in fines in 2009, more than ever before, but with little effect on the number of avoidable fatalities.

Affordable, existing technology could prevent the needless loss of life. Remote sensors, wireless communications and computer-data management have dramatically increased the ability of operators to monitor conditions hundreds or even thousands of feet below the surface. "It's not that the technologies don't exist," says Raymond C. Pilcher, a mining consultant who chairs the United Nations' committee on coal mine safety. "The problems generally have to do with people not applying the technology that's available."

Take the Aracoma Alma fire: A federal investigation identified 16 root causes, each of which contributed to the loss of life, including a missing carbon-monoxide alarm at 2 Section, an inadequate fire-suppression system and improperly installed ventilation controls. In April 2009 the Aracoma Coal Company pleaded guilty to willfully violating mandatory safety standards and paid \$4.2 million in criminal and civil penalties—the largest settlement in the coal mining industry's history.

DURING LATE MARCH

2010, federal inspectors tested the Upper Big Branch Mine in Raleigh

County, W.Va., for explosive levels of coal dust. Getting the results would take four weeks. But three weeks after the samples were collected, the mine exploded, killing 29 people. At press time, MSHA had not specified the cause of the disaster, but given the explosion's force, experts believe a coal-dust fire ignited methane.

After the explosion, MSHA criticized the Massey Energy Company, which also owns the Aracoma Coal Company, for repeated safety violations. In June, Massey sued MSHA, alleging that it contributed to unsafe conditions at the mine by barring the company from installing scrubbers to capture coal dust.

Both Massey and the regulators have a point. Some companies, including Massey, have a long history of fighting common-sense rules that would make mines safer. "Bad actors concentrate 100 percent on production and zero on safety," says Dennis O'Dell, administrator of occupational health and safety for the United Mine Workers of America.

MSHA can also be slow to green-light existing technology. There was no technical reason MSHA inspectors needed to wait a month for coal-dust test results; handheld explosivity meters could have provided data immediately. But partly because of MSHA's cumbersome approval process, the devices won't become commercially available until at least 2011. "There's a lot of frustration with MSHA," says James Sharpe, publisher of *Sharpe's Point*, a mine-safety newsletter. "And there should be."

The real regulatory flaw, however, lies in the agency's inability to back up its punitive actions. "There are good regula-



"FOR A FEW EXTRA PENNIES PER TON, COMPANIES COULD IMPROVE MINE SAFETY SUBSTANTIALLY," SAYS JAMES SHARPE, PUBLISHER OF SHARPE'S POINT.



Two days after an April 5, 2010, explosion at Massey Energy's Upper Big Branch Mine in Montcoal, W.Va., rescue workers used a 560-foot rotary drill to release methane gas from an area where miners were believed to be trapped. The final death toll: 29.

INDUSTRY SAFETY: HOW TO IMPROVE THE ODDS



Problem:

Mine operators often lack real-time data on conditions underground—including methane and carbon-monoxide levels—and the location of workers.

Solution: All-in-one wireless systems that combine atmospheric monitoring with tracking and communication. Wireless antennas in the mine gather data from methane and CO sensors, along with readings from air-pressure and airflow monitors. Radio-frequency identification chips transmit the location of workers and equipment in real time, sending warnings above and below ground when miners enter contaminated air or move too close to machinery.



Problem:

Mining naturally produces combustible materials like coal dust and methane. Too often, operators fail to pick up loose coal and flush out the gas.

Solution: Ventstop, which resembles a heavy-duty balloon and inflates to create airtight seals in mine openings. Widely used in Australian coal mines, the temporary system redirects the flow of fresh air while workers move longwall equipment or construct permanent seals. It also helps control the underground atmosphere after mine evacuations or disasters. Ventstop is light, tough and inflates quickly.



Problem:

Miners working in low-light conditions often injure themselves by walking into unseen hazards and cannot detect fissures indicating areas of weak rock.

Solution: A new headlamp for miners' helmets that allows for better vision of dangerous rock formations. The National Institute for Occupational Safety and Health is developing the device, which has a central 12-volt LED high beam surrounded by a circle of lower-power bulbs. Researchers hope it will give miners stronger light and better depth perception to spot cracks that might indicate loose rock in dark, featureless rooms coated with gray rock dust.





UNACCEPTABLE RISK A POPULAR MECHANICS INVESTIGATION

tions in place to protect miners," O'Dell says. "But enforcement is not used like it should be." Massey has received thousands of safety citations for Upper Big Branch, including 425 since 1995 for allowing combustible materials to accumulate and another 427 for failing to maintain proper ventilation. Some may have required only simple fixes, such as rehanging plastic curtains that had fallen to the ground. "The ventilation system didn't work," Stanley "Goose" Stewart, a miner who escaped the explosion, told Congress in May. Upper Big Branch, he said, "was a ticking time bomb."

Yet the mine continued to operate, producing 1.2 million tons of coal in 2009. By Massey's estimate, the mine's high-value coal is worth \$91 a ton, so stopping production for half a day to perform basic maintenance could have cost approximately \$150,000 in lost revenue. Just three months before the Aracoma disaster, Massey's CEO, Don Blankenship, wrote a memo to the company's deep-mine superintendents: "If any of you have been asked by your group presidents, your supervisors, engineers or anyone else to do anything other than run coal . . . you need to ignore them and run coal. This memo is necessary only because we seem not to understand that the coal pays the bills."

(Despite numerous attempts by PM, a Massey representative could not be reached for comment. Blankenship told a Senate committee in May that the memo had been "quickly and poorly drafted.")

One reason repeated citations haven't produced change: For years, the fines were so low companies accepted them as a cost of doing business. The fines increased with the MINER Act, as did MSHA's power to shut down mines that have a pattern of safety violations. However, the agency's own rules bar it from acting on any violation older than 24 months. The Federal Mine Safety and Health Review Commission currently takes 26 months, on average, to rule on a case, which eliminates the regulators' most powerful weapon.

Inflating the fines, as it turns out, didn't work either. Some of the largest coal companies responded by challenging nearly every citation. Within a year, the number of appeals to the review commission grew 400 percent. By the end of June 2010 it had 17,088 cases. "That's a huge backlog," says Michael McCord, the commission's general counsel. "I wouldn't use the word *overwhelmed*, but you get the idea."

To reduce the caseload, MSHA started negotiating with company attorneys. The process results in a 47 percent drop in fines on average, reducing any motivation to avoid violations in the first place. "We have this crazy, perverse incentive for operators to contest, regardless of merit," says Aaron Albright, spokesman for the U.S. House Committee on Education and Labor, which is studying mine-safety regulations. "It's created a system where they have been able to escape tougher scrutiny."

LOW FINES DIDN'T

improve mine safety. Higher fines backfired. So safety problems persist, along with heart-wrenching disasters. One option Congress may consider, Albright says, is to levy steep penalties against mining companies that bring frivolous appeals. Another is to improve protection for whistle-blowers.

Others recommend scrapping the existing regulatory system altogether. At present, violations are evaluated individually. But that's not how mine disasters actually unfold—most, like the uncontrolled fire at Aracoma Alma, involve multiple events contributing to a runaway chain reaction. MSHA is "geared up to write citations and collect fines. That piecemeal approach is not working," Sharpe says. "There's no systematic look at the mine as a whole to determine the hazards."

A more realistic model, called risk assessment, treats each mine as a collection of interwoven systems. In Australia, regulators require mine operators to write their own plans for each system, such as ventilation and coal-dust sup-

"THE MORE DATA YOU HAVE, THE MORE LIKELY YOU'RE GOING TO CATCH A PROBLEM QUICKLY AND REACT TO IT QUICKLY," SAYS TRACY HAYFORD OF MATRIX DESIGN GROUP.



Hayford with the Handheld Tracker, a prototype device that allows rescue teams to easily locate miners.

pression. Instead of looking for places where coal dust has accumulated, for example, risk assessment requires investigators to test the safety of the entire suppression system and assess whether deviations from the plan are minor or pose actual safety risks.

And because companies write the plans, they cannot blame the government if something goes wrong, as Massey attempted to do after the Upper Big Branch disaster. "Don't put any more liability on the federal government, and thereby on the taxpayer," Sharpe says. "Put all the liability on the company. You write the ventilation plan. You write the roof-control plan. And if there's a fatality, it's your ass."



Battery-powered wireless devices handle tracking and communications at the River View Mine near Waverly, Ky.

IN THE OPERATIONS

office at River View, a northern Kentucky mine owned by Alliance Coal, air-quality manager Gary Potts scans six computer screens connected to the mine's advanced atmospheric-monitoring system. A carbon-monoxide sensor blinks red. High CO levels can indicate fire, but Potts suspects a diesel truck is rumbling by. Just in case, he watches the monitor until the blinking light stops.

"The more data you have, the more likely you're going to catch a problem quickly and react to it quickly," says Tracy Hayford, director of technology and development for Matrix Design Group, an Alliance subsidiary that developed River View's monitoring systems.

At the dawn of mine safety, risk reduction was primarily a matter of removing physical hazards, such as donkeys and oil-fed open flames on miners' helmets. Current safety advances focus on gathering and understanding real-time data about the environment inside a mine. The disaster at West Virginia's Sago Mine in 2006 was in part an information failure. Thirteen workers trapped underground had only one way to communicate their position: Bang a single roof bolt with a sledgehammer. They labored in vain, wasting precious oxygen, and 12 miners died.

After Sago, Congress included language in the MINER Act that required operators to install wireless communications systems. The upgrade proved more difficult than anyone anticipated, Hayford says. Transmitting signals through solid rock requires high-voltage electricity, which is unsafe in a post-accident mine with high levels of coal dust and methane. Wireless systems use less power but require line-of-sight transmission, which limits their range.

Some companies, including Matrix and Airo Wireless, recently developed pagers and phones that communicate with wireless antennas hanging near the working face and connect to the surface by redundant wireless antennas and copper, fiberoptic and coaxial cable. Such systems are less expensive than installing hard-wire connections. And as with all wireless systems, the costs are coming down, making it easier for operators to blanket mines with sensors.

At River View, Matrix's system uses radio antennas to transmit not just voice communications but also readings from methane and CO sensors. In addition, it communicates with radio-frequency identification tags on miners' helmets to monitor workers' proximity to mining machines. If a miner walks too close, the sensors disable the machines to prevent the worker from getting crushed.

Since 2006, roof and wall falls have killed 37 underground coal miners in

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AN EARLY ADOPTER'S GUIDE

by Glenn Derene
photograph by Dan Saelinger

POPULARMECHANICS.COM | SEPTEMBER 2010

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Over the past 80 years, televisions have evolved from bulging black-and-white tubes to svelte wall-mounted panels. Despite this metamorphosis, TVs have always displayed just two dimensions. Not anymore: By the end of the year, most major TV manufacturers will have released 3D models. Yet with all the hype, you can't blame customers for being skeptical. After all, 3D TV is a brand-new technology, with premium-priced sets and a mere trickle of content. To see how the tech holds up, we put four new 3D TVs through intensive testing in our labs. Here's what you need to know before you shop.

THE 4-HOUR
3D TV
TORTURE
TEST

The average American watches more than 4 hours of TV per day. So what happens when you spend all that time watching 3D? PM editor Seth Porges decided to ignore manufacturer warnings and find out, while fellow editor Glenn Derene monitored his vitals.

The Glasses



All 3D TVs require battery-powered, active-shutter glasses, which use a liquid-crystal layer on each lens that turns dark when current is applied. The lenses occlude each eye 120 times per second in response to an infrared signal from the television. The TVs display 3D content at 240 frames per second, alternating the view to the left and right eyes to display a slightly different angle to each—thus the stereoscopic separation that makes stuff pop. Some people claim this shuttering makes them feel nauseous or dizzy—and indeed, several of our testers complained about just that—but the same is often said of 3D in movie theaters, which use

passive, polarized glasses.

Although you can't watch 3D TV without shutter glasses, not all 3D sets come with them. ("That's like selling you a bicycle without handlebars," one PM tester said.) Extra glasses cost \$130 to \$200 a pair, so a family of four could end up spending an extra \$800 for glasses.

And if that doesn't burn you up, consider this—currently glasses from every major manufacturer are incompatible. (Some third-party companies are making universal glasses, but none were available for testing.) So, if you bring your Sony 3D glasses to a friend's house to watch football on his LG 3D TV, you'll be greeted with little more than double vision.

The Sets

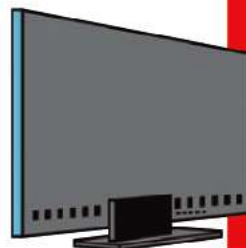


As anyone who's seen an IMAX 3D film can tell you, 3D content works best on a big screen, which is probably why manufacturers are only offering 3D TVs 40 inches and up. The edges of the set tend to break the illusion that content is popping off the screen ("You notice the stuttering of the shutter glasses in the area outside the screen," one tester said), so the farther the edges are pushed to the periphery of your field of vision, the better the effect is.

Those big sets can get expensive, though. Expect to pay about 20 to 40 percent more for a 3D TV than for an equivalent

1:00 HR (PUT DOWN THAT SECOND SCREEN!)

An hour into watching *Monsters vs Aliens* on the Samsung TV, I grab my iPad, only to find that the screen is pitch-black through 3D glasses. (Samsung's engineers claim this is a result of the interaction between polarized shutter glasses and LCDs). Getting work done with 3D glasses on? Not going to happen.



lent 2D set (manufacturers claim prices will come down as 3D becomes more mainstream). Many less expensive sets are labeled "3D Ready," with IR syncing transmitters for the glasses sold separately.

Some TVs have a trick called 2D-to-3D conversion, wherein the television's image processor analyzes the video stream and creates an on-the-fly stereoscopic separation. We tried the effect out on a Samsung 3D TV playing a 2D Blu-ray disc of *No Country for Old Men*, and the results were deeply weird and inconsistent. The set managed to correctly put actors into the foreground and stretch the desert landscape behind them into the distance, yet reviewers complained that the actors seemed to "have lines around them," as if they were cut out from the scene.

The Setup



So, if you plunk down a few thousand dollars for one of these new 3D sets, then a few hundred more for glasses, you're ready to watch 3D, right? Not exactly. You'll probably need a new Blu-ray player too.

The issue here is a standard called HDMI 1.4. HDMI is the protocol for the cables and interconnects used for digital hi-def video, and the standard was only recently updated to 1.4 to support 3D. Because audiovisual equipment sold

before 2009 uses version 1.3 or lower, it can't handle full HD 3D video (one notable exception is the Sony PlayStation 3, which can have its firmware updated to support HDMI 1.4).

Still, while older hardware can't handle 3D, our tests found that older HDMI 1.3 cables work just fine with the new standard, so don't get talked into paying extra for any "3D-ready HDMI" cables. Likewise, you can probably get along just fine with your existing home theater by using different cables for sound than you do for video. Use the HDMI cable for your Blu-ray's video, but send audio to your receiver via digital optical or coaxial cables.

The Content



At press time, there were exactly two Blu-ray movies encoded for 3D (*Monsters vs Aliens* and *Cloudy With a Chance of Meatballs*), but there promise to be around six by the end of the year and many more next year. Likewise, broadcast content is still fairly limited. You can catch ESPN 3D through Comcast, AT&T U-verse and DirecTV (which also offers its own suite of 3D stations); the Discovery Channel is scheduled to launch a 3D network in early 2011; and Verizon FiOS promises to add 3D by the end of the year. But be wary: Some providers charge extra for 3D

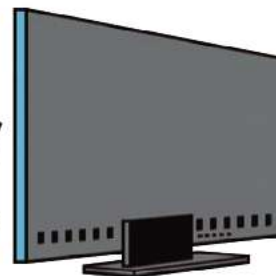
THE TEST



Fourteen volunteers were shown 3D clips of live action, animation and video games, then asked to rate several aspects of each set on a scale of 1 (awful) to 5 (fantastic). To prevent bias, we taped over all branding. Though we found a clear winner, we were surprised both by how positive the impressions were (aside from glasses comfort, no TV scored below a 3 average in any category) and how close the scores were (in the Overall Opinion category, average scores were all between 3.5 and 3.8).

2:00 HRS (SIT UP STRAIGHT!)

As I move on to *Cloudy With a Chance of Meatballs*, I begin to feel the first traces of eyestrain, and lie down to relax. But as I lower my head, the screen turns black on me again (darn you, polarized glasses!). Sitting up, I notice another strange effect of the shutter glasses: The white wall behind the screen seems to flicker distractingly. I scoot up to within 3 feet of the screen—far closer than I'm used to—and fill as much of my field of vision as possible with the TV. Okay, that works.



THE SETS

BEST OVERALL

MANUFACTURER	Sony	Samsung	LG	Panasonic
PRICE RANGE	\$2100 to \$5000	\$1700 to \$7000	\$4300 to \$5400	\$2600 to \$4300
SIZE RANGE	40 to 60 inches	40 to 65 inches	47 to 55 inches	50 to 65 inches
GLASSES	\$150 (two pairs included)	\$150 to \$200 (not included)	\$130 (not included)	\$150 (one pair included)
TECHNOLOGY	LCD	LCD, Plasma	LCD	Plasma
TEST RESULTS	<p>We tested the 52-inch Bravia LX900 (\$4000), which scored highest overall. Sony's set had standout performance in rendering 3D animation ("just like theaters," one tester said) and games. Some griped about the shutter glasses, however, calling them "heavy" and complaining that they "hurt the bridge of the nose." But the set also scored high marks for general picture quality.</p>	<p>Second place went to the 46-inch Samsung UN46C8000 LCD (\$2800). Samsung's glasses scored highest ("much more comfortable than the others," one tester said) and the set got top marks for gaming ("really sharp effects"). On the downside, the 2D-to-3D conversion (it was the only tested model with the feature) gave some subjects a "queasy feeling."</p>	<p>The 55-inch LG Infinia 55LX9500 (\$5000) was a beauty, with its razor-thin profile and transparent bezel. But setup was a chore (for some content, the user must select the proper 3D format). Plus, testers complained that the glasses felt "too tight" and fast-motion scenes were "too blurry." Yet the LG ranked highest in overall picture quality—which it ought to for five grand.</p>	<p>We were surprised that the 50-inch Panasonic TC-P50VT25 (\$2600) came in fourth—though not by much. Our tech editors loved the plasma's picture, yet testers thought it was "too dark" and ganged up on its glasses ("too heavy," "ouch"). The TV got the highest score for live-action footage, and the plasma's 3D worked better than LCD models when subjects tilted their heads.</p>

channels, and none is currently in HD; the high-bandwidth requirements and limited customer base make it financially unfeasible at the moment. And while over-the-air 3D is possible, the National Association of Broadcasters claims the networks have no plans for 3D in the next 12 months.

Perhaps the most compelling use of 3D is video gaming. Many games are natively produced in 3D, and our testers

found that 3D looked great during games. As part of a firmware upgrade to the PlayStation 3, the gaming console can now play a host of titles in 3D. Computers with graphics cards from Nvidia have been able to play 3D games on compatible monitors for over a year, and the company will release software that allows 3D-capable PCs to render 3D on TVs.

Our experience has left us encouraged

by the performance of these sets, yet cautious about high prices and still-evolving standards. We can imagine that two or three years from now 3D capability will be an inexpensive or free feature in most sets, while glasses will be universal and cheap. Prudent sorts will probably choose to wait. As for early adopters, they know that premium prices and evolving standards are just the costs of being a pioneer. **PM**

4:00 HRS (FINAL STAGE—ACCEPTANCE)



After enduring two 3D movies and a dune-buggy game, I'm done. I feel the early stages of nausea, and a mirror reveals that the glasses have left red marks on the bridge of my nose. But while I learned that those manufacturer warnings about the side effects of extended 3D watching are no joke, the sets did provide an almost theater-level experience, and I'd jump at the chance to watch a movie or play a game in 3D again—just so long as I don't plan on reading, working or reclining at the same time. In an age of multitasking, this is one technology that requires—and rewards—your undivided attention.

genius backyard

Popular Mechanics's



Track Star

■ **HOMEMADE ROLLER COASTER**

Jeremy Reid; Oklahoma City

On a 10-acre plot southwest of Oklahoma City, Jeremy Reid built an unexpected addition to his parents' backyard: a roller coaster. "I thought it would be great to have a small one to piece together and ride," he

S

yearly tribute to the world's greatest unsung engineers.



By **Davin Coburn**



Jeremy Reid's roller-coaster maintenance schedule includes regular weed control around the track, wood sealant once or twice a year and oil for the chain.

says. "Once I started taking college engineering courses, I realized I could probably design and build one on my own." And so began a monumental project that included 2900 board feet of southern yellow pine and 7000 assorted screws and nails. For the next four years, Reid conjured up ways to raise dozens of supports for the hills, laminate the track and piece it all together.

Riders—limited to close friends and family because of liability concerns—sit in a single-seat cart built from an abandoned stadium seat, which is winched up the first hill by a 1-hp electric motor. A 16-foot drop propels the car to 18 mph; the rider then zips over another hill, down the sloping backyard and around a 50-degree bank that pulls 2 g's. Nearly 1 minute and 450 feet after the

initial drop, the car returns to the lift. Reid estimates he spent \$10,000 on the project—though it paid off by helping him lock down a post-college job with coaster design company Arrow Dynamics (now S&S Arrow). In fact, the project was such a success, it's worth wondering if the married engineer will build another one in his own backyard. Or maybe not. "Once was definitely enough," he says.

PHOTOGRAPH BY **CHRIS BUCK**

Sky-High Shooters

■ VIDEO FROM THE STRATOSPHERE

James Ewen, Barry Sloan, Garrett Sloan;
Edmonton, Alberta

A DECADE AGO, A GROUP of amateur radio enthusiasts picked up on the growing hobby of sending balloons into near space. Recently, they came back with a YouTube sensation. “We posted video of the flight online, and it went viral,” says 44-year-old James Ewen, who leads tracking operations for the group. This isn’t the first time they’ve made news: Three years ago, the friends sent a Nikon Coolpix to 117,597 feet, and it came back with photos of the upper atmosphere. That success prompted a mission to launch the next logical piece of electronics, an HD video camera. So last August, they built a Styrofoam box to house a Canon iVHS HF20 camcorder. They outfitted the box with an APRS tracker, a GPS receiver and 10 lithium batteries. After clearance from Canada’s civil aviation authority, the group launched its balloon from an Edmonton-area park; the payload touched down 89 miles away. The balloon burst at 107,145 feet, 21,234 feet shy of the record, but the camera captured some of the first amateur HD video of the arc of the Earth. In the future, the group plans to include an RC plane to its balloon payload and fly the camera home.

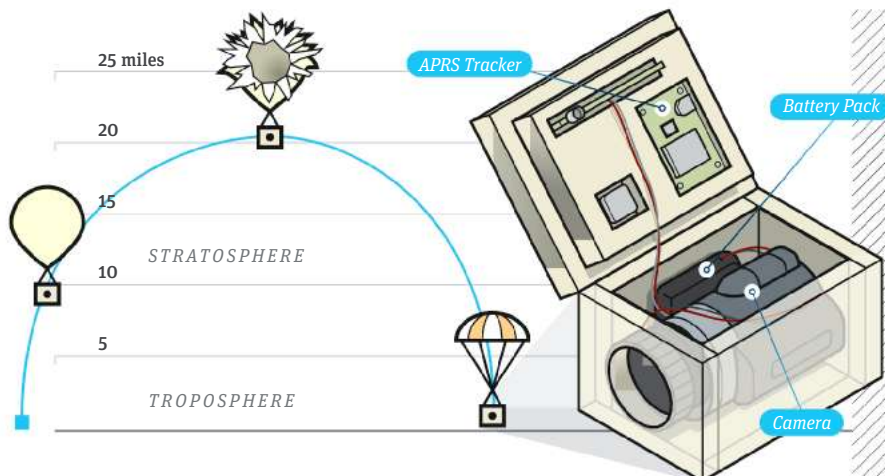
When Corbin Dunn first met his future wife, Louise, he was intrigued by her mountain unicycling; she by his homemade treehouse in a grove of California redwoods. He soon took his tinkering to Apple, where he worked on the first-generation iPhone; she taught aerial silks at the circus. He arrived at their wedding via homemade zipline. “My dad built our house from the foundation up. I’d help him hammer nails,” Dunn says. “My parents always encouraged me to build things.” It comes as little surprise, then, that as Dunn picked up Louise’s passion for off-road unicycling, he headed into his shop—and emerged with a unicycle for two. Dunn introduced a pair of salvaged Huffy mountain bikes to a Sawzall, a 4.5-inch angle grinder and a MIG welder. After severing the bikes’ front halves, he remounted the main drive hub and welded the rear triangles together around the wheel. He reinstalled the sprockets and hubs and put in a pair of chains. “I spent a week trying to machine a special transmission,” Dunn says, “but then I realized the stock components would work fine.” So far the 20-pound tandem has been used mainly on special occasions—usually, Dunn admits, for short bursts of time. “We’re still learning how to ride it.”



Balanced Marriage

TANDEM UNICYCLE

Corbin Dunn and Louise Lovelle; Los Gatos, Calif.



ILLUSTRATIONS BY DOGO

Dave Shinsel has posted all the source code and schematics for his Loki robot at dshinsel.com.



Digital Geppetto

■ LOKI HOME ROBOT

Dave Shinsel, Portland, Ore.

DAVE SHINSEL'S LATEST robot may look like WALL-E—but it takes after the Jetsons' Rosie. "I was just going to attach a webcam to a mobile pedestal, but then I figured I should make it more personable," says the longtime engineering manager at Intel. "Then I decided it should at least pick

up the pet toys." What Shinsel ultimately created was the 4-foot-tall Loki—named for the Norse god of mischief, partly for its unpredictable AI responses in "conversation mode," and partly for the 40-pound bot's early predilection for running into walls. The aluminum chassis is loaded with two dozen

sensors, 11 servos, a pair of webcams for eyes and 70,000 lines of custom code. Thanks to the OpenCV vision program, Loki can recognize people, identify CDs, count cash—and, yes, pick up objects from the floor. Microsoft Speech API allows Loki to respond to voice commands. A digital map of the house, along with a compass and an odometer, helps the robot navigate between rooms. Next task for the \$2000 droid? Tackling the refrigerator's tricky vacuum seal. "I'd love for him to grab me a beer."

New Haven Choppers

■ SPOKELESS BICYCLE

Student team from Yale Mechanical Engineering 489; New Haven, Conn.

IN THE NEARLY 150 YEARS since the bicycle debuted, its operation has remained remarkably consistent. That is, until this year, when a group of mechanical engineering students at Yale created what might be the first

spokeless bicycle.

Redesigning something so fundamental was bound to be difficult. So Vern Van Fleet, a Sikorsky test engineer who taught the course, broke his students into three groups (frame, drivetrain and wheel)

to tackle the challenge.

The result? An 8-pound frame, made from sheet aluminum, which holds the spokeless rear wheel in place. Inside the wheel housing, rollers fit into grooves carved into the wheel rim to prevent wobbling and to provide support. In place of the normal rear hub, the team added teeth along the inner rim of the wheel to spin a small gear behind the pedals. That gear ratio, however, is

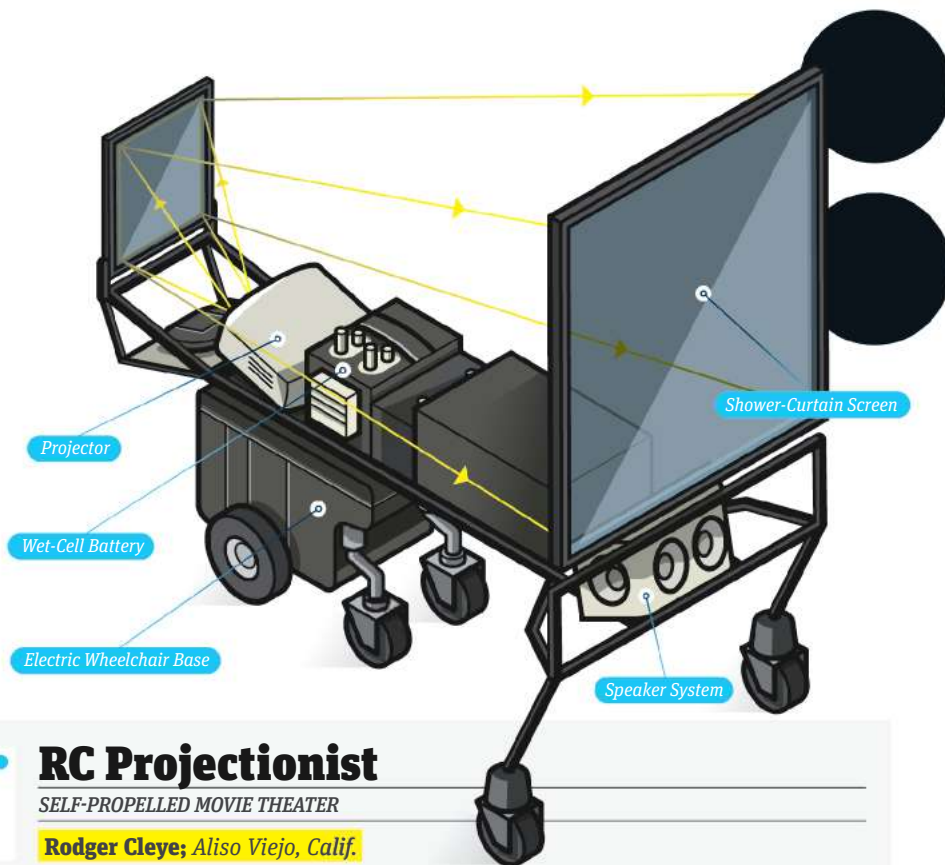
lower than first gear on most 10-speeds. So the team improved performance by connecting an 18-tooth rear cog to two 53-tooth chain rings. An outside vendor who was supposed to machine the bike's wheels fell through, forcing the students to focus solely on the rear wheel to get things done quickly and inexpensively. "That was a good lesson," Van Fleet says. "You've got to have contingency plans."



The Yale University Mechanical Engineering 489 class, from left: Henry Misas, Sean McCusker, Jordan Carter, Nicholas Tsouris, Gregory Brown, Trevor Hines, Derek Zhao, Stephen Miehl and Aaron Fuchs (not pictured).

When electrical engineers get into the Halloween spirit, there's no telling what might happen. Last year Rodger Cleye outdid himself with a creation as simple as it was elegant: a radio-controlled home theater on wheels that displays video of a flaming head while blaring Rockwell's 1984 song "Somebody's Watching Me." The heart of the system is an electric wheelchair he bought off eBay; Cleye tapped into the chair's control box and converted it to remote operation. "Suddenly I could puppet around any 300-pound object," he says.

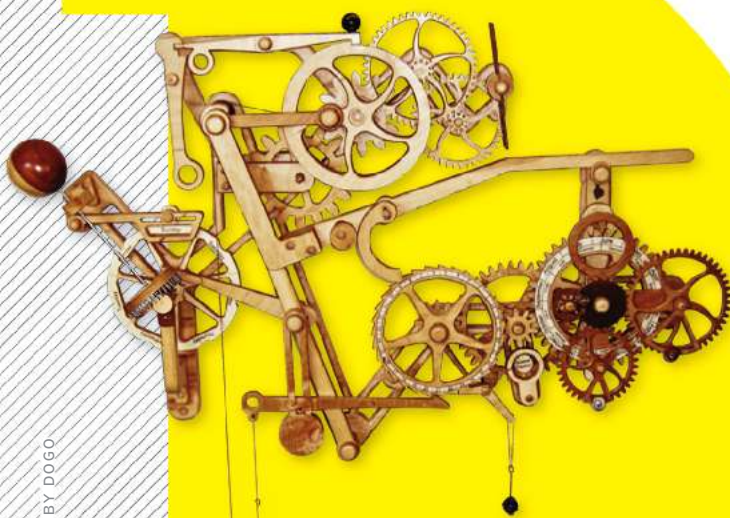
On top, Cleye stacked a DVD player, a marine battery and a 300-watt projector. The image bounces off a mirror and splashes across a 5-foot screen from Target. "It's a shower curtain. 'Frost,'" he says. "It has excellent optical properties." A separate 12-volt battery powers a 100-watt speaker system and a two-channel amp, which are attached to a simple steel frame from a shelving unit. "We had a blast sending it down the street after the children," he says. Not only did neighbors enjoy the handiwork, but Cleye says there was an unexpected safety benefit: Drivers who would otherwise have sped by slowed down for a look at the video puttering down the street beside them.



RC Projectionist

SELF-PROPELLED MOVIE THEATER

Rodger Cleye; Aliso Viejo, Calif.



Divine Clockmaker

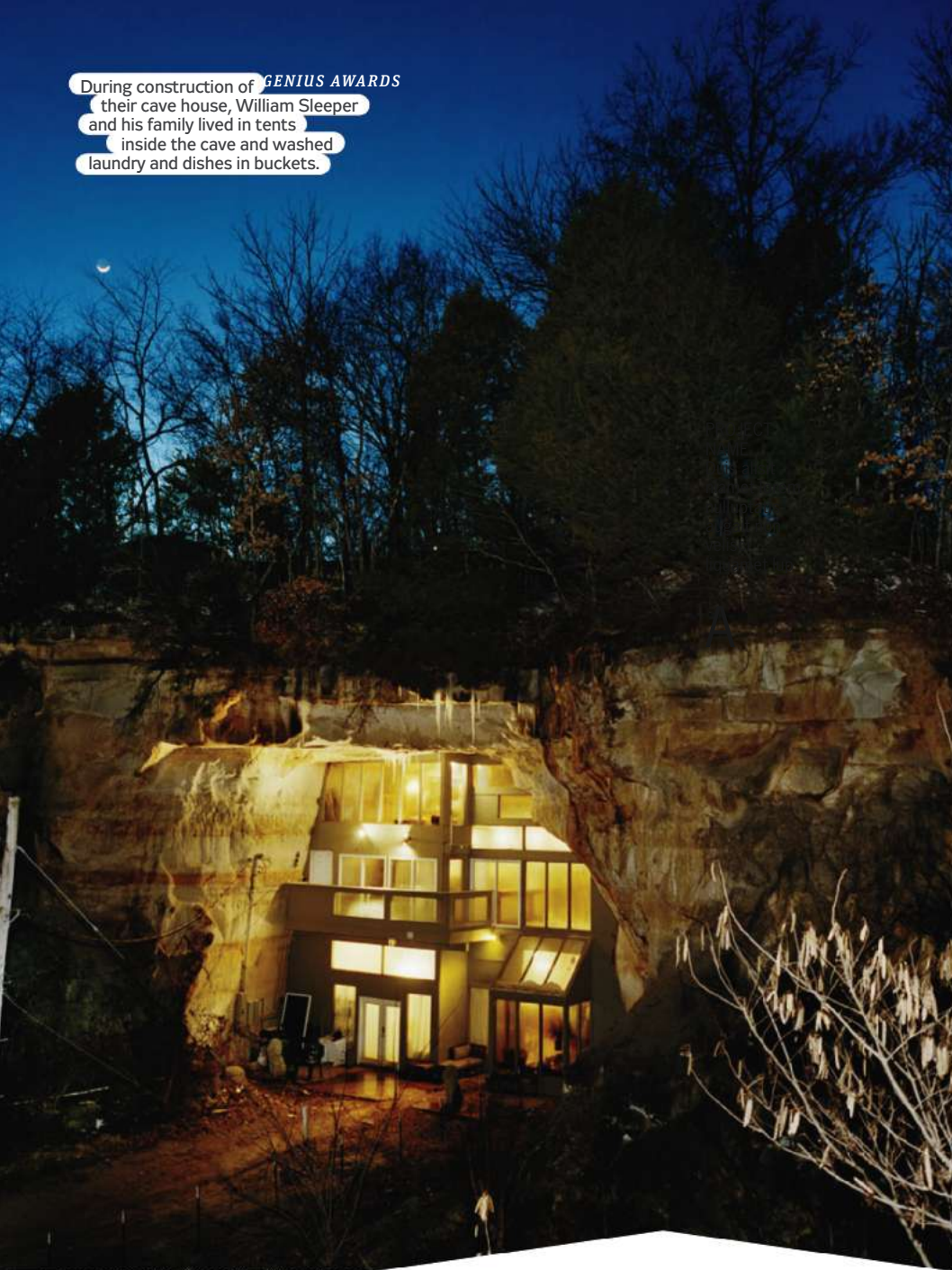
WOODEN MECHANICAL CALENDAR AND ORRERY

Clayton Boyer; Kauai, Hawaii

CLAYTON BOYER WAS inspired to build wooden clocks by plans he saw in *POPULAR MECHANICS* 45 years ago. Since building his first clock, Boyer has designed more than 50 extraordinary timepieces. But his recent wooden creation, the majestic *Celestial Mechanical Calendar and Orrery*, doesn't tell time at all. "This is driven by clockworks," the retired chiropractor says. "But I've got other things that tell time." This 42 x 26-inch machine, however, is remarkable for its comprehensive attention to other details. Powered by 14 gears, a 5-pound drive weight and three counterweights, the Baltic birch device shows the

day of the week; the day of the month; the month; the zodiac sun sign; the phase of the moon (represented by a ball that rotates to reflect the moon in the night sky); the equinox and solstice; cross-quarter holidays such as Groundhog Day; and the synodic rotations and retrograde cycles of Mercury, Venus and Mars. Boyer says it took only a week or two to build—but four months to plan. "This is like building two or three clocks at once," he says, "but it's just step by step. Start with the frame, then add this wheel, then that wheel, then the levers, then the weights. It just takes a little stick-to-it-iveness."

During construction of **GENIUS AWARDS**
their cave house, William Sleeper
and his family lived in tents
inside the cave and washed
laundry and dishes in buckets.



The Cave Dwellers

■ FAMILY HOME BUILT INTO A CAVERN

William, Deborah, Kian, Perry and Wesley Sleeper; Festus, Mo.

SEVEN YEARS AGO, William and Deborah Sleeper found a choice piece of property just west of the Mississippi River. The defining element? A 17,000-square-foot sandstone mine that at one time housed a roller-skating

rink and a concert hall. “We loved it,” William says, “but the property is just 3 acres and a hole. No one wanted to finance it.” The family bought the property themselves, but were cash-strapped when it came to building there. “One

wall was a lot cheaper than four,” William says. So he incorporated nearly three dozen orphaned sliding-glass doors into a 45 x 45-foot outer wall at the mouth of the cave. Inside the 2000-square-foot front chamber, the Sleepers—including daughter Kian, 16, and son Perry, 14—spent four years building a sprawling kitchen, an office and three bedrooms with recycled hardwood floors. A stairwell gently spirals through the home’s three levels. “I had a bit more confidence than common sense,” William says. “I wasn’t intimidated by the project. But that stairwell took me six months.” The doors’ double-paned, insulated glass provides passive solar heating to bring the cave’s temperature to 70 degrees, year-round. Three industrial-grade dehumidifiers pull 300 gallons of water from the air daily, keeping the living space between 60 and 70 percent humidity. Interior roofs and umbrellas shield sensitive areas such as the kitchen from the sand that sheds from the walls. The Sleepers worked with the city of Festus every step of the way to build evacuation routes and meet building codes. “Some people can’t imagine that cooperation, but the politicians all roller-skated here as kids,” William says. “Three generations of folks have enjoyed this property.” And maybe more to come: These underground geniuses refinanced in March 2009 for the long haul—right after a doctor visited the home to deliver their third child, Wesley.

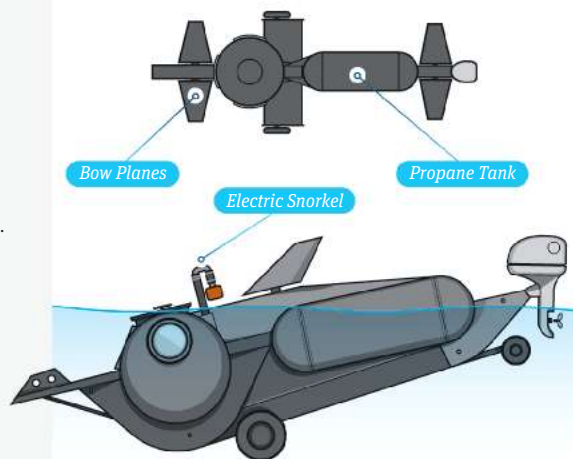
Radio Fliers

■ SPACE STATION RADIO CALL

Gino Cunti, Paul Je, Kevin Luong, Patrick Neelin;
Toronto, Ontario

LAST YEAR, FOUR Humber College students working on their senior project became the first college students to contact the International Space Station (ISS) on a radio they built themselves—to NASA specifications. “When they first suggested doing it, I almost laughed,” says Mark Rector, an electronics engineering professor at Humber and their mentor for the project. “Maybe they could achieve nuclear fission while they were at it.” He quickly learned how serious his students really were. While ham operators—like Neelin’s grandfather—have long contacted astronauts through NASA’s Amateur Radio International Space Station program, no other group of college students had built a system from scratch. Over 22 months, the students designed and constructed the system, which included a transmitter, VHF transceivers, a pair of antennas and their own adapted tracking system and software that would allow them to reach the ISS as it traveled at 17,000 mph, 250 miles overhead. With a \$4000 budget, the NASA-approved radio squawked to life on Feb. 2—and flight engineer and science officer Sandra Magnus answered.

Building a personal submarine may seem as fanciful as a DIY jet pack—but Cal Giordano proved that with a little ambition, and a recycled 500-gallon propane tank, most anything is possible. “After drawing a zillion sketches, it occurred to me I could actually make this,” the longtime boat mechanic says. The 32-foot semi-sub, which is fashioned from an industrial buoy cockpit welded to the propane tank, dives by pitching its 4-foot-long bow planes forward. The front half submerges about 8 feet, while the engine continues breathing air, guiding the sub through Auke Bay at a leisurely 10 knots. If the boat drops below 3 knots, it loses the forward momentum necessary to force the craft underwater, and it pops back to the surface. (Should some malfunction pull the 3000-pound boat into too steep a dive, the rear prop would leave the water, eliminating thrust—and popping it back to the surface.) An electric snorkel cycles fresh air through the cockpit, and a video camera mounted on the top deck allows Giordano to steer when visibility gets hazy. “Around here, once you hit the deep water, it all just gets green,” he says. For wintertime, he affixed a blade to the bow that can plow through 4 inches of ice. Giordano also attached small wheels to the semi-sub’s keel, so that running aground was no longer a threat. In fact, it’s convenient: The boat can drive onto the beach after an outing and requires no trailer to transport. And what about the Dahlgren cannon mounted on the bow? “I only fire that on the Fourth of July,” he says. “And maybe my birthday.”



The Submariner

HOMEBUILT PERSONAL SEMI-SUBMERSIBLE

Cal Giordano; Juneau, Alaska

ILLUSTRATION BY DOGO





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A GREENER GARFIELD

One hot, spring day in early June, **Popular Mechanics** teamed up with **Rebuilding Together Philadelphia** and some dedicated volunteers on a Block Build that not only brought repairs to houses in need, but also brought a little bit of green to the inner city.



When you think of living in the city, “green” may not be the first word that comes to mind—especially one as historic as Philadelphia. The Germantown section of Philadelphia is a city unto itself, dating back to the 1700s. Germantown was the site of a pivotal battle during the Revolutionary War and later a stop on the Underground Railroad. Many of the homes, including those on East Garfield Street, where this project took place, were constructed in the 1800s. It’s against this backdrop that Popular Mechanics (PM), and Rebuilding Together Philadelphia (RTP) commenced work on providing this historic area a green upgrade. The approach to this project was somewhat novel from the outset: instead of working on one home at a time, the leaders at RTP decided to take on an entire city block. According to Executive Director Carrie Rathmann, a block build “can increase the impact of individual repairs and modifications.”

Making homes green is a priority for the broader Rebuilding Together organization. “It’s something we’ve always done; making things energy-efficient,” states Tiffanie Kinney, Associate Director, Green Housing for Rebuilding Together. “What’s more green than rehabilitating a home? It provides a great return on investment for local Rebuilding Together affiliates and saves the homeowner money.” Rebuilding Together estimates that with the general energy efficient improvements they provide, homeowners can save up to 20-30% on their utility bills.

To get started on PM’s Philadelphia-based project, RTP sought out Residential Energy Solutions, an independent home energy assessment company, to perform home audits on two homes on East Garfield to gauge the extent and types of repairs



**CARRIE AND JIM OF
REBUILDING TOGETHER PHILADELPHIA**

Rebuilding Together Philadelphia (RTP) is one of 200 independent affiliates of Rebuilding Together, a national organization based in Washington, D.C., that works to provide warm, safe, dry housing to the elderly, the disabled, veterans and those displaced by natural disaster. While some local affiliates have a large infrastructure in place to manage projects and volunteers, RTP relies on the power of three: Executive Director Carrie Rathmann, Operations Manager Jim Coburn, and Administrator and Program Coordinator Jen Wootten. “We rely on each other very heavily,” reflects Rathmann, explaining how they manage with a small team. “And, we’re very appreciative of our volunteers.”



TALKING ABOUT COMMUNITY

The Block Build on June 5 kicked off with a press conference organized by Rebuilding Together Philadelphia (RTP), featuring city and state representatives, members of Rebuilding Together’s national organization, local neighborhood action committees and Popular Mechanics.

Each speaker stressed the sense of community required for a project like this. According to City Councilwoman Donna Reed Miller, “If it wasn’t for the residents of this block working hard together and wanting to make things better, this wouldn’t be happening.”

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needed throughout the block. Basic repairs, such as caulking, applying weather stripping, installing smoke and CO₂ detectors, installing hot water heater blankets and furnace filters, were done to nearly every home. And certain areas of the block received custom touches, where project sponsors like Minwax, Johns Manville, Frog Tape, Kilz, Delta Faucet, Cooper Lighting and Lee Jeans contributed with generous product donations.

East Garfield is made up of row houses. However, there are a few empty lots on the block which had the potential to be transformed into something useful and green. 61 East Garfield was one such lot. And thanks to the volunteers from PM, 61 East Garfield was turned into a community garden.

The plot was littered with trash, broken glass, concrete blocks and other debris. Once the land was cleared, volunteers began to build six raised flower beds, two to a row. Planks were nailed together into 7' x 4' rectangles and supported with wood screws to accommodate expansion from the fresh dirt that was shoveled into the beds.

A 6' wooden fence was erected to give the garden borders on the side and the back, next to another neighborhood house. A wide three-person bench for visitors to sit on was built by the volunteers and a young boy from the neighborhood. The bench was placed at the front of the garden near four newly planted holly bushes. White gravel around the beds provided a simple walkway for visitors.

To help maintain the garden, volunteers constructed two rain barrels for water and a compost pile to help replenish the soil. Later on, residents will choose what to plant in their new community garden.



PM CREATES A COMMUNITY GARDEN.

1. The lot at 61 East Garfield before work started.
2. The new community garden at 61 East Garfield.
3. Volunteers shoveling dirt off of the dump truck and into the garden.
4. A PM volunteer wearing Lee Jeans plants a bush in the new community garden.

THE GREEN EFFECTS OF A COMMUNITY GARDEN INCLUDE MORE OXYGEN IN THE AIR AND LESS AIR POLLUTION.

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1 COAT OF PAINT

(over water stains)



Joel Wasserman,
KILZ primer user and
pro painter for 18 years

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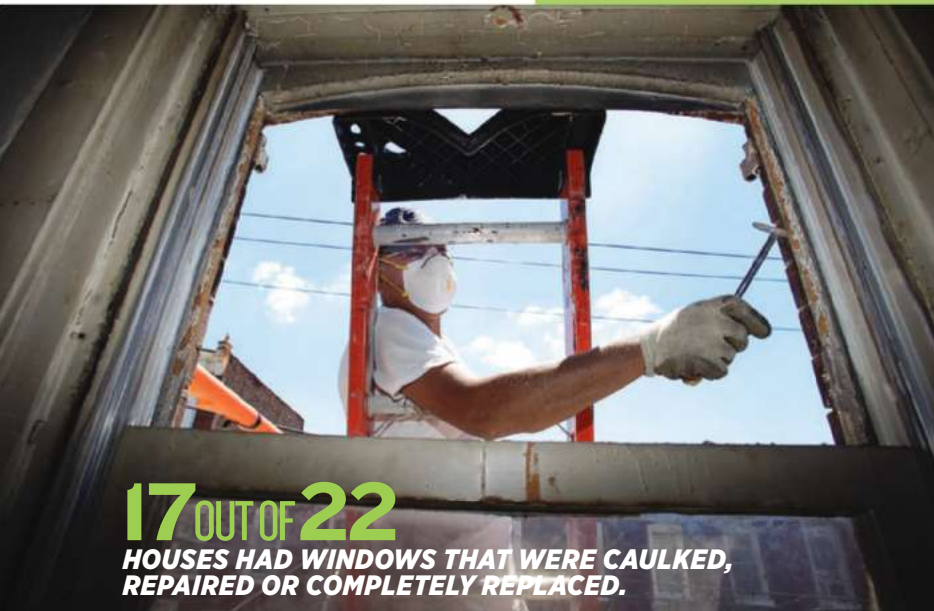


The home at 77 East Garfield required the most work of any home on the block. The roof had major holes. The front steps were nearly unusable. The front door was damaged and the faucets were leaking.

On the outside, volunteers installed Cooper Lighting's Precision Plus Doppler Radar™ Motion-Activated Security Floodlights. New cement stucco front steps were built to replace the broken brick steps. Screens were put into the windows of the above-ground basement for ventilation. Inside the home, lead-based paint was removed from the walls, and holes in the plaster were repaired. The walls were then given a new coat of paint, with FrogTape for edging. A Delta Allora Single Handle Pull-Down Kitchen faucet replaced an old, leaky faucet in the kitchen.

REPAIRS COMPLETED:

PATCHED AND INSTALLED COOL ROOF, REPLACED WINDOWS, STAINED NEW FRONT DOOR, ADDED NEW FAUCETS, BUILT NEW FRONT STEPS, INSTALLED EXTERIOR LIGHTS, NEW PAINT THROUGHOUT HOUSE



VERNON ROBERTS

77 E. Garfield // Years in home: 13

Vernon Roberts is a Philadelphia native and has lived at 77 East Garfield for 13 years. He is blind in his left eye and has chronic arthritis, limiting his ability to work full-time. Roberts is very appreciative of the work that's been done to his house. "I couldn't wait for this to happen," he says. "All this is making my house livable. I'll be able to save money with the energy efficient things being done."

PRIMING AND STAINING FOR PROTECTION

For the exterior of the house, volunteers primed the door frame, windows and trim using Kilz® Premium primer before a fresh coat of paint was applied. The front door was stained front and back with MinWax® Wood Finish. One of the volunteers, a general contractor by trade, provided a helpful tip—stain both the top and bottom of the door to help prevent rot and moisture from seeping into the wood.



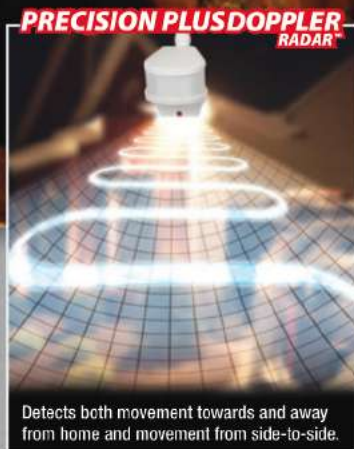
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Nowhere is the green effect more apparent than at 106 East Garfield. The application of a cool roof coating to this house took energy efficiency to the next level. Cool roofs help reflect heat from the sun instead of allowing it to seep into the house. According to the Cool Roof Rating Council (www.coolroofs.org), cool roof coating can result in energy savings of 10–30%, as well as a longer roof life. Cool roofs also reduce greenhouse gas emissions by conserving electricity for air conditioning use—resulting in less CO₂ emissions from power plants.

In addition, Johns Manville Formaldehyde-free™ fiberglass building insulation was installed in the refurbished basement, the foundation was resealed and a Delta Addison Two Handle Centerset faucet was placed in the bathroom. To top it off, there's a full garden along the right side of the house, complete with rain barrels and a Cooper Lighting Precision Plus Doppler Radar™ Motion Activated Security Floodlight.

REPAIRS COMPLETED:

INSTALLED COOL ROOF, SEALED FOUNDATION, REPAIRED PLUMBING, PUT IN NEW BATHROOM FAUCET



SANDRA SMITH

106 E. Garfield // Years in home: 19

For the 19 years she's lived at 106 East Garfield, Sandra Smith hasn't been able to sleep in her 2nd floor bedroom. "The drafts are overwhelming. It's either freezing or sweltering up there," says Sandra. But the cool roof has changed that. "Now I can actually walk up and down the stairs without a sweater or breaking a sweat. What a wonderful thing!" Sandra is an active member of the community in and around East Garfield. She is the Block Captain for East Garfield and has served a variety of roles in the neighborhood action committee. "We're a very active block," says Sandra. "This whole project is amazing to us."



PRODUCTS FOR A MORE ENERGY EFFICIENT HOME

As with any repair, you've got to have the right products to do the job right. And that holds true for the work done to make East Garfield more energy efficient. These products helped Rebuilding Together Philadelphia provide homeowners with warm, safe, dry and green homes.



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Mike Rowe
Mike Rowe



Like 77 East Garfield, the house at 80 East Garfield needed a lot of work, both inside and out. The siding and flooring needed repair, and some basic electrical work was in order. With such extensive repairs, there were many opportunities to make this house more energy efficient.

The energy-efficient renovation started with the addition of a solar water heater. Installed by Arvak Energy Solutions in Philadelphia, this solar water heater has two panels, or collectors, on the roof which transfer heat to a Rheem 80-gallon solar storage tank in the house. Solar water heaters have a reduced impact on the environment and increased savings on energy bills compared to electric or gas water heaters. They can save a resident an estimated 40-50% on heating costs.

Other repairs included putting Johns Manville Formaldehyde-free™ fiberglass building insulation in the remodeled back laundry room to insulate against drafts and to reduce energy costs. Damaged windows and porous window frames were replaced or repaired. An exhaust fan, washer/dryer vent, a low-flow toilet and second floor ceiling fans were installed to increase energy efficiency and promote water conservation.

REPAIRS COMPLETED:

INSTALLED SOLAR WATER HEATER, ADDED INSULATION, REPAIRED OR REPLACED WINDOWS, WINDOW FRAMES, AND FLOORS, SET UP LOW-FLOW TOILET, REWORKED ELECTRICAL WIRING, PUT IN CEILING FANS



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**PRICILLA JAMISON**

62 E. Garfield // Years in home: 26

For Pricilla Jamison, the repairs made to her home at 62 East Garfield not only improved her living conditions, but also her working conditions. Pricilla is a seamstress by trade, doing the majority of her work in various carpeted rooms in her house where she often stepped on loose pins and needles. With the installation of the Cooper fluorescent light in her tiled kitchen, she can now work in a well-lit area and can pick up any loose pins or needles with a magnet. "This is such a great help to me. I just can't afford a lot of this stuff that needs to be done," says Pricilla. "It's a real blessing."

62 E.
GARFIELD
PHILADELPHIA, PA



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For the house at 62 East Garfield, the primary repair was replacing two existing light fixtures in the kitchen and hallway with 4' Cooper fluorescent lights. Volunteers also added Cooper Lighting's Precision Plus Doppler Radar™ Motion Activated Security Floodlights outside the house and sealed up a large section of the basement's foundation. A smoke detector and CO₂ detector were installed, as well as some basic additional electrical work.

REPAIRS COMPLETED:

INSTALLED FLUORESCENT LIGHTING, SEALED FOUNDATION, REWORKED ELECTRICAL WIRING, PUT IN EXTERIOR LIGHTS

"This is going to make people take more pride in this block and in their homes." — Earl Tribble

It's through the donations of time, effort and resources, and the hard work of so many dedicated people working side-by-side that make a neighborhood greener, and the earth better, one block at a time. "I'm almost 90 years old," says Earl Tribble, an East Garfield resident of 40 years, "and this means so much to me. I'm flabbergasted. This is going to make people take more pride in this block and in their homes. And I'm going to have a beautiful garden next to my house. And that makes me happy."

It goes without saying that none of this would have taken place if not for the amazing group of people who run **Rebuilding Together Philadelphia** and their dedicated volunteers. If you would like more information about the organization, or if you want to volunteer or make a donation, visit www.rebuildingphilly.org. You can find out how to volunteer or donate to your local Rebuilding Together affiliate at www.rebuildingtogether.org.



BLOCK BUILD VOLUNTEERS FROM RTP AND PM, AND THE RESIDENTS OF EAST GARFIELD AT THE END OF THE DAY

Popular Mechanics would like to thank Cooper Lighting, Delta Faucet, Frog Tape, Johns Manville, Kilz, Lee Jeans and Minwax for the materials they graciously donated to this project.



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Henkel



diy

Home

Prime Movers

WE TEST BACKPACK LEAF BLOWERS TO FIND THE BEST BLASTER. BY ROY BERENDSOHN

➔ **Time versus money.** Would you rather put in more hours doing yardwork or spend some cash on powerful tools to do the job quickly? If you're willing to invest, nothing can speed outdoor jobs more than a backpack leaf blower—the

gardener's answer to the jet pack. We gathered five homeowner models, ranging from 45.4 to 50.8 cc, and gave them a workout blowing wet and dry leaves, sticks, pine cones and seedpods. We also evaluated two new pro models that rep-

resent the industry's future—one is a four-cycle and the other a two-stroke hybrid. During a second phase, we tested how homeowners used this gear by working alongside volunteers clearing leaves at a church. Here's what we found.

INSIDE

×

GUTTER GUARDS + FIRE SAFETY + PM SATURDAY PROJECTS

THE

GOODS

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PM
DIY HOME
///
LEAF
BLOWERS



DOLMAR
PB500R

ENGINE: 48.6 CC
AIR (CFM):
447 @ 171 MPH
DRY WEIGHT (LB): 22.7
dBA (AT 50 FT): 71
PRICE: \$300

Likes: Only the Dolmar is equipped with both a top handle and a roll-cage handle on both sides. Sounds like a minor feature until, like us, you find yourself on and off a tractor and in and out of a pickup truck. Those handles make all the difference. This is a capable machine, if somewhat less powerful than its competitors.
Dislikes: The Dolmar is cursed with a kooky graphic on the left control arm. It's confusing. You can too easily try to start the machine with the ignition switch off.

ECHO
PB 500

ENGINE: 50.8 CC
AIR (CFM):
450 @ 162 MPH
DRY WEIGHT (LB): 21.8
dBA (AT 50 FT): 70
PRICE: \$320

Likes: Simplicity and power. Our volunteer corps, working at clearing leaves at a church, needed no coaching to use the Echo. Anyone can start it, sling it on his back and start blasting leaves in seconds. The gas tank is designed so you can position your foot on the blower frame for an easy pull start, the primer bulb is right where you can see it, and the flexible left control wand—which has the throttle mounted on it—is so smart, you wonder why other manufacturers haven't copied the design.
Dislikes: Nothing noted.

HUSQVARNA
350BT

ENGINE: 50.2 CC
AIR (CFM):
494.4 @ 180 MPH
DRY WEIGHT (LB): 22.5
dBA (AT 50 FT): 71
PRICE: \$300

Likes: The Husqvarna is one of the most powerful of the residential models—you've got to strap this thing on to appreciate how effective it is. It not only moves a lot of air, but the blast from its tube seems unusually productive; perhaps it's more laminar and has less turbulence than others. It's also the most comfortable machine. We were skeptical about its hip belt until we started scaling steep hills and stone walls. It works. If you clear difficult areas, this is your blower.
Dislikes: The upside-down purge bulb is a nuisance.

KAWASAKI
KRB650B

ENGINE: 45.4 CC
AIR (CFM):
580 @ 164 MPH
DRY WEIGHT (LB): 19.1
dBA (AT 50 FT): 71
PRICE: \$410

Likes: Simplicity. Kawasaki doesn't overthink things with this machine. There's no left wand; the throttle is on the pistol-grip assembly on the blower tube and has the old familiar rabbit-and-tortoise graphic. There's also a choke control that's easy to find and to understand, as well as a forward-pointing purge bulb. These features make this machine easy to start and fun to run.
Dislikes: The Kawasaki moves a lot of air, but it needs more velocity to be as effective as other blowers.

REDMAX
EBZ5100

ENGINE: 50.2 CC
AIR (CFM):
487 @ 171 MPH
DRY WEIGHT (LB): 22.7
dBA (AT 50 FT): 71
PRICE: \$380

Likes: Comfort. We know it's subjective, but at least for our shoulders and back, the Max has the best padded shoulder straps; they're firm—and it has a correctly shaped back pad. An accessible and visible gas tank makes it easy to fuel.
Dislikes: An upside-down purge bulb that's buried on the left side of the engine between two plastic tubes is not optimal. The left control bar with its clunky spring-loaded detent positioning also needs some improvement.

Clearing the Air

The future is clear for two-stroke power equipment. It either becomes cleaner or it disappears. That's especially true for the varieties that pros operate for hours a day. We tested two low-pollution models, both of them commercial-duty. The Stihl is a hybrid that uses a four-cycle engine but two-stroke fuel. The Makita is a true four-cycle machine.

Do you give up performance when you go with cleaner equipment? No. These machines move an awesome amount of air—and leaves. Although it's difficult to quantify, I'd say they'd allow you to cover about a third more ground than you would with the residential equipment mentioned here, and they can move material that's soaked, packed or lightly frozen. After a thorough workout, we'd have to say that these machines fought to a draw—each has advantages.

Likes: Everything. As with its formidable orange competitor, when you point the nozzle straight down, you get a sensation that you're hovering a couple of inches off the ground. Okay, we're kidding, but it is extremely powerful. I used it to make a chest-deep pile of leaves, then easily blasted a channel through it.

Dislikes: Should be quieter.

Likes: Again, everything. During the second phase of this test, when I stepped out with a group of volunteers, I chose to shoulder the Stihl because it's so powerful yet lightweight. Later in the day, I handed it off to another volunteer who also raved about it. It's the ultimate pro-grade leaf-clearing rocket.

Dislikes: Nothing noted.

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- HIGHLY ACCESSIBLE FUEL SPOUT; TRANSLUCENT GAS TANK
- LEDGE LARGE ENOUGH TO PLACE YOUR FOOT ON WHEN STARTING
- HANDLE WITH THROTTLE

BEST OVERALL

MAKITA BBX7600 CA

ENGINE: 75.6 CC
AIR (CFM): 720 @ 195 MPH
DRY WEIGHT (LB): 22.6
dBA (AT 50 FT): 74
PRICE: \$450

STIHL BR600

ENGINE: 64.8 CC
AIR (CFM): 712 @ 201 MPH
DRY WEIGHT (LB): 21.6
dBA (AT 50 FT): 65
PRICE: \$490

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Homeowners Clinic

by Roy Berendsohn

Q+A

Clearing Gutter Clutter

Q I absolutely hate cleaning gutters. Do gutter covers work? Can I install them myself?

A There's a lot to answer with that question. Yes, gutter covers do work. I've owned a house with them, and I can vouch for their effectiveness in stopping a buildup of leaves and seedpods from deciduous trees. As effective as they are, I can see where models with a slot for water drainage could let pine needles in. If you want to guard against pine needles, a perforated guard may be a better choice.

Also, not all gutter covers work with all types of roofing. Many covers are designed to be installed at the edge of a roof with standard three-tab shingles, the most popular type of roofing. Those covers may not work with a slate, clay-tile or standing-seam metal roof. Check with the

manufacturer or retailer before purchasing anything.

You can install gutter covers yourself. Some models simply snap into place above the gutter. More frequently, some advanced DIY skills are necessary; basic roofing and sheet-metal work may be required. If you decide that the work is too complex—or dangerous—any roofing or gutter-siding contractor can do the job.

Even before you install a gutter guard, there's a lot you can do to make gutter cleaning easier. You can bring a

bucket up a ladder or you can throw the leaves down onto a tarp placed on the ground. The first method works best with small quantities of dry leaves, especially if you use a rectangular bucket that you can hold against the gutter's edge. The second technique works best with large amounts of wet leaves, and where there's lots of room to lay out the tarp. The best part about this technique is that you can hold the ladder with one hand and scoop with the other.

When I was a young guy, I would

Gutter Toppers

→ There are two types of gutter covers. One type consists of a formed hood, the back of which slides under shingles at the edge of the roof. The other (shown here) is a screen that snaps in place over the top of the gutter.

simply walk up onto the roof, squat down at the edge, scoop out the gutter and move on. While I suppose that works with a reasonably pitched roof, it is dangerous. These days I plant the foot of the ladder on firm and level ground, lean the ladder at a 75-degree angle and take my time cleaning. Wherever possible, I avoid placing the ladder against the gutter so as not to damage it. Instead, I lean it against the siding and use a ladder stabilizer. That provides a more stable platform and complete access to the gutter, because the top of the ladder isn't sticking above the gutter's edge. When that isn't possible, I lean the ladder near where the gutter is supported by a bracket.

Report Card

We're new homeowners and our home inspection report pointed out damage to the vinyl siding in several places. Some parts have tiny dark spots that look like paint, while other areas are warped or look melted. Can the spots be removed, and can the other areas be repaired? One of the warped sections of siding is pretty high off the ground. We want to avoid re-siding the entire house if possible. Thanks for your help.

The spots are probably dried spores from microorganisms known informally as shotgun or artillery fungi. They broadcast their spores toward light-reflecting surfaces, such as light-colored siding, and they stick tenaciously. It may take pressure washing to remove them—or at least a scrubbing with a siding cleaner and a siding brush on a telescoping pole. These fungi flourish in wood mulch, especially if it's spread on flower beds near a house. Turning the mulch regularly can reduce the chance of its forming.

The bowed or melted siding could have several causes. For one thing, a nearby energy-efficient window with an optical coating may be reflecting intensified sunlight onto the wall. A committee formed by the National Association of Home Builders found that such reflec-

tions can generate surface temperatures above 200 degrees F. That doesn't happen often, fortunately.

A more common cause of siding damage is the heat produced by a gas or charcoal grill placed too close to the wall, usually near a patio or deck. In fact, the previous owners of my place left a heat-damaged section of siding for me to deal with, so you're not alone.

And, finally, the installers could have set you up for trouble. Nailing the siding too tightly, so that it doesn't have room to expand and contract, will cause it to buckle.

You may be able to blend in a repair by using siding pulled from less visible places, like the back of the house. Or you can simply repair everything with new siding and then paint the siding a light color to ensure that the whole surface has a uniform look. A topnotch acrylic latex paint will bond extremely well to clean vinyl siding and can provide a decade's worth of protection. Granted, it's a lot of work. Your alternative, however, is to re-side the house.

Rinse and Repeat

I want to pressure-wash my tractor, boat and some patio furnishings, but I have a problem with sticky detergent residue fouling my pressure washer.

What am I doing wrong?

Many homeowners neglect the purge procedure on their machine, causing detergent residue to build up. Once this happens, a pressure washer won't dispense detergent properly.

For example, if your pressure washer uses a siphon hose to pick up cleaning solution out of a bucket, you're probably supposed to fill the bucket with clear water and run that through the washer. It may take 5 to 15 minutes of this purge procedure to completely clear the hose, the cleaning solution filter, the pump and the chemical injector.

It's also possible that you're using the wrong detergent (one not rated for use in a pressure washer), or that you haven't diluted the chemical properly.

Continued on page 120

HOW YOUR HOUSE WORKS

→ Garage Door

The Rise and Fall

FEW MACHINES REVEAL THEIR INNARDS LIKE THE GARAGE-DOOR SYSTEM. HERE'S HOW TO MASTER THOSE SQUEAKING SPRINGS AND CHAINS. BY HARRY SAWYERS



🔧 The garage door dies

some time during its 13,476th operation, while it's being closed. It goes out without much drama—there is no audible snap as the torsion spring breaks, no parts dangle loose in telltale failure, and the motor still lights up, strains and stops. Maybe its decline started that day you closed the door on the Buick bumper, or maybe during the last big freeze, when ice swelled the door sections. Or maybe it was just the mechanism's time. The average American garage door opens and shuts 1500 times a year, and this torsion spring—rated for 10,000 cycles—was positively geriatric in garage-door years. Regardless, you're in the market for a new system. Here's everything you'll need to know.

ILLUSTRATION BY MERCE IGLESIAS

INSIDE

→ BELT DRIVE → TORSION SPRING
→ U-FACTOR → OPERATOR ANATOMY
→ NEW CULT DRIVE-IN MOVIES

DRIVE MECHANISMS

DOOR DETAILS

→ The **torsion spring**, not the operator (or motor), does the heavy lifting. Aesthetics aside, the big changes in today's 300-pound steel doors are in insulation. Tighter perimeter seals and sandwiched polyurethane panels get some doors' U-factors, which measure resistance to heat flow and air infiltration, down as low as 0.2. A door under 0.3 qualifies for a 2010 tax credit of up to \$1500.

Mounting
Hardware

Pulley & Cable

Belt

Tracks
(Door &
Trolley)

Torsion
Spring

Curved
Door Arm

Emergency
Release
Rope

Garage Door

Safety
Reversing
Sensor

DRIVE-IN MOVIES

→ A popular short-film genre has hit YouTube: garage doors opening and closing. The blockbuster example, with 43,985 views, is titled *Garage Door*. In 1:23 minutes, a door rises, falls, rises and falls. No dialogue, no characters, no accident. (Similar YouTube hits: footage of grass growing and paint drying.)





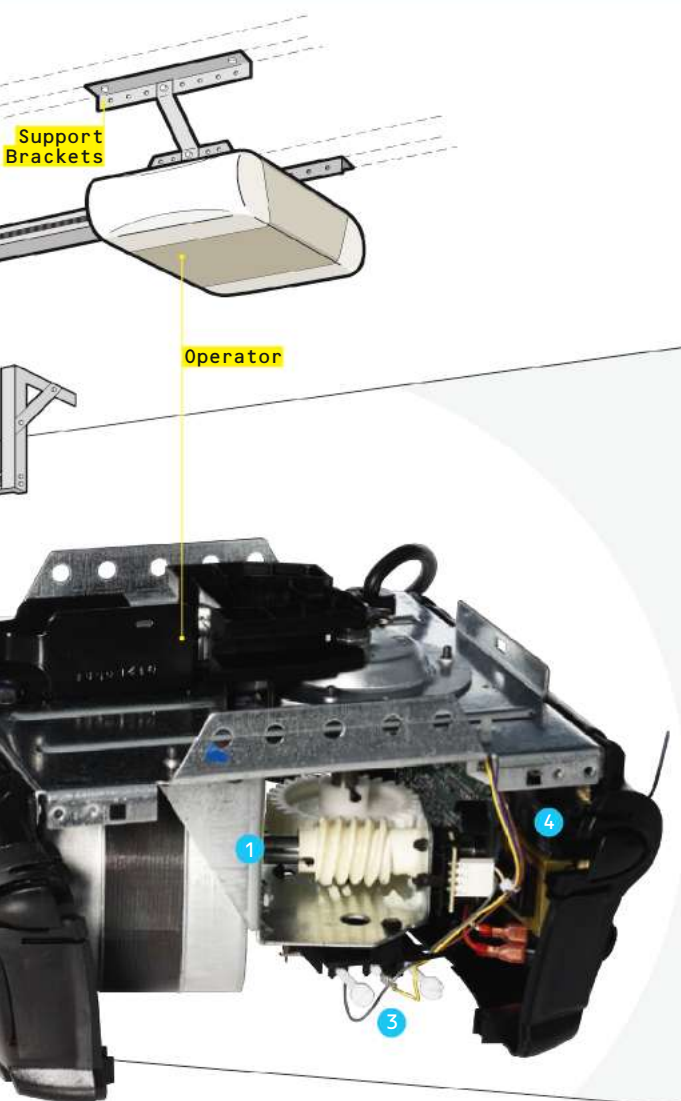
Belt → Among the quietest (and costliest) drive options, the belt's Kevlar polymer body is molded into nubby teeth on one side. These rotate through a gear on the operator top to pull the trolley.



Chain → The cheapest and oldest technology, the bike-chain-style chain sits slightly slack when the door is open—at least ½ inch above the bottom of the T-rail. The chain makes a racket, but maybe that's a good thing when your teenagers are sneaking out.



Screw → A continuous threaded shaft connects the operator to the trolley, and its arm reaches for the door. Its threads require biannual lubrication with silicone, and it wears out the trolley more quickly than the other options. But the screw is the Goldilocks drive—median price and noise level.



ANATOMY OF AN OPERATOR

1 Motor & Gears

The motor is typically about a ½-hp, 6-amp machine hooked to a 120-volt outlet—that's all it takes to overcome the inertia of a stopped door. The machine also slows a door in transit, preventing it from crashing to the garage floor.

2 Drive Guide

This track (aka the T-rail) guides and shields the chain, screw or belt as it moves the door open and closed. It connects the operator to the trolley, which in turn is connected to the door.

3 Height Adjustment

Operator settings determine the distance the door travels. The machine kicks in to arrest the door's motion or to make adjustments if a door isn't opening or closing completely. The force of the door's motion can also be adjusted so the door stops moving if grabbed.

4 Inverter & Battery

To allow smaller, more efficient motors, most garage-door operators use DC current. An inverter switches household AC power to DC, which is also used to charge a battery backup system that kicks in when the power is out.

THE CUL-DE-SAC HACKERS

In the past, suburban burglars sometimes gained access to garages by using radio scanners to eavesdrop on a code transmission between a remote control and a garage door. Doors in the 1960s were easy targets—they used only one code. In the 1970s and '80s, code grabbers pilfered one of 256 codes that the remotes cycled through. "Since the mid-1990s, we've had rolling codes with billions of combinations," door-operator manufacturer Chamberlain's Paul Accardo says. "The remote sends a code to the receiver; it opens the door and creates a new code for the next time the door opens. Someone could still capture that code, but it won't be used again." Hear that, punks?

PHOTOGRAPHS BY J MUCKLE

TITLE →
New automatic garage door opener!
VIEWS → 42,591
DURATION → 1:01
COMMENT → "Craftsman's openers Rock and LiftMaster rock too"

TITLE →
Garage Door Opening on October 22
VIEWS → 25,173
DURATION → 0:31
COMMENT → "OMG LOVE IT! ... that remote is so slick"

TITLE →
AUTOMATIC GARAGE
VIEWS → 25,512
DURATION → 2:00
COMMENT → "NOT an automatic garage door. It is merely an electric garage door"

TITLE →
Fastest Garage Door Ever
VIEWS → 20,944
DURATION → 0:11
COMMENT → "Dude there's no way a garage could go that fast"

TITLE →
My Garage Doors Opening And Closing
VIEWS → 8733
DURATION → 6:49
COMMENT → "Wow, my only regret is that this video is only 7 minutes"

*There's nothing half
so pleasant as
coming home again.
—Margaret Elizabeth Sangster*

Jack 2-10
Jane 10-26
Jack 6-09
Jane 11-07
Jack 10-09
Jane 08-04
Jack 11-07
Jane 09-01

PJ 5-10

There's a reason homeownership is the foundation of the American Dream.

Over time, owning your home has proved to be a good decision. And while lately the economy has presented some challenges, it has also helped us focus on what matters most. It's reminded us that home is where we make memories, build our future and feel comfortable and secure. When you're ready, a REALTOR®, a member of the National Association of REALTORS®, can help you find the home that's right for you. REALTORS® are prepared—to answer your questions, show you options and guide you home.



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Continued from page 116

Washers that have an onboard chemical tank may require the use of a cleaning solution mixed at a specific ratio. If you drop two or three cleaning packets into that tank instead of one, it doesn't just waste cleaner—it will also gum up your equipment.

Danger in the Walls

I bought a 100-year-old house, and I want to insulate the exterior walls and install new drywall throughout. We plan to use blown-in cellulose. Does insulation add fire-stopping protection as well? As far as I can tell, there's no fire blocking inside the walls.

It's quite possible that your house lacks fire blocking—pieces of lumber nailed horizontally into a wall cavity to stop the spread of superheated air, sparks and combustion gases that race up through a wall cavity during a fire. Without this blocking, a tall exterior wall cavity that is not interrupted by window or door framing becomes, in effect, a chimney with a powerful upward draft. The unchecked spread of fire is more likely in balloon-frame structures in which long, uninterrupted wall studs run from the foundation sill to the eaves. Balloon framing was the preferred construction method starting in the 1830s and was used until the 1950s, when it was replaced by the still-current platform frame (one platform is built on top of another without uninterrupted wall cavities). Moral of the story: If you renovate a balloon-frame structure and find no fire blocking, install it.

Yes, cellulose insulation can reduce the spread of fire. Although for the most part it is nothing more than recycled newspaper, it's treated with fire retardant, and its use is permitted by national building codes and in many places that have state-specific codes. Any properly installed, code-approved insulation reduces the spread of fire by reducing the flow of superheated air and combustion gases inside wall cavities.

KNOW YOUR STUFF

We Didn't Start the Fire-Sprinkler Mandate

About 3000 Americans die in house fires every year.

Beginning in January 2011, a change to the International Residential Code (IRC) aims to reduce that number by making fire sprinklers mandatory in all new single-family residences. Sounds good, but home-building lobbies from Texas to Georgia have defied what they call an impractical, expensive mandate, convincing legislators to pass bills overriding the requirement.

"We're not against residential fire sprinklers—as a voluntary measure," says Steven Orlowski, program manager for construction, codes and standards at the National Association of Home Builders (NAHB). "A building code provides the minimum balance between cost, safety and welfare. You could do everything to the nth degree and get 100 percent safety, but that's not the purpose of the code."

The sprinkler mandate was one of 2400 code change proposals in the past IRC revision. The NAHB took a position on 960 proposals, with an eye on one particular concern: "You have a number of manufacturers trying to promote a specific product," Orlowski says. According to the NAHB's communications director, Calli Schmidt, "The only way

for sprinkler manufacturers to make money is to focus on mandates. Otherwise, they're not financially feasible."

Maria Figueroa, of the National Fire Protection Association (NFPA), turns that argument back on the builders, saying their reluctance to embrace expanded rules is driven by a desire to sell houses. "Protecting lives should be a priority over profits," she says.

The California Building Industry Association estimates sprinklers will add about \$5000 to the

Jayson Drake says. Insurance discounts of about 10 percent a month also chip away at the price, according to Jim Lindahl, a State Farm agent in Minnetonka, Minn. "With sprinklers, the cost and volume of the claims go down, and the severity of the claims go down. When we get to a house that has sprinklers, the damage is so much less," he says.

The fire survival rate in homes with working smoke detectors is 99.41 percent, according to the NFPA. Toss in



price of a new home. To reduce costs, plumbing-systems manufacturer Uponor has devised a simplified AQUASAFE system that ties into the home's existing cold-water supply. "Our system integrates with the home's plumbing, like another fixture, faucet or toilet," Uponor product manager

a sprinkler, and the rate rises to 99.6 percent. "Consider how little it costs to install smoke alarms," Orlowski says. "For the cost of the sprinklers, you're really not getting a significant increase in safety." But you are, for better or worse, buying a house that's built to the latest code. — HARRY SAWYERS



→ A slab-jacking contractor will bore a hole using a rotary hammer (a rock drill). Next, he will pump grout under the slab to lift it and trowel off the excess grout.

Probably the most important fire-preventive measure that you can take with an old house, though, is to have it rewired to comply with the current National Electrical Code, or whatever version of the code is in practice where you live.

That Sinking Feeling

One end of my concrete driveway near the garage has dipped below the rest of the driveway, and a large pool of water forms there when it rains.

What do I do? Can I cut out and remove that part and pour a new piece of concrete without damaging the rest of the driveway?

Yes, a knowledgeable concrete contractor can certainly cut out the piece of concrete and install a new slab without damaging surrounding concrete. The job can get tricky, however, if the sunken section is positioned so that there's not enough room for a masonry saw at one or more edges. That can happen in corners where a slab meets a foundation wall or where it meets another slab. Also, the color of the replacement piece won't match that of the surrounding pavement, though that can be mitigated by using concrete stain on the entire driveway.

An alternative to cutting and removal is slab jacking (also known as mud jacking). A contractor uses a rock drill or a core drill (a holesaw for

masonry) to make some holes in the sunken slab. Then he or she pumps a material called grout through the hole. This is like concrete, but it lacks coarse aggregate, such as stone or gravel. As this material is forced under the slab, it lifts the slab up. After the slab is lifted, the holes are filled with more grout or a concrete patching compound, or the concrete cores are glued back into place with a specialized adhesive. There's an obvious green benefit to this procedure. It takes less energy and materials to jack up a slab than to replace it and pulverize the old concrete for use as road-building material. The process generates very little debris to dispose of, an obvious benefit in areas where there is little or no concrete recycling.

It takes a lot of experience to do this work correctly. It's easy to crack an adjoining slab or unevenly lift a sunken slab—making it worse than it was before. That puts a premium on hiring an experienced contractor. **PM**

Got a home-maintenance or repair problem? Ask Roy about it.

Send your questions to pmhomeclinic@hearst.com or to Homeowners 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.



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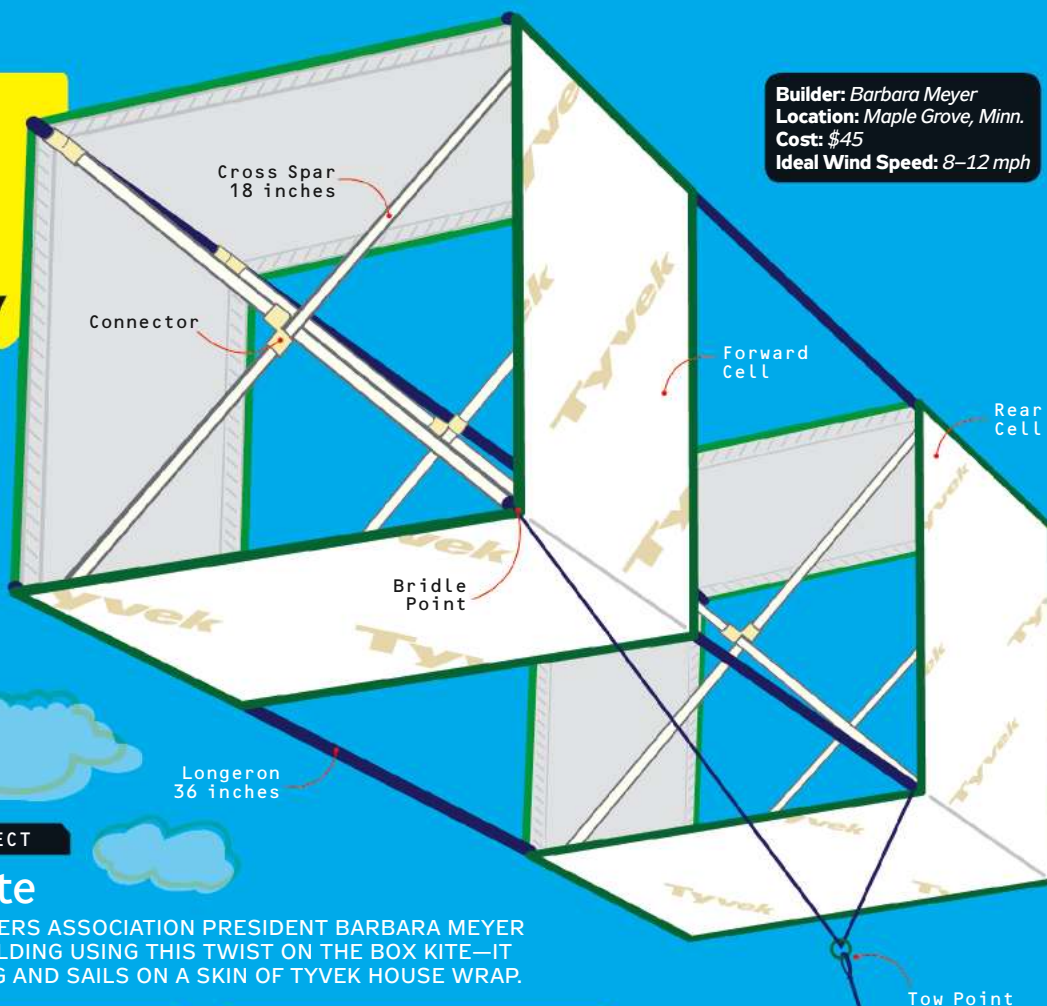
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TYVEK AND TAPE

1 → Woven polyethylene Tyvek house wrap makes a fine, if heavy, kite-skin substitute for standard nylon spinnaker cloth. Tyvek fastens with 2-inch tape instead of stitches. Cut two Tyvek cells to 12 x 82 inches. Join them into a circle. Fold the edges over ¼ inch to prevent fraying.

DOWELS

2 → Cut four 36-inch-long ¼-inch-diameter dowels and eight 18-inch-long ¼-inch-diameter pieces. Short dowels span the kite as spars. Tape the long dowels, the longerons, inside each corner. Slip dowels into pockets or tape them at each end.

VINYL TUBING

3 → Join the dowels with 2-inch lengths of ¼-inch-inside-diameter vinyl tubing, slit partway across so that it bends into an L. Fit a dowel tip into each L end at the joints, using two tubes where spars cross. Use 40 inches of tubing to make 20 joints.

BRIDLE LINE

4 → To attach 50-pound bridle line to the cells, thread line into a sewing needle, slip the needle into the Tyvek and tie a knot around the longeron at the points shown. Merge the lines at a ¾-inch tow ring. Leave 30 to 39 inches of line from the tow ring to the cells. Wind above 10 mph? Wear gloves.

+ MORE TO DO IN SEPTEMBER



Sweep the Chimney → According to Captain Soot, a chimney-sweep service in Copiague, N.Y., September is ideal for a DIY de-cresote job in a dirty flue. “You need to get up on the roof, look down and give it a good inspection,” says Jeff Caracristi, chimney sweep at Captain Soot. See black,

shiny glaze? Use a chemical cleaner and a rotary wire brush. Oil-furnace chimney? Use a nylon rotary brush. Flaky gray or white soot on a light-duty chimney? Nonrotary wire.
Or Just Play → At the Big Boy Toy Expo, Sept. 4 and 5 in Punta Gorda, Fla. Drool over custom cars and vintage pinball machines.



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Starting With the Right Foot

THERE ARE PLENTY
OF WAYS TO BREAK
IN YOUR NEW CAR.
SOME OF THEM ARE
THE RIGHT WAY.

BY MIKE ALLEN



→ **It's a thing of beauty:** A brand-new car, shiny and crisp. It makes you want to spend the whole evening walking around it. Pretty soon, the neighbors wander over to congratulate you—and to render advice.

Break it in carefully, one says: "No more than 30 miles per hour until it has 1000 miles on the odo."

"No," another says. "Drive it like you stole it, if you want it to be fast."

Others recommend synthetic oil, or nitrogen in the tires, or a mouse-milk oil additive, guaranteed to double fuel economy.

The ritual of breaking in a new car is part of the body of knowledge we refer to as conventional wisdom. It's not

necessarily wise, and the technology of building a modern automobile has evolved to the point where a lot of "wisdom" is obsolete. Few cars specify a break-in procedure anymore, simply cautioning you to avoid extreme acceleration or extended idling for the first thousand miles or so, and there's little in the way of extra service up front.

INSIDE



CARE AND FEEDING OF NEW CARS + GREASE IS THE WORD + FIND THE SENSOR

Some don't even mandate an oil change until 6000 miles. We think your new ride deserves better. Here are a few tips.

Engine Cylinder Walls

→ **Piston rings don't rely** on their spring tension to seal against the cylinder bores. Instead, combustion gases work their way between the rings and the piston and force the rings outward. During the first few minutes of engine operation, it's important that the throttle be opened pretty far at lower rpms to provide this high pressure. Otherwise, the rings won't burnish the cylinder walls properly, and the engine will have high volumes of blow-by—which means excessive oil consumption and shortened engine life. If you've ever seen the car jockeys who drive new cars off the end of the production line into the storage lot, or the transporter drivers zipping up and down the car-hauler ramps,

you'll realize that this all-important step has been performed for you many times. If you're installing a new engine, simply give it a few seconds of wide-open throttle in a high gear. For the first thousand miles, avoid constant speeds and throttle settings. If you commute in normal stop-and-go traffic, you'll be fine. I advise against cruise-controlled sojourns across Nebraska.

Bearings

→ **The admonition to keep** engine revs low for an extended break-in period stems from the days when bearing and crankshaft manufacturing tolerances were far less rigorous and lubricating oil wasn't nearly as good. While modern engines are assembled to much the same design clearances, the tolerances are much tighter, meaning the variability is smaller, greatly reducing the possibility of a tight spot. Redlining a fresh motor is generally a bad idea, but there's no reason you shouldn't drive normally. I would, however, avoid top-speed testing, drag racing or towing

heavy trailers for the first 1000 miles.

Oil

→ **I customarily change the oil** in a new engine after about 20 miles, and again at 1000 or so. That 20-mile oil, you would think, would look pretty much like fresh oil right out of the bottle. Wrong. It usually looks more like metal-flake paint, iridescent with tiny particles of metal worn off rubbing surfaces inside the new engines. After a few hours of operation, this completely normal phenomenon slows down as the rings, camshaft, lifters and bearings burnish their respective mating surfaces.

Transmission

→ **The engine break-in** procedure also covers the gearbox and the clutch on manual-transmission cars. Most cars with automatic transmissions today are factory-filled with ATF and, supposedly, will never need changing. Some manufacturers are so confident of this that they don't even have a dipstick or a fill hole. If the specified fluid is a more



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PM DIY AUTO /// BREAKING IT IN

normal mineral oil, I'd change it and clean the pan after a thousand miles or so. The organic linings on the clutch packs shed a lot of debris, and it generally just turns into sludge that lies in the pan. You don't want wear metals and sludge to get picked up by the pump and start circulating in the expensive bits.

Brakes

→ **New brake pads** on new brake rotors don't really require a break-in procedure. The texture deliberately left on the surface of the iron discs will grind down the fresh surface of the pad material within a few miles. Even so, refrain from high-speed stops or dragging the brakes for a few hundred miles. Racing pads, however, need to be heated up enough to fade and then carefully cooled off, which removes the top layer and provides better fade resistance.

Interior

→ **Avoid the impulse** to slather the interior trim with shiny protectants, which can leach the plasticizers out of new vinyl and increase the likelihood of age-related cracks. On the other hand, a generous dousing of Scotchgard on the cloth upholstery and carpets will keep dirt, pollen and mildew from clinging.

Paint

→ **In years past**, it was considered a good idea to not wax a fresh paint job for 90 days, to allow the paint to fully cure and any solvents to escape without being trapped under the wax. Modern catalyzed clear-coat paint is as hard as it will ever be as soon as it cures, before the car ever leaves the plant. Applying 3M Paint Protection Film to the leading edge of the painted bodywork will go a long way toward minimizing stone-chip damage. Otherwise, a good coat of wax will repel water, atmospheric pollutants and dead bugs. **PM**

■ NOW YOU KNOW

Is synthetic oil too slippery for proper break-in?

Conventional wisdom says that a new engine should be broken in on conventional mineral oil, regardless of your intentions to use a synthetic for the long haul. The conventionally wise say that synthetic oil is *too* slippery and won't let the microscopic high points properly lap themselves in, delaying the break-in process.

I say rubbish. Many modern cars, notably such high-performance marques as Porsche, Ferrari and Corvette, are factory-filled with synthetics. You can bet that somebody has determined that the break-in process will proceed normally with synthetic in the sump of

these ultra-high-performance engines. And that goes for your Toyota or Jeep as well.

Nonetheless, I do prefer to use a mineral oil for break-in. It's \$3 a quart versus \$7, so I don't mind changing it after 20 miles and again at 1000. I would not, however, change the factory-fill synthetic back to mineral for break-in. Those vehicles typically have carefully assembled engines with instructions to do the first oil change at the regular interval, which could be up to 10,000 miles. In those cases, I simply change the oil early, before 1000 miles, just to be safe.

Synthetic oil is a superior product, particularly if your engine operates at the extreme

ends of the temperature scale: high-temperature climates, towing or racing. But like any oil, synthetic will become contaminated with atmospheric dirt, wear particles, carbon, partially burned fuel, water and acid. Eventually, even if the oil itself is performing properly, all this extra junk will manifest itself as engine wear.

Also, the first oil change invariably reveals small particles of gasket sealer, chunks of unidentified plastic, the occasional metal flakes that weren't cleaned off before assembly and even the odd washer or nut. It's pretty scary. Better this junk come out sooner rather than later.



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Car Clinic

by Mike Allen

Q+A




Mix & Match

Q I shot a bunch of expensive marine-style grease into the bearing buddies on my bass-boat trailer last fall. It was recommended to me by a marine mechanic as the best product for my trailer, because the wheels get dunked regularly, and this particular type of grease is supposed to be more water-resistant. I finally got a chance to go fishing last weekend and noticed that the grease cups had all leaked oily snot all over my brakes. So instead, I spent the afternoon cleaning and repacking all six wheel bearings and replacing all of the greasy, oily brake shoes. Can you suggest a brand of grease that won't do this?

A You mentioned the brand of grease in your letter, which I removed, because it's a perfectly good product, and the correct one for your application. Specifically, it's an aluminum-complex grease, and this type of grease has excellent performance when there's a chance of water contamination, like on your trailer.

A primer about grease: It's basically nothing more than a heavy oil mixed with enough soap to make it stringy and clingy enough to remain in place as the bearing spins. This will ensure the bearing's rollers or balls are constantly covered in the oil. The soap is based on a variety of compounds, notably lithium or aluminum complexes for most of the greases used in cars, trucks and boats.

Problem: Not all the soaps are compatible with each other. This causes the soap and the oil to separate, letting the latter settle to the bottom of the cavity the bearing is in. No surprise—a lot of grease caps have a poor metal-to-metal seal and will let the oil leak out after

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some weeks. Like yours did.

Your wheel bearings were probably originally lubed with a lithium-12-complex grease, a perfectly good grease for wheel-bearing use, even on a boat trailer if it's maintained. Shooting some more grease into the bearing cap with a grease gun isn't a bad idea. Shooting an incompatible grease in is.

This counterpoints the need to completely remove the last vestiges of old grease from a bearing whenever it's repacked. Yes, you want to remove the dirt and wear particles, but odds are you won't know what kind of grease the last mechanic used.

I'm not going to print a huge grease compatibility chart here, although that



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Now that you know you have seepage, how do you know if it is too wet to paint? Simply run your fingers along the wall surface, if your fingertips are wet with water from the wall surface, it is too wet to paint and you should wait for a dry, rain free period. Remember, seepage and condensation can happen at the same time and a dehumidifier may help. Once the area is dry follow the step-by-step instructions found in the DRYLOK Masonry Waterproofer how-to booklet at www.ugl.com.

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PM DIY AUTO /// CAR CLINIC Q + A

kind of information is available on the Internet. If you always clean the bearings properly before repacking, it will never be a problem.

Don't have a nice parts-washing sink with recirculating solvent handy to your driveway? It's still easy to clean the bearings properly. Remove the bearings, inner and outer, and any shims, lockwashers and clamp nuts. The bearing inner or outer races can stay pressed in place, however. Scrub the inside of the bearing cavity with paper towels until you've got as much grease out as possible, and wipe as much off the bearing itself. Dump the used paper towels. My favorite bearing cleaner for the field is a disposable aluminum pie tin, but any suitable vessel will do. One at a time, clean the parts in solvent, whether it's turpentine, paint thinner, kerosene or even hot, soapy water in a pinch. Keep the bearings separate so they go back into the same wheel—don't mix and match. Use a cheap disposable paintbrush to scrub all the old grease out. Let dry, then finish with a quick blast of carb or brake cleaner to get the last dust off. If you have compressed air, you can use it to dry the bearings as long as you don't spin them into destruction. Pack the bearings by hand, and fill the cavity approximately halfway with grease.

Locks Only Keep Out Honest People

I cannot open the tailgate on my Honda minivan. The exterior release handle is no longer connected to anything and will not release the door. There is no actuator on the inside of the door. Can you tell me how to get the door open so I can work from the inside to fix the problem?

Not easily. It's probably a failure of a cheesy nylon clip inside the mechanism, one that holds an actuator rod to a bellcrank, handle or the latch mechanism. The clip fails, the metal rod pops out of the bellcrank, and the door won't open. Easy to fix—once you have access.

I'd start with getting a locksmith to slim-jim (basically a long, flat coat-

hanger analog) the door open, which may not be possible. The procedure is to wedge the rear glass open a crack, and then use the long, hooked probe to trip the latch. Oh, your door or liftgate or whatever has fixed glass? You're in trouble, dude. See if you can disassemble the license-plate light or any other hardware on the door to gain access, even if it's only a couple of square inches, to insert a slim jim. I've had to resort to dismantling a door on a similar vehicle and make or modify a slim-jim or lock-pick tool to fit.

No access from outside? You'll have to remove the door interior trim panel to get to the latch. What's that you say? The screws that hold the inner door panel are hidden when the door is closed?

You're screwed.

At this point you have three options: Break the interior panel to get it loose from its fasteners (I'd have a line on a cheap, used replacement before I tried this), drill out the old lock tumbler or, worse yet, drill, chisel or saw into the sheet-metal door skin to access the latch mechanism.

Cracked and Not Filled

I have tried to take exceptionally good care of my 2006 Jetta's interior and exterior, but this winter a ¼-inch crack appeared in my dash. It almost looks like it has been cut, and I have no idea where it came from. My greatest concern is the crack getting larger. What are my options?

That dash consists of a vinyl fabric over a foam padding. Sunlight, excessive cleaning and incessant slathering with protectant can leach all the vinyl-chloride plasticizer out of the vinyl—which then gets brittle and cracks. Eastwood (eastwood.com) has a repair kit that will let you make a pretty good repair if the crack is small, especially if it's in an unobtrusive place. Unfortunately, odds are the vinyl will crack elsewhere fairly soon. The only real cure is to recover or replace the entire dash, which is neither simple nor cheap.

Your other solution is one of those cheesy-looking fabric dash covers. You also could go retro and glue on some shag carpeting...

Next time, don't use anything

except a soft rag and warm water to clean the dash. Avoid harsh cleaners like 409, Janitor in a Drum, ammonia, alcohol, window cleaner or even detergents. They'll leach the plasticizers out of the vinyl coating prematurely.

Bug Report

Can you recommend anything to put on the front of my vehicle that will make the task of removing the bugs easier?

Aside from a good layer of car wax? Some 3M Paint Protection Film applied to the leading edge of the hood and fenders will keep bug guts from dissolving the clear coat, but it won't help the chrome or glass. I'd keep any rubber parts slathered in protectant, the windshield laved in Rain-X and a fresh coat of wax on everything else.

I've found the best thing for bugs is a 30- to 60-minute water soak, followed by a pressure washer and a hand wash with some car-wash soap on a clean terry-cloth or micro-fiber towel. Skip the sponge from the sink or any household cleaning products—they'll scratch.

Mud Boggin'

I have a 2002 Toyota Tundra with a V8 engine that has become dirty from a little bit of mudslinging. The engine bay is covered, not caked, with water and mud stains. What is the best and safest way to clean the engine without damaging anything in the process?

Used to be that you could just cover the distributor and air-cleaner inlet with some aluminum foil and have at it with the pressure washer or the wand at the self-serve quarter car wash. (Remember when car washes were only a quarter? Me either.) Today's cars have no distributor, and the air inlet is probably pretty well-protected inside the wheel well or grille. There are plenty of wires, though. And a lot of those wires carry very low-voltage, low-current sensor information that will be seriously compromised if corrosion gets into their connectors. A

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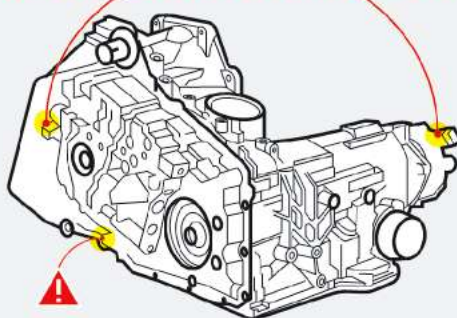
Who Stole My Temp Sensor?

You're crawling uphill in traffic and the "Transmission Hot" warning light comes on, only to shut off when traffic breaks and you're cruising. Was that normal? Maybe the sensor is out of calibration, or there's a bad connection. You check the wiring diagram and component locator chart to find the temperature sensor so you can test or replace it. But you can't find mention of a transmission temperature sensor on the schematic. Where is it?

Stop looking—this transmission doesn't have one. You've heard of virtual reality? Well, now we have "virtual sensors," where the computer uses other measured data to make an educated guess about the status of some other parameters. For example, the new Ford Fiesta with the automated dual-clutch transmission doesn't directly measure the temperature of the clutches. But the computer analyzes the current required to drive the clutch shift actuators, engine run time and rpm, throttle position and vehicle speed, and calculates the clutch pack's temperature. If the vehicle is driven for an extended period of low-speed/high-load operation without periods of braking or coasting to reduce heat, a Transmission Hot message may appear. Engineers program and validate the warning-light algorithm during the car's testing phase, when they torture-test it in all conceivable operating conditions.

Why not just use a temperature sensor?

VIRTUAL SENSORS Before you spend the afternoon dissecting the schematic diagram for a sensor you can't quite place your finger on, be aware that sometimes they're not really there.



Sensors add cost and wiring complexity; their readings may drift with age. The algorithm reads many different high-frequency sensors, and that redundancy means the calculated value is more accurate than a direct-reading sensor.

MANY OTHER "SENSORS" ALSO ARE VIRTUAL, SO PERUSING THE WIRING DIAGRAM WON'T TURN THEM UP. EXAMPLES:

ENGINE MISFIRE No sensors directly check cylinders for fuel-mixture ignition. The crankshaft-position sensor, used for engine starting, also measures tiny changes in crankshaft acceleration that appear when an engine misfires. The computer knows which cylinder misbehaved based on data from the crank- and camshaft sensors.

VEHICLE SPEED Some transmission-mounted vehicle-speed sensors (VSSs) are still around, but if the vehicle has antilock brakes, the computer may use wheel-speed sensor signals to get a more accurate true speed over the road, making the VSS redundant.

AIRFLOW Most cars have a mass airflow meter (MAF) to detect how much air enters an engine. Some, notably Chrysler cars, use a "speed density" system that calculates the airflow based on throttle position, manifold pressure and engine speed. The algorithms were developed using computer models and the measured volumetric efficiency of the engine (cylinder filling). To meet emissions standards with speed density requires a robust algorithm and continual updating of the computer models.

FUEL TYPE This applies to E85-capable flex-fuel vehicles. There's rarely a sensor anymore that directly detects how much ethanol is in the fuel. Rather, the computer relies on ethanol's notably lower energy content compared with gasoline's. So if the computer sees the oxygen-sensor signal go lean, indicating ethanol, it switches to richer fuel injection and ignition "maps" for the alcohol concentration.

— PAUL WEISSLER

1500-psi stream of pressure-washer-driven aqua can easily blow past even the multiple-lip seals used underhood if the spray is trained on the connector for only a second or two.

That leaves you the old-fashioned option: the garden hose and a rag. Pick up a bottle of Simple Green or some car-wash soap and a bucket and go to town. I suggest doing this on a nice day, and just let that last rinse evaporate with the hood open. Don't use ammonia, bleach, vinegar, TSP, laundry soap, oven cleaner or anything with an extreme pH, high or low.

If you've got a really greasy engine, there are some engine cleaners you can pick up at the auto parts store that will help break up the oily glop. Be aware that cleaning an engine and letting any oily effluent drip into a storm drain can potentially contaminate the groundwater, and is probably illegal in many municipalities. Sure, you're just cleaning off the mud, but try explaining that to the judge.

Blowup

I just installed a new set of tires on my '98 Accord, Hankook H727 165/95-R15. The guy who installed them says I should inflate them to the pressure molded on the side of the tire, 44 psi. Consumer Reports and the owner's manual both say I should use 30 psi. I am 80 years old, and my wife and I used to travel all over the country. Who should I believe?

Let's see, you'd rather believe a guy wearing dirty coveralls who stands in a hot garage all day busting tires, not the owner's manual in your car. Okay, here's the tiebreaker: You can believe *me*—use 30 psi in all four tires, like it says in the owner's manual.

The pressure printed on the side of the tire is the maximum permissible pressure, regardless of the particular

vehicle or load. Hankook listed that pressure for safety reasons, and it is not calibrated to your Accord. Instead, use the tire pressures listed in the owner's manual or the placard on the doorsill. The car manufacturer has determined that these pressures are the best compromise between grip, handling, wear and comfort. Increasing the pressures significantly will reduce all these attributes. Specifically, it will reduce grip under braking on dry pavement and make the tires wear poorly.

And before you all start to write

*PM DIY AUTO ///
CAR CLINIC Q+A*

smarty-pants letters, it might be possible—on some vehicles shod with some tires—to slightly improve on the factory pressure recommendations. Trust me, you won't be helping things much, and the revised pressure settings you arrive at won't be very far from where you started. And I guarantee they won't be nearly 50 percent higher than the OEM-recommended settings.

PM

Got a car problem?

Ask Mike about it. Send your questions to pmautoclinic@hearth.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 cannot answer questions individually, problems of general interest will be discussed in the column.



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Tech

The Superdrives

NETWORK-ATTACHED STORAGE TAKES EXTERNAL HARD DRIVES BEYOND BACKUP. BY GLENN DERENE

→ **Hard drives have** traditionally been pretty dumb devices—for the most part, they neither know nor care about the machine they are attached to. For both internal and external drives, the setup is generally plain and simple: Plug your drive in, wait for the driver to install and—*voilà!*—more capacity.

A dumb drive is actually great if all you want is extra storage or a place to back up data from a single PC. But say you have multiple computers in the house, or



Network-attached storage devices such as the iomega StorCenter ix2-200 (\$260) can hold data for all the connected devices in a home.

INSIDE



FREE SOFTWARE + XBOX DRIVES + IPAD NETFLIX

a gaming system, or a networked security camera, or a huge music and movie collection that you'd like to stream out to a variety of portable devices. That's when you want a hard drive with a brain—a network-attached storage (NAS) drive.

NAS drives aren't hooked directly to any one computer. Instead, they connect to a router via Ethernet or Wi-Fi and are visible to any computer connected to that network. Because they are tied to the network, rather than to any one computer, NAS drives continue to be available even when your computers are turned off. They are, in fact, little computers in their own right, delivering most of the functionality of a business-style server with a more consumer-friendly interface and a more wallet-friendly price.

They will, however, tend to set you back a bit more than your average external hard drive. A variety of manufacturers such as Iomega, Western Digital, Seagate, Buffalo and D-Link make these devices; expect a 1 TB NAS drive to cost between \$120 and \$220. (A comparable capacity USB desktop drive will cost between \$80 and \$100.) That extra cash, however, buys you plenty of flexibility and functionality.

Back It Up

→ **Because they operate** over your network, NAS drives centralize backup for all the computers in the house. You can use the software that comes with the NAS or use the automated backup functionality built into Microsoft Windows or Time Machine in Mac OS X.

If you buy the right drive and configure it properly, you can effectively design a foolproof double-backup system that ensures you'll never lose your data. Start by buying a two-bay NAS—you can buy diskless NAS enclosures cheaply and add your own drives or buy a NAS with drives included. You'll want at least double the storage you need to back up all the computers on your network. (NAS drives can be outfitted to staggering capacities—a four-bay



Network Hubs

Not everybody wants to buy a new network-attached storage (NAS) drive—especially those who've invested in a USB backup drive. The good news is that devices such as the Pogoplug, Seagate FreeAgent GoFlex and Iomega iConnect allow you to turn USB drives into networked drives. Pogoplug and Seagate's GoFlex require an Ethernet connection. Iomega's iConnect can work via Wi-Fi or Ethernet.

device can hold up to 8 TB.) Like most computers, NAS drives allow you to set up your drives in a RAID (redundant array of independent disks) configuration that mirrors your data across drives. If one fails, the other maintains your files and repopulates them to a replacement drive. Configuring RAID on a computer is geeky stuff, but most NAS drives walk you through the process in plain English when you set them up. The

downside is that you are effectively paying for twice the storage capacity you can actually use, but the peace of mind is bulletproof.

Serve It Up

→ **If NAS devices were** just about backup, they'd be the equivalent of buying a single, really good insurance policy for all your data—practical, but hardly exciting. What makes NAS drives truly fascinating devices is everything they do besides backup. Because they are always on and always connected to your network, NAS devices can function as a central repository for data you use on a variety of devices. That means music, movies, photos and documents no longer need to be redundantly stored on multiple computers throughout the home. NAS devices show up automatically in the Network section of either Windows Explorer or Mac OS X Finder—alternatively, they can be mapped as lettered drives in Windows or dragged to the Dock in OS X.

It's an efficient place to store your data. If multiple people on the network use a file from multiple locations (say, the family-budget spreadsheet), then by keeping that file on the NAS device, you avoid conflicting files. Got files that you want to keep private? NAS drives allow each member of the household to set up an account—you can choose what to keep

private and what to make available to other users.

And NAS drives are especially friendly to media files. Many NAS devices can function as networked iTunes servers—just drag your music collection into the music folder on the networked drive, and all that music shows up automatically in the iTunes software on all the computers on your network. Most NAS drives also conform

to the Universal Plug and Play (UPnP) and Digital Living Network Alliance (DLNA) standards, which allow NAS drives to function as media servers for all sorts of compliant devices—game consoles, set-top boxes such as Western Digital's WD TV and Iomega's ScreenPlay, as well as network-connected home theater equipment and HDTVs.

For those who use peer-to-peer file sharing (we'll assume what you're sharing is legal), NAS drives can also manage torrent downloads even when your computer is off.

And here's another trick up the NAS's sleeve: Many of these devices have dedicated USB ports. Plug in an extra external drive and it shows up on the network. Plug in a printer and it can be configured as a network printer that all of your computers can use.

Log In

→ **Surprisingly, NAS** devices, once hooked into your home network, are at their most useful when you're away from home. Almost all NAS drives can be set up to let you log in remotely over the Internet and access your content through either a Web browser or dedicated software. This can be a trickier proposition on some drives than others, requiring you to open up a port on your router and set up a variety of security procedures. Many newer NAS drives make the process much easier by using third-party interfaces such as Pogoplug and Twonky. (Pogoplug also has a dedicated iPhone app to allow access from your phone; Twonky has an app available for Android devices.)

NAS devices not only make your data more secure; they can also do the same for your home. Some NAS drives can automatically record footage from networked home-security cameras. Using camera systems from companies such as Cisco and D-Link, you can record directly to a section of your NAS device, then log in remotely through a password-protected Web page to view footage on your smartphone. Let's see a USB drive do that. **PM**

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Digital Clinic

by Seth Porges

Q+A

Free Alternatives to Pricy Software

Q I recently started using OpenOffice as a free alternative to Microsoft Office. Are there any other free versions of common applications that I should be aware of?

A Man, software can be expensive. With a fully loaded Microsoft Office suite costing up to \$350, and the pro-level version of Adobe Photoshop costing an extra \$1300, the price of basic software utilities can easily trump the cost of even a high-powered new computer.

So, much as doctors may find themselves recommending generic drugs over pricey name-brand pills, I increasingly find myself advising people to pro-

cure free, open-source or Web-based alternatives to expensive programs. For most users, these applications should serve as adequate replacements for big-name apps. On the downside, their (lack of a) price tag means you can't expect on-call tech-support agents to walk you through problems—but the programs tend to have legions of devoted users who are willing to fill this role for free on Web-based tech-support forums. Google your problem and you're sure to find a solution.

Virtually every type of program has a free alternative—from word processors to image-editing programs to time-wasting Tetris clones. In general, heavier computing tasks (high-definition video editing, for example) are better serviced in fully downloaded hard-drive-based programs, while lighter lifting (word processing, simple image retouching) can often be done in Web-based applications. For the most part, these programs are fully compatible with their pricey cousins, as long as you are sure to save your files in a common file for-

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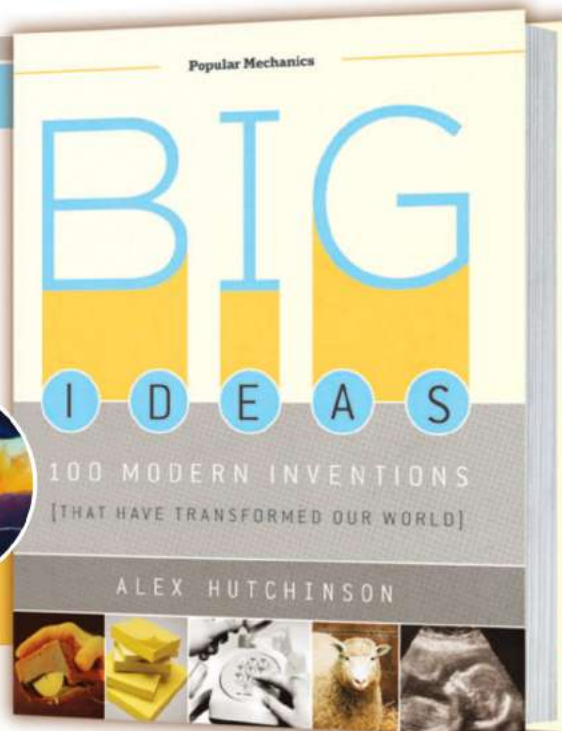
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mat. The free OpenOffice office suite, for example, by default saves text documents as .odt files—a format that could cause problems for people who attempt to open the file in Microsoft Office. To fix this, select “Save As” and change to the familiar .doc format.

In addition to their low cost, Web-based programs also often have features and a level of convenience that can make them preferable to installed

software. Key among these is the fact that because they are based in the cloud, Web-based programs—and any files you might have saved in them—can be accessed from any computer with an Internet connection. They are also often designed specifically to facilitate collaboration. In Google Documents, multiple people can edit a single file simultaneously—and see the changes pop up on their screens in real time.

These features have left the legacy brands playing catch-up: With the brand-new Office 2010, Microsoft has finally added support for online collabo-

ration to its staid software suite—years after Web-based word processors popularized the feature. (That’s not to say the new Microsoft Office Web Apps suite isn’t nice—it offers a full, free version of Office online, along with an impressive level of integration with your paid-for, hard-drive-based Office suite, if you have it.)

As for tracking down free software, I’ve found *osalt.com* to be the Web’s single best depository, with an exhaustive list of programs for every operating system.

Expansion Pack

I want to expand the storage space on my Xbox 360. Can I just plug in an external USB hard drive?

For years, Xbox 360 users who wanted to expand their console’s storage beyond the built-in hard drive were forced to plunk down serious cash for Microsoft-branded drives. The problem with this is simple: While the market rate for a 250 GB external hard drive is currently around \$50 (and dropping almost by the day), a comparable Xbox-compatible drive goes for \$130. And even though hard-drive capacities can now be measured in terabytes, Microsoft doesn’t produce any drives for the Xbox 360 that are larger than 250 GB.

This problem is now solved—at least partly. A recent firmware update gives users the ability to expand the Xbox 360’s storage without purchasing a proprietary drive. Instead, you can plug up to two extra drives—either flash drives or external hard drives—directly into the console’s USB jacks. One lingering problem: The Xbox is currently only able to recognize up to 16 GB of storage from each external drive.

Picking Episodes

I love the Netflix iPad app. However, when I try to watch a TV show, I can’t figure out how to select an individual episode. Is there any place in the program to do this?

I agree: The Netflix iPad app is fantastic—being able to walk around streaming shows on such a thin device almost feels like magic—so it’s a shame that its programmers seem to have buried the method for selecting individual episodes. Here’s how you do it: Instead of

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hitting the "Play" button under the icon for the show, tap the show's title and then click "More Details" on the box that pops up. This will bring you to a screen where you can select any available individual episodes.

Untapped Deposits

I heard that Chase Bank customers can now deposit checks using their phone. How the heck does this work?

Indeed they can. Like most major banks, Chase has long had an iPhone app that allows customers to check their balances and engage in simple online banking functions. But an update issued in July offers a clever new feature: Customers can now deposit checks directly from their phone, drastically cutting down on the number of time- and gas-wasting trips to the ATM or bank branch. And there's no add-on fee for using this service.

How it works: Customers enter the target account and the amount of the check. The app then taps into the iPhone's camera, allowing users to take and send a picture of the front and back of the endorsed check from within the app. We gave the app a try and, after a bit of tinkering (the app let us know that our initial attempts at photographing the check didn't fit all the necessary info into the frame), found it to work as advertised.

This isn't the first time we've seen this feature—the much-smaller bank USAA has offered iPhone- and Android-based mobile check depositing for about a year, during which time there have been no publicized cases of anything going wrong, security-wise. But the adoption of the feature by megabank Chase (and the announcement that Citibank plans on tackling the tech later this year) should knock the idea of phone-based check deposits firmly into the mainstream.

PM

Got a technology problem?

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Send your questions to pmdigitalclinic@hearst.com or over Twitter at twitter.com/sethporges. While we cannot answer questions individually, problems of general interest will be discussed in the column.



Danger Below

(CONTINUED FROM PAGE 79)

the U.S., emphasizing the need for more data on structural stability. Currently, engineers test roof strength by taking rock cores, but the cores don't accurately reflect underground stresses once they've been removed. Kot F. Unrug at the University of Kentucky developed a test that involves drilling holes into the mine's roof and walls, inserting hydraulic pumps and increasing the pressure until the rock splits.

An even simpler way to improve safety is to enhance mine lighting. Currently, most illumination underground comes from spotlights on mining machines and from miners' headlamps. The National Institute for Occupational Safety and Health is developing lamps that use LED light. "This is not a big-brainer," Unrug says. "You can see more in brighter lights."

Some industry officials claim that installing the latest safety gear is an unfair financial burden. Since all mines are different, it's difficult to assess how much it would cost to bring mines into compliance with the MINER Act. But most experts are confident that mines could install basic safety technology, improve mine maintenance—and reduce fatalities nearly to zero—with very little added expense. "For a few extra pennies per ton, companies could improve mine safety substantially," Sharpe says. "And I don't think it would be noticed by consumers."

Many companies have decided that safety and productivity can go hand in hand. But every day, miners descend several hundred feet into the labyrinthine chambers of mines that still fail to meet readily achievable safety standards. For those miners, cheap coal may come at a great—and unnecessary—cost. "I published my thesis on improved mine ventilation safety when I was 33," says Andrzej M. Wala, a professor at the University of Kentucky and one of the nation's top ventilation experts. "I'm now 73 years old. How much longer do we have to wait?"

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4. GPS AND MAP

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× When Jeff Stetz was a kid, he wanted to be a pilot—but a love of large animals turned him on to conservation instead. Now the 37-year-old studies the dynamics of threatened grizzly and black bear populations in the Northern Rockies. He practices noninvasive sampling, securing strands of fur from trees where bears scratch their backs, then sends the fur to a lab for DNA analysis. "We need to understand how our actions impact wildlife populations," Stetz says. "Grizzlies are a true symbol of the wild and a huge part of America's culture. Failing to ensure their persistence would be unforgivable." — LAURA KINIRY

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