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2010

# Nov.

PM FEATURES ///  
VOL. 187 NO. 11

## 72 Digital Sight for the Blind

Thanks to an artificial retina, 10 million people in the U.S. with degenerative eye diseases can hope to someday have their vision restored. PM follows a year in the life of one New York City woman who received the implant, as she blazes the path for others.

BY JENNIFER BOGO

## 61 Breakthrough Awards 2010

PM celebrates the brilliant minds behind the year's boldest inventions, from a soccer ball that generates electricity to a laser-based treatment for cancer. **Plus:** Ten revolutionary products available right now. BY LOGAN WARD

## 82 Heavy-Duty Diesel Pickup Test

Since serious work—and play—requires serious torque, we hitch three Detroit-built diesels to 10,000-pound trailers and crown the king of performance, handling and hauling excellence.

BY BEN STEWART

## 88 Treacherous Waters

Nearly every year, commercial fishing ranks as the most dangerous job in the U.S.—even more lethal than police work and firefighting—due to hazardous vessels, human error and inadequate safety equipment. But why must every catch be so deadly? A PM special report.

BY KALEE THOMPSON

Breakthrough Leadership Award winner J. Craig Venter conducting algae biofuel research in a La Jolla, Calif., greenhouse. Photograph taken by Greg Miller on July 15.

ON THE COVER

PM's 2010 Breakthrough Award winners include (counterclockwise, from main illustration by Jeremy Cook): the D series jet (designed to burn 70 percent less fuel than the Boeing 737); NASA's LCROSS mission (confirming water ice on the moon); and the Chevy Volt, which, along with the Nissan Leaf, is poised to usher in the era of the electric vehicle.



# PopularMechanics

PM DEPARTMENTS

diy

pm do-it-yourself

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**100 Hall Monitor**  
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If a Ford mod V8's plug threads go bad, it's time to call a pro. **Plus:** Should you trust GPS or your vehicle's speedometer?

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PM's Xbox Backpack brings at-home gaming to the streets. Photograph taken by Michael Lewis on July 22 in Brooklyn, N.Y.

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**17 Asteroid Forensics**  
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## UPGRADE

**33 Moving Pictures**  
The Sony NEX-VG10 is a camcorder that allows the user to switch digital SLR lenses. **Plus:** LaCie's nearly indestructible XtremKey Flash Drive; measure speed and distance as you ski with the Zeal Transcend GPS Goggle.

## NEW CARS

**43 Mind Changer**  
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Tarah Knaresboro, Brian Resnick,  
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*Contributing Photographers & Illustrators:*  
Bircu Avsar, Levi Brown, Leandro Castelao, Zach DeSart, Dogo, Christopher Griffith, Chad Hunt,  
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## WHAT THEY'RE DOING



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NASA Goddard Institute for Space Studies climatologist Gavin Schmidt is preparing the latest climate research to add to the 2013 IPCC report by the end of this year. To maximize accuracy of the report and help determine and refine potential causes of climate change, he incorporated additional atmospheric components in his research. Schmidt is also featured on an online PBS series, *The Secret Life of Scientists and Engineers*.





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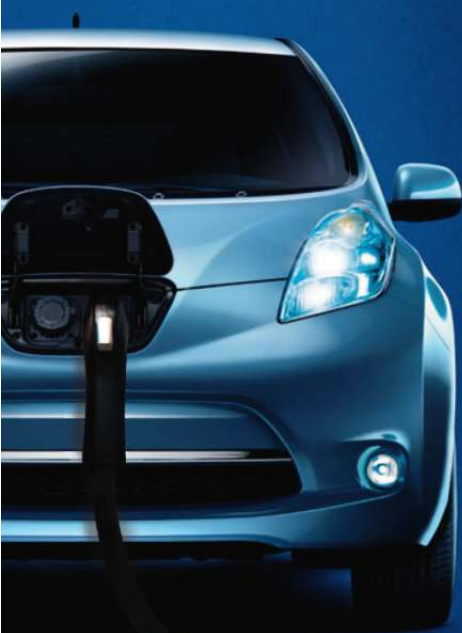
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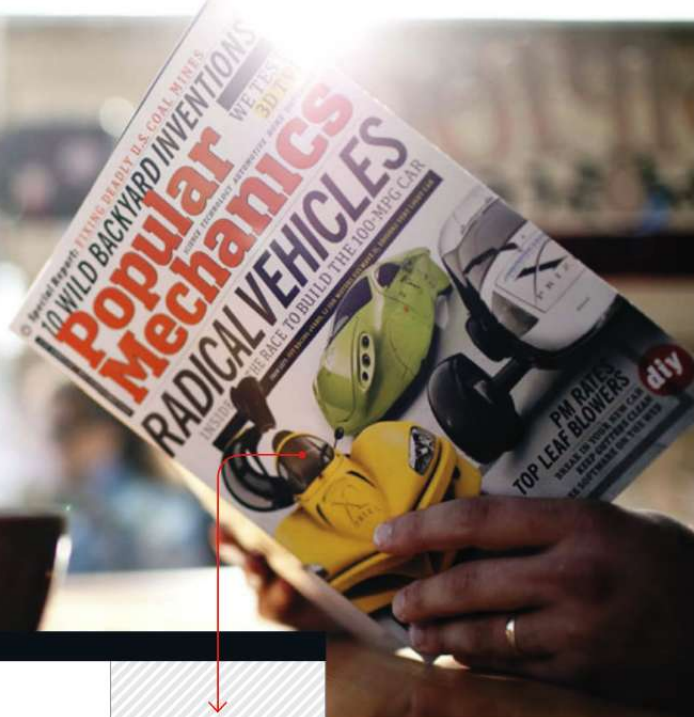
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## PM on the iPad

When we launched our first POPULAR MECHANICS iPad app this past July, we didn't know quite what to expect. Well, thanks to an enthusiastic community of iPad owners—longtime PM readers as well as newcomers to the magazine—it turned out to be a hit. Our pilot interactive edition sold more than 40,000 copies and got the best customer reviews of any magazine app to date. That was particularly gratifying since we designed and programmed the app in-house: a fitting approach for the classic DIY magazine.

Now we're going to do it every month. Starting with this issue, PM goes monthly on the iPad. Our November interactive edition contains everything the print original does—plus more. Inside we've packed video clips, 3D woodworking plans, photo galleries, interactive diagrams—all the things people want to see in a digital edition. And we've redesigned every single page to make the most of the iPad screen. We think it is a fresh way to read, one that complements the print magazine that we take such pride in.

In addition to the interactive edition, we also have a replica of the print edition available for both the iPad and the iPhone, through our partner Zinio. Any way you choose to get your POPULAR MECHANICS, our commitment remains the same: authoritative reporting and practical information, delivered in the clearest, most useful—and fun—way possible.

—The Editors

### Mileage vs Safety

In your article on the Automotive X Prize ("The X Factor"), I found it interesting that the cars designed to achieve 100 mpg are meant to be similar to the cars we drive today. Yet they missed an obvious feature of modern cars—safety. Would you allow your kids in one of these cars? If any were in an accident with anything larger than a bike, what would be the probability of surviving?

WILL VANDER WAL  
ZEELAND, MI

I was psyched to read about the Automotive X Prize. Then I noticed your DIY Home story on gas-powered leaf blowers. It's a little ironic that the issue discussed both the environmental advantages of 100-mpg cars and air-polluting fans. Maybe people should just use a rake.

JOHN SHEROCK  
IRON, MN

### Built Out Back

Just when I thought there could be nothing new in the bicycle world, I open your September issue and there it is! A spokeless bike ("Backyard Genius"). It's good to see that there are some people still thinking outside the box. How about an article with detailed

# Sept.

ISSUE

09 / 10

=

x

Readers responded to our stories about 100-mpg cars, coal mining and backyard inventing.

photos and plans? Maybe a home project?

EDWARD BRYANT  
BURLESON, TX

### Safety-Minded

Testing requirements for coal mines seem a bit muddled, as described in "Danger Below." In the '70s, the Navy did not permit sailors to enter any void without testing for an explosive atmosphere and available oxygen. These are operational tests done with equipment known as an explosimeter. Today the tool is of cellphone dimensions. Local police and fire departments use it to determine explosive hazards.

WILLIAM H. MENTZER  
PITTSBURGH

**CORRECTIONS:** In the September issue, Tech Watch should have stated the speed of the X-51A Waverider as 3800 miles per hour; the craft moves at 1700 meters per second.

The Upgrade department should have identified the Dremel Trio as a corded power tool.

what  
do you  
think?



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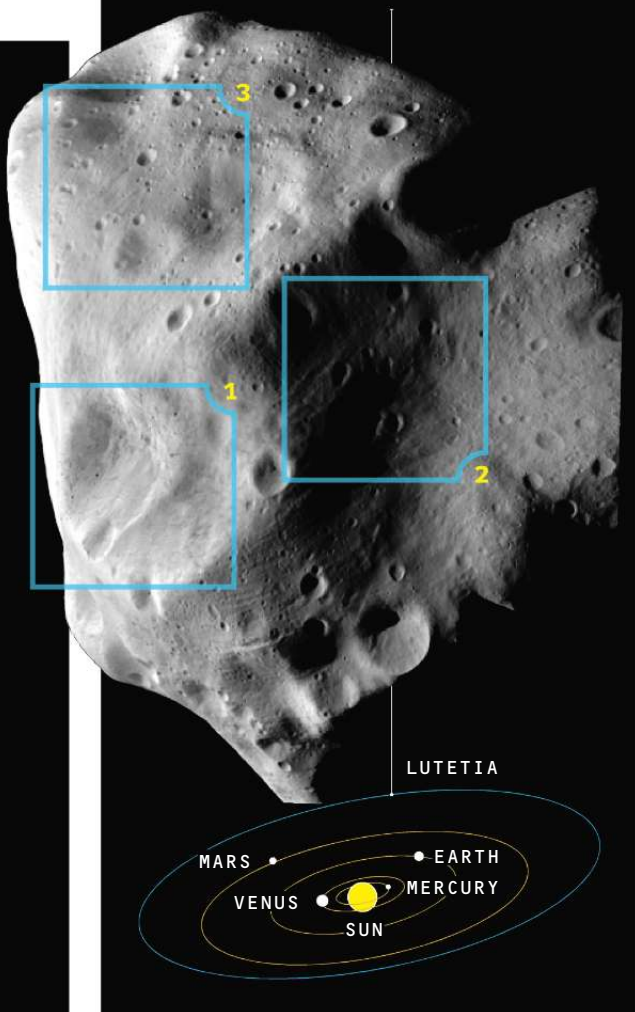
  
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# Tech Watch



## Asteroid Forensics

Whipping past at a speed of 9 miles per second, the European Space Agency's Rosetta space probe captured the first-ever images of the scarred surface of the asteroid Lutetia. The flyby provided clues to astronomers puzzling over the origin of the asteroid—and the universe. Next stop for Rosetta: comet Churyumov-Gerasimenko, where it will attempt to deploy a landing craft in 2014. —ALEX HUTCHINSON

### 1. Dusty Landslides

Powder accumulated in craters looks like the result of landslides—surprising since the asteroid's gravity should be too weak to cause such activity. Lutetia likely experienced an orbital irregularity or spin that generated the necessary force to move the powder.

### 2. Impact Divots

Large dents in Lutetia's side hint at the asteroid's violent history. Scientists say these features indicate that Lutetia

has been around 4.5 billion years—since the birth of the solar system—rather than breaking off more recently from a larger rock.

### 3. Surface Grooves

Long, parallel grooves on the surface may have been left by rolling boulders or could represent sedimentary layers from an extraterrestrial process. Scientists are studying data from Rosetta's sensors to determine how the asteroid was formed and how the grooves were created.

## Spill Stats

Roughly 4.9 million barrels of oil—205.8 million gallons—spilled into the Gulf of Mexico from the runaway well drilled by BP's Deepwater Horizon rig. About 95.6 million gallons of gasoline could have been refined from the amount lost. That equates to a whole lot of mileage.

—JEREMY REPANICH

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around the  
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Toyota  
Prius  
hybrid  
electric car.



## 'Shroom Packing

Forget petroleum-based Styrofoam peanuts. Ecovative Design uses fungus from mushroom roots, grown from agricultural waste such as cotton seeds or wood pulp, to create a foam-like packing alternative. The process uses one-eighth the energy—and produces just one-tenth the carbon dioxide—of the manufacturing process that creates Styrofoam packing material. Ecovative hopes to market a kit in 2013 that customers can use to grow their own packaging. —A.H.

## ANCIENT AIR

## Down in the Hole

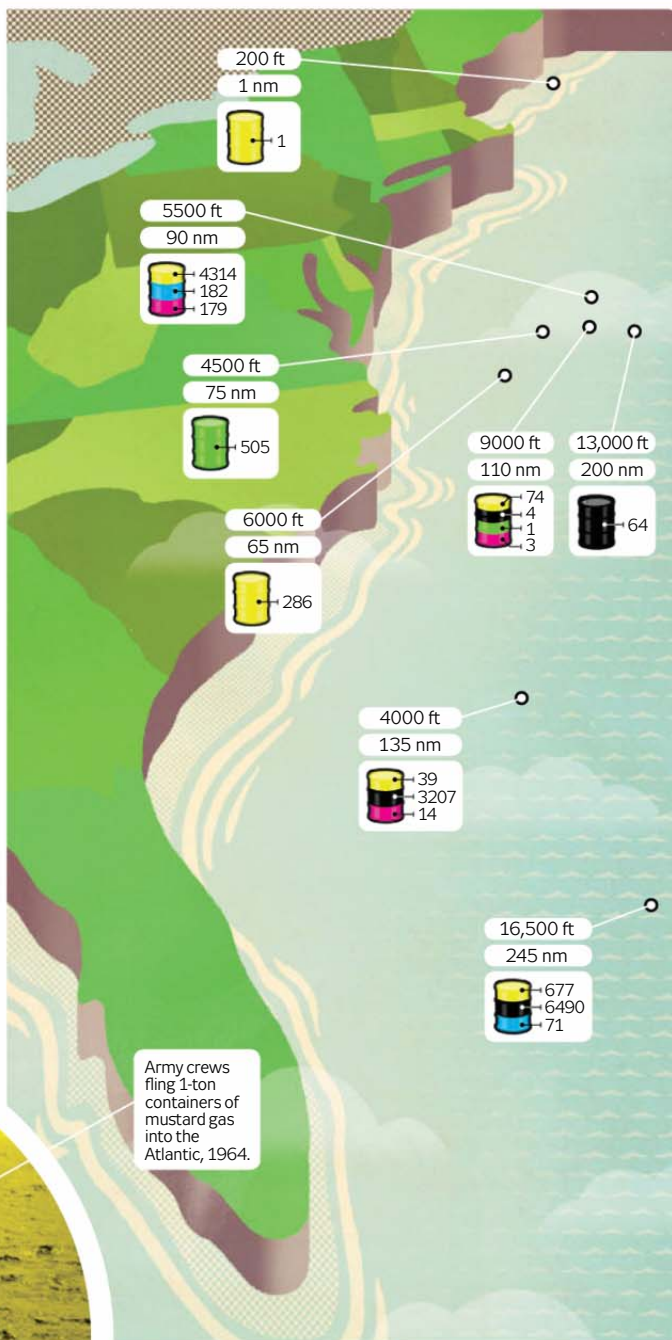
After 14 months and 8300 feet of drilling, an international team of scientists in Greenland finally hit bottom. The team removed 3-inch-diameter core samples that date to a period between ice ages, 115,000 to 130,000 years ago, when the Earth was as much as 5 F warmer than it is today. Bubbles of air trapped in the ice will reveal how levels of greenhouse gases in the atmosphere changed as global temperatures fluctuated. —A.H.

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## • RELICS OF WAR

## Deadliest Catch

When the crew of the *E.S.S. Pursuit* dredged the ocean 45 miles off Long Island, N.Y., they found more than the clams they sought: They caught 10 artillery shells stamped with dates from World War I. When one canister broke open, the contents—later identified as mustard gas—blistered one man's arm and leg, while other crew members suffered from eye and nose irritation. According to Army records, the government sank about 32,000 tons of chemical agents, plus conventional weapons, off the U.S. coast between 1917 and 1970, when the practice stopped. "We don't see a big influence on the surrounding environment," says the University of Hawaii's Margo Edwards, who in 2010 completed a comprehensive study of chemical munitions in deep water. "But they're continuing to deteriorate at an unknown rate. What happens later?" To be prepared, the Army this year purchased a remotely operated vehicle (ROV) that can safely collect discarded weapons from the seafloor. The ROV uses cameras and a laser measuring system to identify ordnance, two arms to manipulate the weapons and compartments that protect operators from contaminants. The Army plans to deploy the robot next spring for a three-week field test off Oahu, Hawaii. — AMBER ANGELLE



Depth  
Distance  
From Shore  
WMD  
IN  
TONS

## SYMPTOMS



### MUSTARD AGENT

Skin and eye irritation, difficulty breathing, nausea, seizures.



### LEWISITE

Chemical burns, weakness, fluid accumulation in the lungs.



### CHLORINE-BASED GASES

Coughing, watery eyes, chest tightness, burns to the throat.



### SARIN

Pupil constriction, spasms, coma, death.



### OTHER GASES

### OTHER CHEMICAL WEAPON DUMPS

**OAHU, HAWAII**  
2051 tons, including mustard, lewisite and cyanide agents  
**DEPTH:** 6000 ft  
**DISTANCE:** 11 nautical miles

**SAN FRANCISCO, CA**  
11,003 tons, including mustard gas and lewisite  
**DEPTH:** 13,500 ft  
**DISTANCE:** 95 nautical miles

**GULF OF MEXICO**  
7 tons of mustard gas inside German bombs  
**DEPTH:** 60 ft  
**DISTANCE:** 11 nautical miles

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PHOTOGRAPH BY ASSOCIATED PRESS







Don't let a stuffy nose get in between you and some Z's.



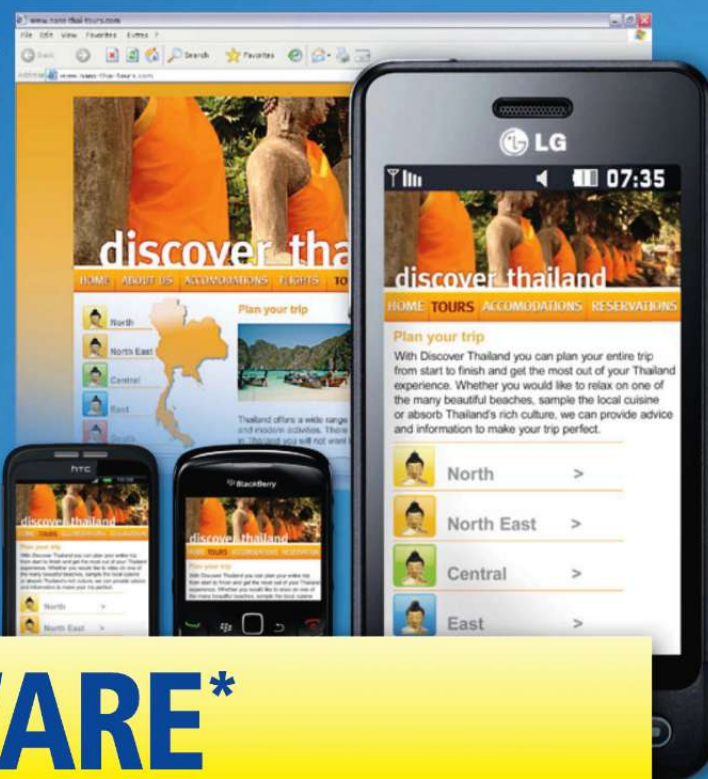
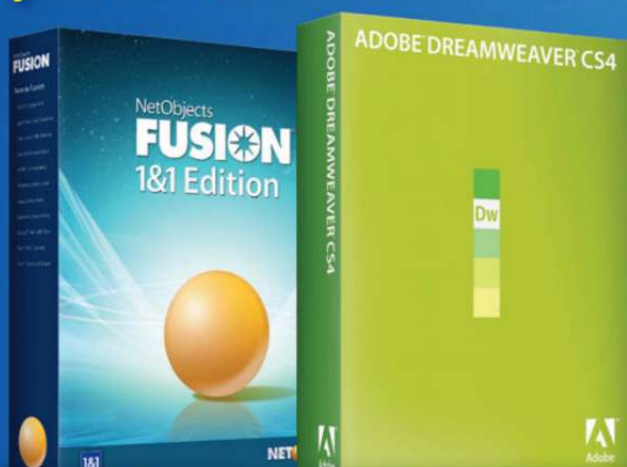
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- Extensive Programming Language Support: Perl, Python, PHP4, PHP5, PHP6 (beta) with Zend® Framework
- NetObjects Fusion® 1&1 Edition or Adobe® Dreamweaver CS4



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## • 21ST-CENTURY CURES

**DNA vs Disease**

Researchers have engineered mosquitoes that are 100 percent immune to *Plasmodium*, the primary single-cell organism that causes malaria in humans. University of Arizona entomologist Michael Riehle, collaborating with scientists at the University of California, Davis, boosts the insects'

resistance by introducing genetic material into mosquito eggs—which, in turn, prompts increased production of an enzyme capable of warding off the parasite. Because the process involves altering only one DNA molecule in the insect's genome, the outcome is easier to control. It's also consistent. "If even a single parasite can evade the killing system, it will result in an infectious mosquito that can transmit malaria to dozens of people," Riehle says. Millions of mosquitoes would have to be released to spread the new gene, and there's no way to know how it will function outside the lab. But because *Plasmodium* is becoming increasingly resistant to drugs, transgenic mosquitoes could be an attractive gamble in places such as Africa, where pharmaceuticals are failing. Still, Riehle says, controlled testing is needed to guard against unintended consequences. — BRIAN RESNICK

Scientists tag genetically modified mosquitoes by altering their eyes to become fluorescent under ultraviolet light, as seen in this larva.

**A SHORT-LIVED OPPORTUNITY**

The gene that helps regulate a mosquito's immune system is also linked to those that determine the insect's life span. Researchers exploit this connection to fight malaria: The parasite that causes the disease needs more than a week to gestate inside the insect, so shortening mosquitoes' two-week life span could further reduce human infections.

## • OBSCURE SCIENCE

**The Hidden Physics of Peeling Paint**

Engineers from Yale and Princeton have published a gripping study of how paint dries. (No, really.) They injected fluorescent tracer particles into paint, which they then coated onto a flexible silicone rubber surface. The technique, called traction force microscopy, allowed them to observe the formation of microscopic cracks in real time by recording the movement of the tracer particles. The slight deformations in the soft rubber also created a 3D map of the mechanical stress that causes paint to peel. The research could inspire longer-lasting paint and improve other protective coatings. — ALEX HUTCHINSON

## • MILITARY AVIATION

**Airships for the Army**

By 2012, the U.S. Army hopes to field three unmanned reconnaissance airships capable of hovering at 20,000 feet for more than three weeks. The Long Endurance Multi-Intelligence Vehicles (LEMVs), each the size of a football field, will be developed by Northrop Grumman under a \$517 million contract. The company estimates the cost of a three-week mission to be about \$20,000—far cheaper than comparable missions by conventional aircraft. Another advantage: Airships can monitor large areas longer than fixed-wing UAVs, which have to refuel and are often called away on other missions. Slated for test flights next summer, LEMVs are part of a Pentagon procurement strategy of new lighter-than-air craft, including a radar blimp that can stay aloft for years at a time. — A.H.





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Craig Payne  
Automotive Engineer  
Toyota Technical Center



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## • DIGITAL ANONYMITY

## The Pedestrian Vanishes

**Prompted by privacy concerns**, Google already blurs the face of anyone whose picture is captured by its Street View program. Still, many feel uncomfortable with their image appearing in the ubiquitous online maps. Searching for a solution, computer scientists at the University of California, San Diego, developed a program that makes people disappear from Google Street View data, filling in the missing pixels with images taken by Google's vehicle-mounted cameras immediately before and after the offending shot. The developers unveiled the program at a software conference over the summer, but challenges remain—like fine-tuning the algorithm to avoid weird artifacts like a dog on a floating leash or a pair of shoes walking themselves down the street. — ALEX HUTCHINSON

## • MEDICAL FRONTIERS

## Amazing Arm

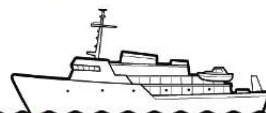
MODULAR PROSTHETIC LIMB

FINGERS CAN MOVE INDEPENDENTLY

JOINTS OFFER 22 DEGREES OF FREEDOM

WEIGHS 9 POUNDS, SIMILAR TO A NATURAL ARM

This year, a person will test the first prosthetic limb to be controlled by thought alone. HDT Engineered Technologies' Modular Prosthetic Limb (MPL) allows unprecedented dexterity, weighs only as much as a natural limb and, most notably, will be connected to electrodes in the user's brain. The MPL is the product of a consortium led by Johns Hopkins University—and funded by a \$34.5 million DARPA grant—aiming to merge the latest in brain-computer interfaces with advanced prosthetic-limb technology. The team plans to test the limb on five other patients within the next two years. — A.H.



## Scanning Surveys

**As Arctic sea ice melts**, an increasing number of cruise liners and commercial fishing ships are able to navigate the waters around Alaska. Only most of the state's north and west coasts haven't been mapped since the 1960s—if ever—so existing charts leave vessels vulnerable to hidden hazards. The National Oceanic and Atmospheric Administration (NOAA) dispatched the survey ship *Fairweather* to spend two months mapping critical sea routes in the Bering Strait around Cape Prince of Wales. The ship can profile depth and topography of the seafloor with a multibeam sonar and discern rock fields, shipwrecks and other obstructions with a side-scan sonar. There are 568,000 square nautical miles of U.S. Arctic waters, of which NOAA has identified 38,000 as high priorities to survey. The agency says it will take more than 25 years to survey the priority sites. — A.H.



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## TECH WATCH

### TECH CULTURE



SFX makeup artist Greg Nicotero applies prosthetics on a zombie.

## Dead Ringer

**Greg Nicotero sees zombies everywhere**—even among the living. In fact, he can't stop pointing them out. "See this tall guy with the glasses?" he asks. "He'd be a great zombie." Five minutes later, he's at it again. "This girl has a long face, nice bone structure. Look at her forehead! Great zombie."

It might seem macabre, but Nicotero has a reason to look for potential ghouls: As the special-effects makeup supervisor on *The Walking Dead*, a new television series about a group of humans trying to survive in the aftermath of the zombie apocalypse, he's tasked with bringing the show's most gruesome characters to life. (*Dead's* first season begins on AMC on Oct. 31.)

The creation of the zombies starts with casting. The series is based on a graphic novel, and Nicotero drew from its depiction of the undead to find tall, slender actors with ideal bone structure. "If you start with someone whose proportions are already thin, it feels organic and realistic when you add prosthetics," he says.

For more involved looks, Nicotero made molds of the actors' heads and bodies and used them to create foam latex prosthetics that mimic rotting anatomy. For the simpler ones, he relied on partial facial prosthetics, dental plates that distort the jaw and 3D prosthetic transfers that create wounds instantly. Contacts and a tongue-blackening stain completed the look. "Every person is a new canvas," Nicotero says. "You go, 'What should I do with you today? I think I'll tear part of your face off!'" Things that can't be done in-camera—removing an arm, for example—happen in post-production. But even without those tweaks, the zombies look eerily real. "Most of the actors have never dealt with this level of prosthetics," Nicotero says. "They'll say, 'Can I touch that? How did you do that?'" —ERIN MCCARTHY

### ZOMBIES ACTUALLY EXIST

For hundreds of years, when Caribbean shamans have wanted revenge—or needed a compliant workforce—they've given a person poison derived from the neurotoxin in pufferfish. It paralyzes the victim and slows his heart

until a pulse is undetectable. An antidote can revive him, but the toxin causes severe neural damage. "This explains a victim's inability to run away," says Neil Whitehead, an anthropologist at the University of Wisconsin, Madison. It

also explains pop culture's depiction of zombies: glassy stares, dragging feet, incomprehensible noises. Key difference: Real zombies don't eat brains. "George Romero's great," Whitehead says, "but not ethnologically accurate."



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GOUT'S  
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MANAGEABLE SIZE**

**Uloric**  
(febuxostat)  
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## Gout's root cause is high uric acid.

If you have gout, high uric acid can lead to more attacks. To help reduce attacks, lower your uric acid.

## ULORIC can help.

ULORIC is clinically proven to help lower uric acid to a healthy level (less than 6 mg/dL).

## Struggling with gout?

Ask your doctor how ULORIC can help lower uric acid and bring gout's root cause down to a more manageable size.

## Use of ULORIC

ULORIC is a prescription medicine used to lower blood uric acid levels in adults with gout. ULORIC is not for the treatment of high uric acid without a history of gout.

Individual results may vary.

## Important Safety Information

- Do not take ULORIC if you are taking Azathioprine, Mercaptopurine, or Theophylline.
- Your gout may flare up when you start taking ULORIC; do not stop taking your ULORIC even if you have a flare. Your healthcare provider may give you other medicines to help prevent your gout flares.
- A small number of heart attacks, strokes, and heart-related deaths were seen in clinical studies. It is not certain that ULORIC caused these events.
- Tell your healthcare professional about liver or kidney problems or a history of heart disease or stroke.
- Your healthcare professional may do blood tests to check your liver function while you are taking ULORIC.
- The most common side effects of ULORIC are liver problems, nausea, gout flares, joint pain, and rash.

**Please see accompanying Important Patient Information for ULORIC on adjacent page and talk to your healthcare professional.**

**You are encouraged to report negative side effects of prescription drugs to the FDA. Visit [www.fda.gov/medwatch](http://www.fda.gov/medwatch), or call 1-800-FDA-1088.**

**For more information,  
visit [www.ULORIC.com](http://www.ULORIC.com)  
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**Uloric**<sup>®</sup>  
(febuxostat) 40mg/80mg  
tablets



# PATIENT INFORMATION

## ULORIC® (Ū-'lor-ik) (febuxostat) tablets



Read the Patient Information that comes with ULORIC before you start taking it and each time you get a refill. There may be new information. This information does not take the place of talking with your healthcare provider about your medical condition or your treatment.

### WHAT IS ULORIC?

ULORIC is a prescription medicine called a xanthine oxidase (XO) inhibitor, used to lower blood uric acid levels in adults with gout.

It is not known if ULORIC is safe and effective in children under 18 years of age.

### WHO SHOULD NOT TAKE ULORIC?

#### Do not take ULORIC if you:

- take Azathioprine (Azasan®, Imuran®)
- take Mercaptopurine (Purinethol®)
- take Theophylline (Theo-24®, Elixophyllin®, Theochron®, Theolair®, Uniphyll®)

It is not known if ULORIC is safe and effective in children under 18 years of age.

### WHAT SHOULD I TELL MY HEALTHCARE PROVIDER BEFORE TAKING ULORIC?

Before taking ULORIC tell your healthcare provider about all of your medical conditions, including if you:

- have liver or kidney problems
- have a history of heart disease or stroke
- are pregnant or plan to become pregnant. It is not known if ULORIC will harm your unborn baby. Talk with your healthcare provider if you are pregnant or plan to become pregnant.
- are breast-feeding or plan to breast-feed. It is not known if ULORIC passes into your breast milk. You and your healthcare provider should decide if you should take ULORIC while breast-feeding.

Tell your healthcare provider about all the medicines you take, including prescription and non-prescription medicines, vitamins, and herbal supplements. ULORIC may affect the way other medicines work, and other medicines may affect how ULORIC works.

Know the medicines you take. Keep a list of them and show it to your healthcare provider and pharmacist when you get a new medicine.

### HOW SHOULD I TAKE ULORIC?

- Take ULORIC exactly as your healthcare provider tells you to take it.
- ULORIC can be taken with or without food.
- ULORIC can be taken with antacids.
- Your gout may flare up when you start taking ULORIC, do not stop taking your ULORIC even if you have a flare. Your healthcare provider may give you other medicines to help prevent your gout flares.
- Your healthcare provider may do certain tests while you take ULORIC.

### WHAT ARE THE POSSIBLE SIDE EFFECTS OF ULORIC?

Heart problems. A small number of heart attacks, strokes and heart-related deaths were seen in clinical studies. It is not certain that ULORIC caused these events.

The most common side effects of ULORIC include:

- liver problems
- nausea
- gout flares
- joint pain
- rash

Tell your healthcare provider if you have any side effect that bothers you or that does not go away. These are not all of the possible side effects of ULORIC. For more information, ask your healthcare provider or pharmacist.

Call your doctor for medical advice about side effects. You may report side effects to the FDA at 1-800-FDA-1088.

### HOW SHOULD I STORE ULORIC?

Store ULORIC between 59°F - 86°F (15°C - 30°C).

Keep ULORIC out of the light.

Keep ULORIC and all medicines out of the reach of children.

### GENERAL INFORMATION ABOUT THE SAFE AND EFFECTIVE USE OF ULORIC.

Medicines are sometimes prescribed for purposes other than those listed in a patient information leaflet. Do not use ULORIC for a condition for which it was not prescribed. Do not give ULORIC to other people, even if they have the same symptoms that you have. It may harm them.

This patient information leaflet summarizes the most important information about ULORIC. If you would like more information about ULORIC talk with your healthcare provider. You can ask your healthcare provider or pharmacist for information about ULORIC that is written for health professionals. For more information go to [www.uloric.com](http://www.uloric.com), or call 1-877-825-3327.

### WHAT ARE THE INGREDIENTS IN ULORIC?

Active Ingredient: febuxostat

Inactive ingredients include: lactose monohydrate, microcrystalline cellulose, hydroxypropyl cellulose, sodium croscarmellose, silicon dioxide, magnesium stearate, and Opadry II, green



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# We found our most important watch in a soldier's pocket



**I**t's the summer of 1944 and a weathered U.S. sergeant is walking in Rome only days after the Allied Liberation. There is a joyous mood in the streets and this tough soldier wants to remember this day. He's only weeks away from returning home. He finds an interesting timepiece in a store just off the Via Veneto and he decides to splurge a little on this memento. He loved the way it felt in his hand, and the complex movement inside the case intrigued him. He really liked the hunter's back that opened to a secret compartment. He thought that he could squeeze a picture of his wife and new daughter in the case back. He wrote home that now he could count the hours until he returned to the States. This watch went on to survive some harrowing flights in a B-24 bomber and somehow made it

back to the U.S. Besides the Purple Heart and the Bronze Star, my father cherished this watch because it was a reminder of the best part of the war for any soldier—the homecoming.

He nicknamed the watch *Ritorno* for homecoming, and the rare heirloom is now valued at \$42,000 according to *The Complete Guide to Watches*. But to our family, it is just a reminder that nothing is more beautiful than the smile of a healthy returning GI.



## The hunter's back

*The Ritorno watch back opens to reveal a special compartment for a keepsake picture or can be engraved.*

We wanted to bring this little piece of personal history back to life in a faithful reproduction of the original design. We've used a 27-jeweled movement reminiscent of the best watches of the 1940s and we built this watch with \$26 million worth of Swiss built precision machinery. We then test it for 15 days on Swiss made calibrators

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 Shodo art by Masako Inkyo



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# Upgrade



## Moving Pictures

→ While we've welcomed the recent transformation of digital SLRs into video-enabled cameras, it's hard to get over the fact that these machines are, at their core, designed for still photography. Audio quality tends to be terrible, and if you don't use a tripod, the cameras' small size can lead to shaky images. Enter the **Sony NEX-VG10 (\$2000)**, a machine that merges the best elements of both SLRs and camcorders. Like an SLR, it has a large, high-quality image sensor and can accept interchangeable lenses (a first for consumer video cams). From the camcorder side of the family, it gets its generous, easy-to-handle body and a high-quality stereo microphone.

— SETH PORGES





TACK UP TRIM, NAIL MOLDING AND FINISH FURNITURE WITH 1¼- TO 2½-INCH NAILS, 130 OF 'EM PER MAGAZINE.

## Nailing the Finish

→ Some tools feel like they were designed in a bubble by well-meaning engineers who've never set foot on a job site. And then there are tools like the **Bostitch N62FNK-2 15-gauge Finish Nailer Kit (\$180)**, which is packed with the sort of clever solutions that would only occur to a seasoned builder—things like a built-in stud-finding story stick, a dust blower for clearing debris, an LED light and a rear exhaust (the first on a 15-gauge nailer) for directing discharged air away from the user's face.

AS SEEN ON TV



### The SKrAPr (\$20 for bundle)

→ **THE CLAIM:** "Remove virtually any unwanted substance from any smooth surface in seconds, without scratching!" The SKrAPr ad shows satisfied customers scraping counters clean, prying dirt from the treads of boots and de-icing windshields. We put it to the test, prying debris off glass, porcelain, wood and metal. While the 1¾-inch blade successfully scoured cookware and mirrors without leaving scratches, using the narrow tool on a large windshield takes plenty of time.

**BOTTOM LINE:** The SKrAPr beats a razor for safety, ergonomics and scratch-free results.

### The Unbreakable Drive

→ Just when you thought USB flash drives were commodities—cheap, plentiful and basically disposable—the **LaCie XtremKey USB Flash Drive (starts at \$50)** comes along. The claim: drop-proof, crush-proof, heat-proof and waterproof, thanks to a 2-mm metal pipe casing and rubber O-ring. In other words, this is the kind of drive you can load with important documents, stash somewhere safe and retrieve after a disaster.

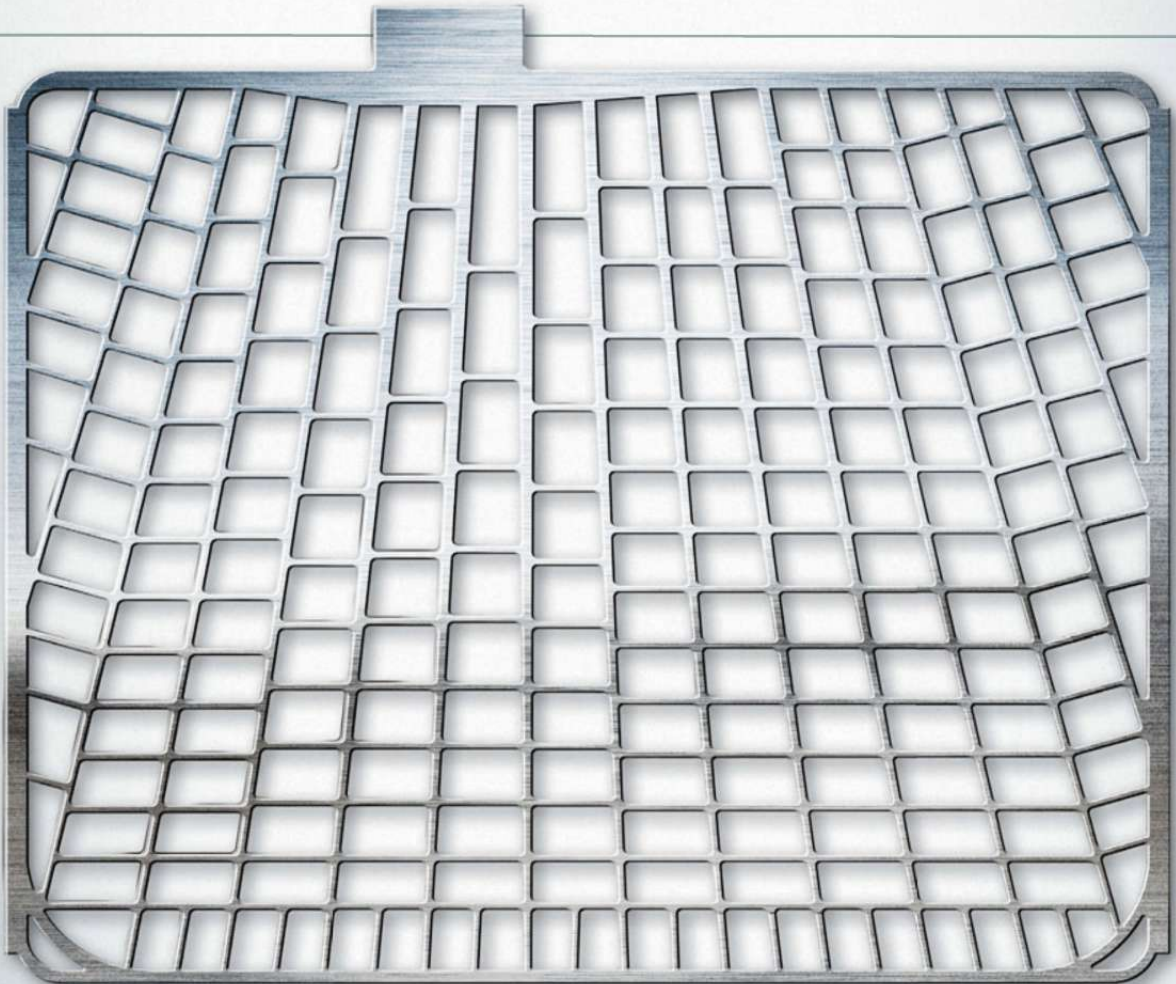






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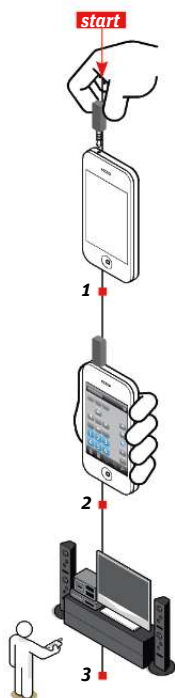
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## Universal Control

→ Here's to clearing coffee-table clutter! Plug the **ThinkFlood RedEye Mini (\$50)** dongle into an iPhone, iPad or iPod Touch headphone jack, and a free app transforms your device into a universal remote capable of controlling a TV, a DVR, a Blu-ray player or virtually any other AV equipment with an IR receiver.

THE REDEYE MINI PLUGS INTO AN IPHONE'S OR AN IPOD TOUCH'S HEADPHONE JACK AND RUNS OFF ITS BATTERY.



### Low-Tech Labeler

→ Sometimes the simplest solution really is the best. Like **Dymo Rhino 101 (\$20)**, a label-maker that strips out batteries and typefaces for a Sharpie. While this admittedly low-tech tool won't serve professional purposes, we'd happily use it for quick notes.

### 3D Moviemaker

→ 3D video cameras tend to be massive (and massively expensive) machines, making them more accessible for the James Camerons of the world than for amateur auteurs. The 1080p **Panasonic HDC-SDT750 (\$1400)** is the first consumer camcorder to shoot in 3D. The secret is a bundled lens that splits the image into binocular vision, which the camera converts into 3D video.



### Smallzall

→ Reciprocating saws are a go-to tool for demolition or high-powered cutting, but their bucking bulk makes them hard to use with one hand or fit flush against a cramped basement

ceiling. Not the **Craftsman 4.0-Amp Compact Reciprocating Saw (\$80)**. It weighs just 3.7 pounds and has a compact, ½-inch blade stroke. And while it's not the first one-handed recip saw we've seen, it is significantly less expensive than most other models—a sign that the once-niche category has reached mainstream maturity.



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## Swiping Control

→ In an age of multitouch swiping, a computer mouse can feel a bit dated. The **Apple Magic Trackpad (\$70)** is basically an oversize laptop trackpad for the desktop set—a keyboard companion that gives all Mac users the multitouch controls (such as pinch-zooming and page swiping) that MacBook users have grown accustomed to. Sorry, PC users: It only works with Macs—at least for now.

UNLIKE OTHER GLOVES, THE ALPHA SV'S FLEECE LINER FORGOES VELCRO TO STAY PUT IN THE GLOVE. SURPRISINGLY, IT DOESN'T SLIP.



## Grand Gauntlet

Gore-Tex gloves tend to be unwieldy sandwiches, featuring a shell, a waterproof bladder and a liner. With the **Arc'teryx Alpha SV (\$275)**, the waterproof membrane is laminated directly onto the outer shell, making the gloves thinner, lighter, more breathable and more dexterous than the typical waterproof gauntlets. While its price might be a bit excessive for the casual skier, it's reasonable for ski guides, or anybody else who spends his days outside fighting freezing fingers.



## Keeping Rhythm

→ Sure, fitness watches that collect real-time workout data such as heart rate and offer full integration to the Web can help exercisers stay motivated—but they can also be clunky and take a workout's worth of time to decipher. Fitness mavens have been waiting for someone to nail the category. The **Suunto M5 (\$210)** comes real close. It's slim and surprisingly easy to use, and it offers some useful new features, such as a notification when one has completely recovered from a workout.



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Actual coin size is 38.1 mm. Note: GovMint.com is a private distributor of worldwide government coin issues and is not affiliated with the United States government. Facts and figures were deemed accurate as of April 2010. ©GovMint.com, 2010

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A SMALL DISPLAY ON THE LOWER-RIGHT CORNER OF THE GOGGLE FRAME SHOWS REAL-TIME STATS.



## Giving a Heads-Up

If you want a head-up display to feed you stats such as altitude, speed and location, you could spend many millions on a jet, many thousands on a luxury car or just a few hundred dollars on a pair of goggles. The **Zeal Transcend GPS Goggle (\$350 to \$450)** uses a GPS chip, accelerometer, air-pressure sensor and thermometer to make real-life skiing and snowboarding as stat-filled as a video game. The data is displayed in real time on the corner of the frame and can be extracted and analyzed via mini-USB to show things like max speed, how high you jumped at a terrain park and where you ventured out of bounds. Superfluous? Definitely. But oh so cool.



### Pocket Producer

→ Pity the pocket video camera, which is now dangerously close to becoming the latest victim of convergence, rendered obsolete by video-enabled smartphones. Still, it's hard not to love the **Kodak PlayTouch (\$230)**. The touchscreen video cam shoots in 1080p HD, snaps 5-megapixel still photos and features in-camera video editing. And, unlike a phone, no contract is required.



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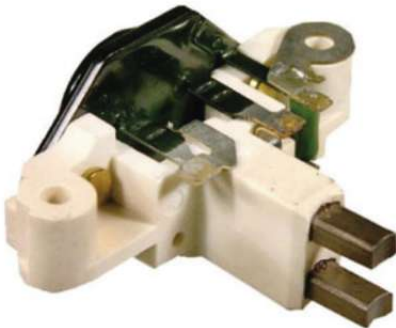
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# New Cars



++ PM TEST DRIVEN

## Mind Changer

**Cadillac wants to share** shopping-list space with BMW and Mercedes, and what better way to achieve that than by spreading around a 556-hp V8? The

6.2-liter supercharged motor is available in the CTS-V sedan, wagon and now this stunning coupe. Hooked to a six-speed transmission—manual or auto—the stout engine whips the two-door to 60 mph in just 4 seconds and all the way to 190 mph. That's called serving schnitzel to the Germans. As fast as it is, the CTS-V coupe is sophisticated too, with adjustable shocks that remove the sting from hard-edged bumps and provide sure-footed handling. Thankfully, massive Brembo brakes are part of the recipe, and they proved indefatigable on Monticello Motor Club's 4.1-mile road course. It's a bit tight inside, especially the back seat, but high style doesn't come cheap. — MIKE ALLEN

2011  
**CADILLAC**  
**CTS-V**

++  
BASE PRICE  
\$64,290





2011 Hyundai Equus

### FREE\* IPAD

As Hyundai's entry to the full-size luxury car market, the Equus (\*with a likely base price in the \$55K ballpark) is the first—and so far only—car to include an iPad as standard fare. The Apple tablet is preloaded with an app that incorporates the car owner's manual, which you'll use to guide yourself through the operation of a lengthy amenities list highlighted by a massaging driver's seat, adaptive cruise control and a 608-watt, 17-speaker Lexicon 7.1 audio surround system with HD radio. And that's just the base model. Step up to the Ultimate trim level, and you get a reclining and massaging rear seat, an 8-inch LCD TV screen and a refrigerator. The rear wheels of the Equus are motivated by a 4.6-liter V8 engine producing 385 hp and 333 lb-ft of torque on premium fuel. If you can pry yourself out of the rear seat, you'll see that in Sport mode, the Equus still feels more like a Lexus LS than a BMW 7 Series. But it's in very good company.

— BASEM WASEF

## The Boss Is Back

preview



2012 Ford Mustang Boss 302

Pirelli-clad 19-inch black alloy wheels and C stripes aren't the only extras on the 2012 Ford Mustang Boss 302, which will hit showrooms next spring in limited numbers. Engineers overhauled the Mustang GT's normally aspirated 5.0-liter engine with a freer-flowing intake and quad exhausts to make a very loud 440 hp. It should reach 60 mph in the mid-4-second range and top 155 mph. Along with engine mods, the Boss gets adjustable shocks, stiffer springs and beefier Brembo brakes. A limited-slip differential and Recaro seats are optional, or standard on the even-more-limited Laguna Seca edition, which swaps out its rear seats for a crossbrace, among other track tweaks. "It's basically a race car with a license plate," says Dave Pericak, Mustang's chief engineer. — G.E. ANDERSON

### REFINED HAULER

The new fourth-generation Odyssey is a buffed version of the outgoing edition, which was already the best handling and driving minivan. As before, it rides on a 118.1-inch wheelbase, but it's a touch shorter and 2.1 inches wider. The suspension's controlled ride motions and superb steering feel remain the Odyssey's greatest assets—it's sometimes hard to believe this is a van. Honda's Variable Cylinder Management (VCM) is now standard on every model's 248-hp 3.5-liter V6. The Touring grade gets a new six-speed automatic, which helps boost fuel economy to 19/28 mpg—the best of the lineup. There isn't a bad seat in the Odyssey house. Each of the eight passengers gets a comfortable perch and cup holder, and there's a range of entertainment options. Prices shouldn't differ much from 2010's: \$27,000 to start and more than \$40K for a fully loaded version. — JOHN PEARLEY HUFFMAN



2011 Honda Odyssey

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2011 Scion tC



## Throwback Celica

From the back, the new 2011 Scion tC (\$18,995) hatchback appears more aggressive than last year's model: thicker C-pillars, more muscular fenders and a chiseled rear bumper cover. And yet that familiar unibody chassis is mostly unchanged. It's a bit wider, thanks in part to the standard 18-inch wheels and 225/45R18 tires. Steering is still rack-and-pinion, but the power assist switches to electric, and the ratio is quicker. The tC's new 2.5-liter engine is virtually identical to the four-cylinder engine in the 2010 Toyota Camry SE—all-aluminum with dual overhead cams, dual variable valve timing and a 10.4:1 compression ratio. With 180 hp and 173 lb-ft of torque, Toyota/Scion claims a zero-to-60-mph time of 7.6 seconds for the six-speed manual version and 8.3 seconds for the automatic. As for efficiency, the EPA says that the 2011 tC will return 23/31 mpg (city/highway). — JOHN PEARLEY HUFFMAN

2012 Infiniti M Hybrid



### LUXURY HYBRID

Infiniti's M-series sedan offers a plush and ergonomic interior, a uniquely swept body and an array of state-of-the-art technology. In 2012, that will include a single electric motor sandwiched between the 3.5-liter V6 and seven-speed automatic transmission via a two-clutch system—à la the Volkswagen Touareg—in which one clutch separates the engine from the electric motor and the second connects motor and transmission.

Result: a smooth transition between electric and gas power. The electric motor adds 67 hp and 199 lb-ft of torque for a total of 369 hp and 457 lb-ft of torque (40 more lb-ft than the M56). Infiniti reckons the M Hybrid will be 25 percent more efficient than the M37, which means mileage in the 22/32 mpg (city/hwy) range. It can even operate on all-electric power below 62 mph, but that's contingent on a very light right foot. The M Hybrid goes on sale next spring, with a retail price likely to start at \$50,000.

— JAMES TATE

### VERSATILE TWIN

The practical Honda NT700V, which starts at \$9999 (\$10,999 with ABS) is one sport-touring model that can be ridden daily. Its good-natured suspension damps out freeway irregularities with ease and the movable windscreen can be easily adjusted from the saddle. A 680-cc 52-degree fuel-injected V-twin paired to a

five-speed gearbox routes 60 hp to the rear wheel via a maintenance-free shaft drive. The transmission and clutch take little effort to master, and thanks to the thrifty V-twin, the NT700V delivers great economy; we got 51.8 mpg on a freeway cruise from the coast to the desert and back. The fuel tank holds 5.2 gallons with a 0.9-gallon reserve—plenty for 200 blissful miles. — BEN STEWART

2010 Honda NT700V



[chevy.com/cruze](http://chevy.com/cruze)

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First, determine where on the wall you want to hang your new flat-screen TV. A piece of cardboard the size of your TV will help you find and mark the location. Next, you want to make sure there is access to the cords and power. If you want to hide the cords, drill one hole in the wall and one at the bottom or near an outlet.

Locate the studs with a stud finder and mark them with a pencil. As a general guide, TVs under 80 lbs. and 40 in. can be mounted to a single stud. For anything bigger, use two studs. Next, drill starter holes and screw the TV mounting brackets into the studs. Make sure everything is level. Continue to follow the kit's instructions to mount the bracket onto the TV.

With someone's help, hang the flat-screen TV on the wall mount. Connect the cables.

Now the hard part! Walk away...and come back in an hour or so. You'll have protected yourself with **Gillette's Odor Shield Anti-Perspirant** so you'll still be fresh, even after that long hour! If you don't find your TV on the floor, then your job was a success! Once you have conquered this task, you'll be ready for the next one.



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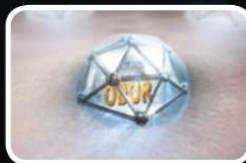


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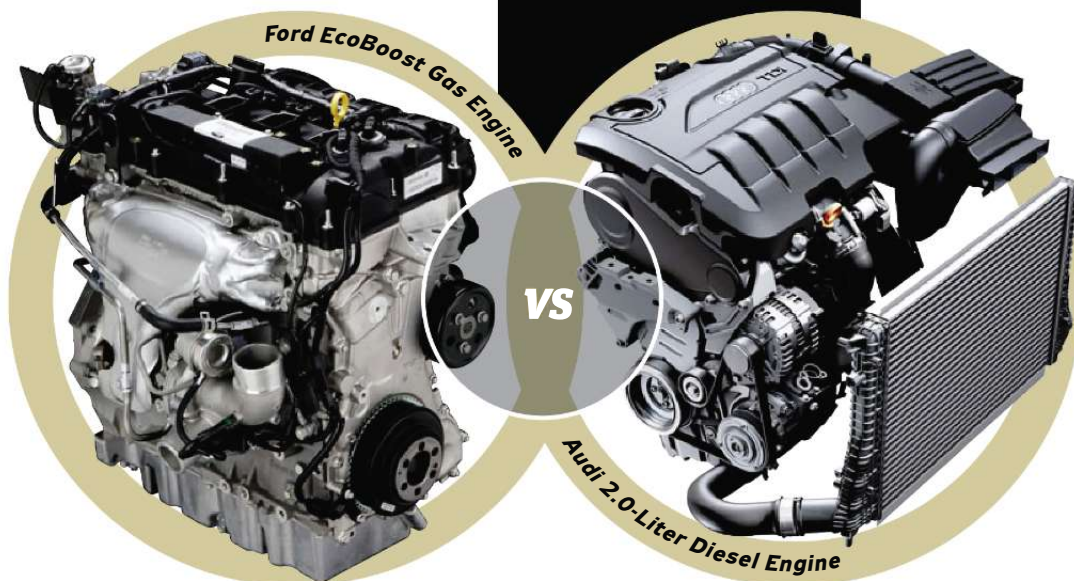


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## Engine Wars: *Gas vs Diesel*

The diesel engine has always been the most efficient internal combustion engine available, but thanks to new technology, the gas engine is quickly catching up. *BY REX ROY*

**W**hen it comes to traversing great distances at highway speeds, the diesel engine's higher compression ratios and lean-burn combustion provide an efficiency that no gas engine can currently match—at least not without a major assist from an expensive hybrid system. Over the diesel's operating range, the average thermodynamic efficiency—how much work the engine produces from the fuel—is in the mid 30 percent range, at least 15 percent better than a gas engine. Not even close, right?

The reality is that this lead is shrinking. As emissions regulations stiffen, diesels are slowly losing their edge; the same pricey after-treatment systems that scrub diesel exhausts also happen to crimp efficiency. Meanwhile, gas engines continue to improve.

"There is certainly a convergence in efficiency levels between gasoline and diesel engines," says Uwe Grebe, GM's director of global advanced engineering. "While diesels will always maintain a slight advantage, the gap will nearly close in as little as 10 years."

Over the past decade, once-exotic efficiency-enhancing hardware such as variable camshaft timing, direct fuel injection and turbochargers have become commonplace on spark-ignited engines. Certainly, these technologies aren't new, but incremental improvements in electronics and materials have pulled them into the mainstream. And there's more on the way, like lean-burn combustion and homogeneous charge compression ignition (HCCI), a gas-combustion technology that blurs the line between gas and diesel engine cycles. Ricardo is working on a turbocharged engine that uses E85, a lofty compression ratio and high boost levels to achieve diesel-like efficiency. Rod Beazley, Ricardo's VP of spark-ignited engines, boasts that "our ethanol-boosted concept engine achieves thermal efficiency in the low 40 percent range."

But don't expect the diesel engine to lie down and play dead. "We'll continue to see incremental improvements in diesel efficiency," says Marc Trahan, Audi's North American director of quality and technology. "It won't be as large as going from sequential port fuel injection to direct injection, but there are still more gains to be made." Trahan says these smaller gains will come from hardware such as variable valve timing and independent cylinder combustion control, as well as improved after-treatment systems.

Moreover, there are other factors in play. As GM's Grebe points out, diesel fuel contains about 14 percent more energy by volume than gasoline. This gives compression-ignition engines a significant edge in fuel economy, as opposed to thermal efficiency. Of course, everything will change if and when spark-ignited engines switch to more energy-dense fuels. This race is far from over.

PM



### TV FOR CAR FREAKS

This fall, the History Channel and the BBC bring *Top Gear* (the iconic and irreverent British TV series that features outlandish car stunts) to American audiences, complete with comprehensible Yankee accents. Comedian Adam Ferrara (top), drift racer Tanner Foust (center) and race analyst Rutledge Wood (bottom) host.



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## MAGNIFICENT OBSESSION: THE DOBLE STEAM CAR

> BY JAY LENO

> PHOTOGRAPHS BY JOHN LAMM

O

### NE OF MY HEROES WAS A GUY NAMED ABNER

Doble, an engineering genius and a perfectionist, who built his first steam car when he was in high school. Later, as an MIT student in 1911, Abner built a steamer with a condenser that turned vapor into reusable water; not even the Stanley Steamer had that range-extending feature.

Some years later, Abner, with assistance from his three brothers, founded the Doble Steam Motors Corporation. But he was a much better engineer than businessman; his outfit built just 36 cars from 1922 to 1931. I own two of them, both 1925 Model Es. One is a sedan, chassis No. 18. The other car, a roadster with chassis No. 20, was once owned by Howard Hughes. My Dobles are only two

cars apart, but they are vastly different because Abner constantly tinkered with the car's design and mechanics. They say this incessant re-engineering meant that each model cost over \$55,000 to develop. At a time when a Model T sold for \$260, the Doble cost about \$20,000, which would be roughly \$250,000 today. And that was a big problem, even for what was, by 1925, the best steam car on the road. Plus, Abner was doggedly pursuing steam propulsion when all signs pointed to the internal combustion engine as the powerplant of the future. He was, in effect, perfecting the VHS tape when DVDs had just been released.

From one Hollywood icon to another: Leno in a Doble once owned by Howard Hughes.



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# JAY LENO'S GARAGE/// STEAM DREAMS

Abner could indulge himself because money wasn't initially an issue. His grandfather made a fortune selling tools to gold miners and his father perfected a power-generating water turbine. Financial troubles, however, eventually dogged the company. The brothers bickered and sued each other. Abner was convicted and then acquitted on appeal in a stock manipulation scandal. I think he was a lot like Preston Tucker. He sincerely wanted to build a good car, but some of his practices were questionable.

At least Doble's customers got an incredibly sophisticated automobile for their money. Superheated steam from a 1200-psi front-mounted boiler drives a four-cylinder double-compound engine, which in turn powers the rear axle via a set of spur gears. The engine's high- and low-pressure cylinders reuse steam as it goes between the cylinder pairs, maximizing efficiency. There are also complex water and oil pumps, a powerful 1-kilowatt electrical system to run the  $\frac{3}{4}$ -hp blower, pumps, lights and ignition, and a number of quartz rods that automatically regulate the steam temperature.

Unlike a Stanley, where you need a match or some other flame to fire up the boiler, the Doble self-ignites. The starting process begins by turning the key and pulling up the floor-mounted water-pump knob. There's a *ticktick-ticktick* from the water pump as it pressurizes the coils and pushes out air bubbles, generating 300 to 500 psi in seconds. Push the water-pump knob back down, turn on the ignition: *zzzzoooouuuuu!* Now you have fire, which can be fed by a variety of fuels, usually kerosene. Tubes coiled inside the firebox hold about a gallon of water and provide a lot of surface area for quick heat transfer. That, combined with about 2 million Btu of heat, quickly builds up steam, and you can pull away within a minute.

Since the crankshaft drives the

rear wheels, there's no transmission and therefore no shifting. Open the hand throttle and acceleration from a dead stop is smooth and continuous. The Doble just continues to pull all the way. It only has about 150 hp, but the torque output is huge: 2200 lb-ft at the rear wheels. If you're on a hill, you just keep your finger on the throttle lever and it holds the car right there. Once it's up and cooking, the fuel is burned almost completely, like a propane torch, so when it's running, visible emissions are minimal. Care and maintenance are very labor-intensive, but as the owner's manual states, "Your man can do that."

My roadster came from the Nethercutt Collection in Sylmar, Calif. The late J.B. Nethercutt paid 10 guys for two years to restore it to exactly what Abner intended. I'd had my eye on it for 20 years. Dobiles are like any other rare artwork. You say you're interested, and decades go by. And you either get a phone call or you don't.

Hughes's old car came very complete, so there have been just a few fittings to replace. Dobiles have to be surgically clean and airtight to eliminate power losses through leaks; they need to hold a vacuum so the water returns to the boiler when everything

cools down. I've driven this car more miles than it's been driven in many years, and it pulls away faster than you'd ever think possible in an 85-year-old car. But its steering is slow and heavy. We're trying different lubricants, and we think the steering box will loosen up. And like most cars of its era, it didn't come with front brakes. I call the Doble's binders the antistop brakes: They slow the car a little, but since there's no engine braking, they're scary. I'm going to install front brakes.

The smoothness and force of the acceleration, however, never fail to amaze me—it's like the Hand of God pushing you along. I was running at 85 mph the other day, and there was more to go. It's dead silent on the road, just *woooooooshhhhhh!!!* Back in the day, Hughes was clocked at 132.5 mph on a Texas highway, faster than anything with an internal combustion engine. It proves what I've always believed: The last days of an old technology are almost always better than the first days of a new technology.

PM



Below: Among the Doble's many innovative features was a primitive turbocharger that augmented the electrically driven blower. Right: The piston steam engine.



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# ANATOMY OF A GRIDIRON COLLAPSE

> BY JOE P. HASLER

O

WHEN THE DALLAS COWBOYS' PRACTICE FACILITY CAVED IN, IT WAS THE PERFECT STORM OF BAD WEATHER AND SHODDY ENGINEERING.

**I**n the stormy afternoon of May 2, 2009, 27 newly minted Dallas Cowboys were finishing a workout in the team's indoor practice facility when the hanging lights 86 feet above them began swaying. On the sidelines of the 83,000-square-foot field house—a tent-like steel-framed building with a tensioned fabric exterior—beat writers and photographers stopped watching the minicamp and stared at the fabric walls, which were snapping like a flag in brisk winds.

"I heard something long before I saw anything," says photojournalist Arnold Payne. "It was this huge crash of metal and steel. You knew it was time to run. Just from the sound."

It was the sound of a massive structural failure. Buckling under the winds, the facility's western wall collapsed on top of the field. The roof and eastern wall soon followed suit. As people dashed for the exits, the fabric covering fell, enveloping them in darkness. Most of the 70 inside the building managed to escape safely. But 12 people were injured, some seriously.

The practice facility had been erected in 2003 at the behest of new head coach Bill Parcells. Summit Structures, an Allentown, Pa.-based company owned by Canadian firm Cover-All Building Systems, put up a \$4 million, 406-foot-long field house over one of the fields at the Cowboys' Valley Ranch campus. But in 2008, after the collapses of four similar Summit- or Cover-All-built facilities over a six-year period, the Cowboys requested structural reinforcements. Summit put in additional horizontal bracing, buttressed some critical structural points and re-covered the field house in a new exterior fabric, all to make the building more robust.

None of it worked. So who—or what—was to blame for the collapse?

First to weigh in was the National Weather Service. Studying Doppler radar from May 2, it concluded that a phenomenon known as a microburst—a localized, concentric wall of air capable of traveling at speeds of up to 150 mph—was a major factor. But investi-

Workers search for trapped people in the wreckage of the Dallas Cowboys' field house, which collapsed May 2, 2009.



PHOTOGRAPH BY RON JENKINS/FORT WORTH STAR-TELEGRAM

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## Henkel



## WHAT WENT WRONG/// COWBOYS' FACILITY COLLAPSE

gators at the National Institute of Standards and Technology (NIST) soon determined that weather wasn't the sole culprit in the cave-in. "There was nothing unusual about this wind event in terms of its relationship to structural design," says Fahim Sadek, who co-authored the NIST report.

Investigators determined that the building, designed to withstand 90-mph winds, broke apart in gusts between just 55 and 65 mph. In its final report, published eight months after the collapse, NIST detailed a series of engineering failures—a progression of flawed calculations, incorrect assumptions and unexplained deviations from original plans. Wind load, the force

applied to an object by blowing wind, was calculated for an average building height of 60 feet; the structure actually had a mean height of 67 feet. As a result, the load on the building was more than double what Summit had assumed. Engineers also assumed that the building was "fully enclosed," but it had vents and several large openings for doors, affecting internal pressure—and wind resistance.

When the facility was upgraded in 2008, Summit calculated the new roof's slope at 11 degrees; the actual slope was 21 degrees—so demands on the building were 68 percent greater. And Summit assumed the building's fabric covering provided lateral bracing for the structure. NIST's computer models showed that it did not.

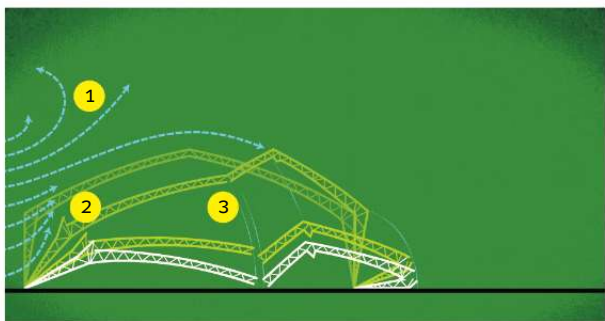
The NIST report noted that tented structures like the field house are rela-

tively unregulated, and the practice of counting the fabric as lateral bracing is a point of disagreement among engineers. Summit may not be around to weigh in on the debate: Cover-All, Summit's parent, filed for bankruptcy in March. (Attempts to contact Summit were unsuccessful.)

In the wake of the collapse, other organizations with similar structures, including Texas A&M and the University of New Mexico, had engineers evaluate the safety of their facilities. But it's not known how many buildings of this type exist—or how many could be suffering from structural deficiencies. But the takeaway from this disaster is clear: Engineering errors and inclement weather can be a tragic combination. The Cowboys' structure was built to fail; it just needed a good push. And on May 2, it got one. **PM**



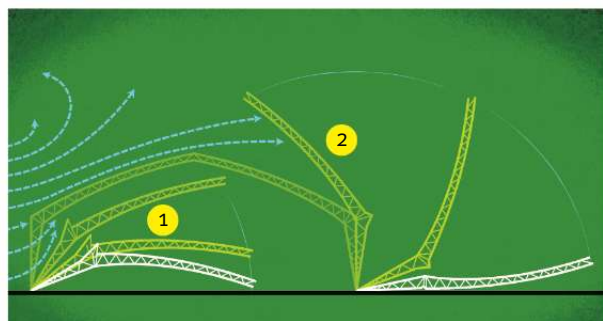
## Inside the Tent Collapse



**NORTH END** At 3:24 pm, the wind smashes into the field house (1). On the western wall of the structure, its critical joints—the so-called "knees"—strain under the wind load, which outweighs the load-bearing capacity of these vital members; they buckle (2). Failures at the knee and ridge (3) cause the north end of the facility to collapse onto the field. The fabric that created the walls and ceiling also falls, cloaking 70 people trying to escape in darkness.

**THE BUILDING** The Cowboys' practice facility (left, mid-construction) was built by Summit Structures in 2003. Twenty-eight steel-truss gable frames, reinforced with steel webbing, created the 86-foot-tall facility's structure. Sheets of fabric hanging from the frame formed the interior walls and ceiling, and a layer of tensioned fabric over the frame created the exterior walls and roof. In 2008, Summit upgraded the facility, purportedly to make it safer.

**THE MICROBURST** At 2:57 pm on May 2, a localized pocket of cool air in the midst of a spring storm drops from the clouds to the ground. The cool air pushes outward, creating a "stagnation point" from which a concentric wall of wind—essentially an inverted tornado—travels at speeds between 58 and 62 mph, blowing north-east toward Valley Ranch, about 1 mile away.



**SOUTH END** As the north end collapses (1), the near-tornado winds blow the east side of the southern end of the structure over onto the neighboring outdoor practice field (2). Most of the players, staff and local media inside the building managed to escape safely, but 12 people were injured. Special teams coach Joe DeCamillis sustained a broken neck, and Rich Behm, a scouting assistant for the Cowboys, was paralyzed from the waist down.

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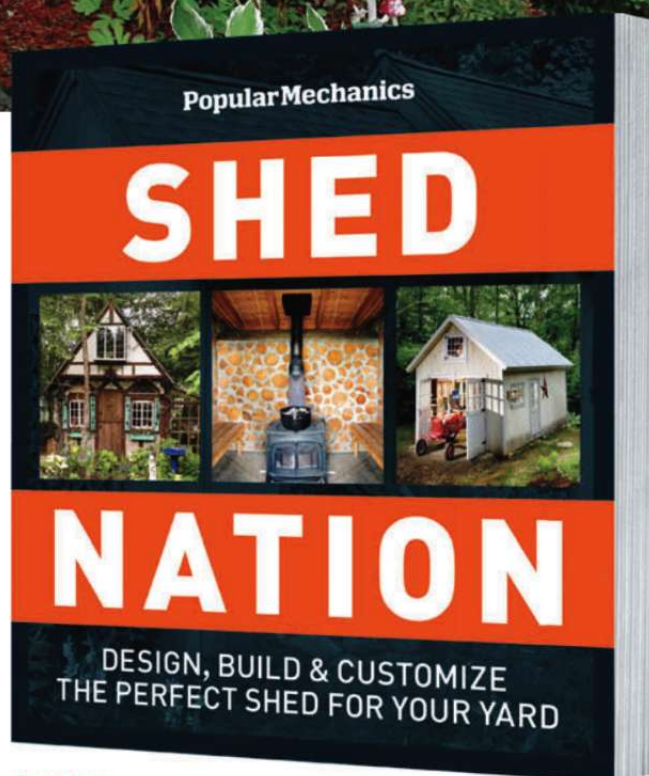
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*& the editors of PM*  
by Logan Ward

n

ever before has technology advanced at such a blistering pace. And yet there's a difference between the latest gadget and innovations that truly move society forward, whether that's driving down the cost of solar power, proving the existence of water on the moon, designing earthquake-proof buildings or finding a cure for cancer. "We're now a society that's 100 percent dependent on science," says this year's Leadership Award winner, J. Craig Venter. We agree. And so we salute the human spirit behind the achievements that really matter.





# PIONEERING NEW



*J. Craig Venter has worked with teams to sequence hundreds of genomes, including his own. In the future, he says, such genetic information will provide valuable insights into issues like aging and disease.*

## LIFE

**Innovator:**

J. Craig Venter

**Brilliant Idea:** Develop methods of quickly decoding genes in order to understand the basic building blocks of life, then use that knowledge to design organisms that can address global challenges.

**ENOMICS PIONEER J. CRAIG VENTER ADMITS** he was a late bloomer. A halfhearted student (his 8th-grade report card shows multiple C's and D's), he spent his 1950s childhood jumping freight cars in the rail yards of Millbrae, Calif. He dug backyard tunnels and waged make-believe battles, igniting model planes and melting toy soldiers with lighter fluid and matches. As a teenager, Venter surprised his father by successfully building a hydroplane using plans clipped from *POPULAR MECHANICS*, a project he describes today as "my earliest foray into some type of science."

Yet Venter looks back on what some might call a misspent youth with pride. "I was able to fulfill my imagination," he says, "and that is one of the best traits to carry into science."

Discipline and a hunger for knowledge help, too—qualities Venter honed while serving in the Vietnam War. As a medic, he says, "knowledge was essential. That's why I was absolutely determined, even though I hated school, to go to college after I got out of the military."

While working at the National Institutes of Health in the early 1990s, Venter grew impatient with the snail-like pace of gene identification and developed a way to rapidly discover genes by exploiting snippets of DNA called expressed sequence tags. In 1992, he founded

The Institute for Genomic Research (TIGR), and three years later, a TIGR team decoded the first genome of a free-living organism, the bacterium *Haemophilus influenzae*.

That led to Venter's best-known breakthrough, mapping the human genome. Last May, he wowed the world again by creating the first synthetic cell. His ultimate goal is to design new organisms that will benefit humanity. To that end, he has entered into a deal with Exxon Mobil to develop a biofuel alternative to petroleum. And he's working with healthcare giant Novartis to produce more effective vaccines.

When PM caught up with Venter, he was aboard his sailboat—*Sorcerer II*, moored in Ostia, Italy—preparing to join the Global Ocean Sampling Expedition for a monthlong Mediterranean journey. Unlike another famous scientist who sailed the seas collecting specimens, Venter was after an invisible quarry—microbes that would be shipped back to the J. Craig Venter Institute in Rockville, Md., for DNA sequencing.

**Q: I hear barking in the background. Is that your dog? What's its name?**

Darwin. He's a miniature poodle puppy. He's becoming a boat dog for the summer. I mean, Darwin had to have a ship, right?

**Q: Much of your life's work seems to revolve around applying scientific discoveries to the task of problem solving. Will this expedition have specific applications?**



It ultimately will. Organisms in the ocean provide over 40 percent of the oxygen we breathe, and they're the major sink for capturing all the carbon dioxide we constantly release into the atmosphere. I've described the 40 million genes my team has discovered to date as design components for the future. When we're designing organisms for the purposes of producing food and fuel and chemicals—all the things we need for daily life—those components get more and more important. Right now we're at a primitive stage. There's not a direct link between discoveries we're making in the ocean and something we're doing in the lab, but there's certainly an intellectual link to the future.

**Q: How might one of these future organisms function?**

Our project with Exxon Mobil is to try to use algae cells that capture carbon dioxide and convert it to long-chain hydrocarbons—basically, creating a biocrude that can go into refineries to make gasoline, diesel and jet fuel. We're talking about facilities that will have to be multiple square miles, producing billions of gallons a year, to have any effect at all. Those are huge challenges. The research program is to push the science and engineering. If that works, it could have a huge impact.

**Q: Did this desire to find new and useful technology also inspire your quest to create synthetic life?**

No, that began by asking incredibly basic questions about life: What is the minimal life form you could have for a self-replicating organism? We decided the only way we could answer that was to make a chromosome synthetically, so we could alter the gene content to get down to what would be the minimal gene set for life. Having a clear definition of which genes are essential is going to be important for future design projects. As the population goes from 6.8 billion people to more than 9 billion over the next 40 years, we're going to need a lot more food, clean water, medicine and fuel to power all these things. We're now a society that's 100 percent dependent on science for our survival. It's not a gentleman's sport. We think this is one of the most powerful tools—at least on the biology side—that we can apply to all these critical needs.

**Q: How did a former surfer, as some have called you, make the transition to genomics pioneer?**

I'm not sure I was ever a surfer! I was a surfer wannabe. I left home at age 17

and moved to Southern California to try to take up surfing as a vocation, but this was in 1964 and there was this nasty little thing called the Vietnam War. As a result, I got drafted. I ended up in the Navy Medical Corps, and that was a rough education that totally changed my view of where I was going and how I was going to get there.

**Q: Had you been interested in science up to that point?**

I was such a horrible student, I figured my chances of ending up a scientist were pretty low. The Vietnam War totally turned my life around. Some people's lives were eliminated or destroyed by the experience. I was one of the fortunate few who came out better off.

**Q: Why did you decide to pursue genetics?**

Genetics didn't come until much later in my career, when I was working as a biochemist. I had become a section chief and a lab chief at the National Institutes of Health. I had a large budget and could work on anything I wanted, so I stopped everything I was doing and taught myself and my lab how to do the new field of molecular biology. It was clear those were the only tools to really make dramatic headway in the kind of science I was interested in. All the discoveries that I'm known for came shortly after that moment.

**Q: Is it useful to think of cells as biological machines?**

I use the term "machine" quite loosely. Biology is much more dynamic than the diesel engine here in my boat. Our parts are constantly being remade from our information system. I think that's the most important thing for people to think about for the synthetic cell. It shows what life really is. The only reason you're alive and I'm alive right now is that our DNA is being read in every one of our trillions of cells on a second-by-second basis, making new protein molecules to replace the ones that are decaying. It would be like having a self-repairing diesel engine: Every time there's a little decay on the piston, it would repair itself.

**Q: What role do you think the federal government should play in promoting science and technology?**

As I said, we're a society 100 percent dependent on science for our future, so the government can't just sit back and hope that somebody will do something in the private sector. People in the government need to think intelligently about how to stimulate new areas.

**"I WAS SUCH A HORRIBLE STUDENT, I FIGURED MY CHANCES OF ENDING UP A SCIENTIST WERE PRETTY LOW. THE VIETNAM WAR TURNED MY LIFE AROUND."**



# J. CRAIG VENTER'S AMAZING DECADE

**2000** President Bill Clinton declares a tie in the race to map the human genome, giving credit to both Venter and his publicly funded rival, Francis Collins. Far from being finished, Venter considers it “the starting line” for the future of medicine.

**2001** The Institute for Genomic Research, founded by Venter, helps sequence the genome of the anthrax strain mailed in the attacks that killed five people—evidence that eventually leads the FBI to the source.

**2004** *Sorcerer II*, Venter's 95-foot sailboat, leaves Halifax, Nova Scotia, on a two-year circumnavigation of the globe in search of new microbial species for DNA sequencing.

**2005** Venter starts the for-profit Synthetic Genomics Inc. (SGI) to work on solving global problems, such as fossil-fuel dependence, environmental degradation and disease epidemics.

**2007** He establishes another first by mapping the 6-billion-letter code of his own “diploid” genome (DNA from both chromosome pairs, one from each parent), discovering a genetic predisposition for blue eyes, antisocial behavior and heart disease.

**2008** Using a computer code and four bottles of chemicals, Venter's lab creates the largest man-made DNA structure by synthesizing and assembling the 582,970-base-pair genome of a bacterium.

**2009** He announces SGI will receive \$300 million from Exxon Mobil to engineer algae cells that turn sunlight and carbon dioxide into biofuel.

**2010** Venter's team uses a synthetic genome to boot up the world's first man-made bacterial cell. *Mycoplasma mycoides* JCVI-syn1.0 becomes the first living organism to have its own website encoded in its chromosomes.

Things like putting a tax on carbon so that renewable fuels are an option and working on diseases that are below the radar of the pharmaceutical industry.

**Q: Some people contend that genes from living organisms aren't inventions and therefore cannot be patented. How do you feel about that?**

We're a country of laws and rules, and the Supreme Court has ruled that life forms are patentable entities. Intellectual property is a key aspect for economic development. Something has to drive investment. We have investors putting up tens of millions of dollars—in the case of Exxon, \$300 million—and they need to know that they won't lose that money because somebody else owns the intellectual property.

**Q: Do you plan to patent your synthetic cell?**

We've been patenting all the new tools we've developed along the way. The synthetic cell has no commercial value itself—it's just proving that something is possible. Patents are basically rights to try and develop a commercial product. It's a contract that our government makes with its citizen inventors that encourages them to publish and disseminate information about their inventions so that other people can get to the next stage. People equate patents with secrecy; that secrecy is what patents were designed to overcome. That's why the formula for Coca-Cola was never patented. They kept it as a trade secret, and they've outlasted patent laws by 80 years or more.

**Q: How do you feel about the pace of genomics-based personalized medicine since your team first sequenced the human genome 10 years ago?**

It's been moving substantially slower than I like to see things move. Not much happened with government funding in the decade that followed. Private industry has invested a tremendous amount, and there are some pretty exciting new technologies. In fact, it's amazing something that cost \$3 billion to \$5 billion a decade ago can now be done by an individual scientist using a single machine in a very short period of time.

**Q: So you're optimistic about the next 10 years?**

We have 100 trillion human cells, along with 200 trillion microbes associated with us. That's a lot of complexity to sort out. I don't want to underestimate the scope of the problem—of understanding all this information and have it affect our understanding of human disease. It's a huge challenge.

**Q: One final question: Did your hydroplane work?**

Absolutely! It was an 8-foot hydroplane with pontoons. Because I had no money, I built it totally with hand tools out of marine plywood. I was given a junked 1948 outboard motor. I had to learn how outboard motors worked by taking it apart and rebuilding it from scratch. I took it out on the San Francisco Bay, got it up to 25 or 30 miles per hour. It was a real thrill.





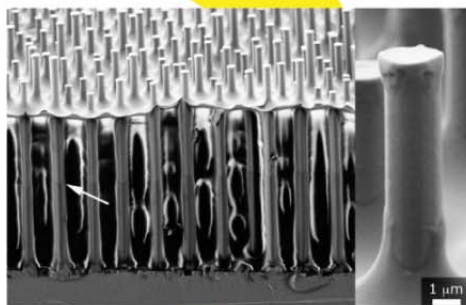
## More-Affordable Solar

**Innovators:** Harry Atwater, Michael Kelzenberg, Nathan Lewis, California Institute of Technology  
**Brilliant Idea:** A solar cell that requires only a fraction of the silicon used in standard PV.

Chemist Harry Atwater's gift for manipulating light has led to some eye-opening innovations, including an "invisibility cloak." His most recent feat: reinventing the solar cell.

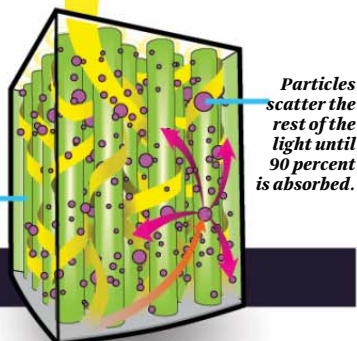
More than half of the silicon acting as a semiconductor in standard photovoltaic (PV) panels—made of wafers—winds up as shavings on the factory floor. Atwater's team at Caltech wastes virtually nothing, instead growing silicon microwires using vapor deposition. (Picture a tiny bed of nails growing out of a cloud of silicon-rich gas.) Researchers coat the microwires with a light-absorbing material, then embed them, along with light-scattering particles, in a clear polymer that has a reflective backing. As light pours in, it bounces around until 90 percent has been absorbed.

The wire arrays require only 1 percent of the silicon—which accounts for roughly half of the manufacturing costs—of standard PV. The first tests of the technology at scale converted light into electricity at a rate of 8 percent, which the team is convinced it can double (standard PV has 20 percent efficiency). Plus, the cells are flexible enough to be applied to roof shingles or curtain walls. "They have the photovoltaic properties of conventional solar cells but the mechanical properties of a plastic bag," Atwater says.



Cross-section of a silicon microwire array.

Silicon microwires take in some sun directly.



## MOON MISSION

**Innovators:** Daniel Andrews, Anthony Colaprete, NASA's Ames Research Center; Stephen Carman, Craig Elder, Northrop Grumman  
**Brilliant Idea:** Sending a spacecraft made from off-the-shelf parts careening into the moon at 2.5 kilometers per second to find water ice.

### 1. SHEPHERDING SPACECRAFT

Rather than commission expensive new devices for the shepherding spacecraft, the team beefed up non-aerospace technology, including near-infrared spectrometers designed for carpet recycling and Nascar engine-block thermal-imaging equipment.

### 2. CENTAUR

The Atlas V's empty upper fuel stage, called Centaur, smashed into the permanently dark Cabeus Crater on Oct. 9, 2009, blasting a swimming-pool-size hole and ejecting a 6-mile-high plume of vapor and dust that had not seen sunlight for more than a billion years.

### 3. MOON DUST

LRO spacecraft analyzed the ejecta, as did Hubble and Earth-based telescopes. Before crashing into the moon itself, LCROSS's shepherding spacecraft relayed the most intriguing data: evidence of water ice, which may have been deposited by the impact of an ancient comet.

It's hard to decide what's more impressive: the confirmation of water ice on the moon, or the scrappy way that a team of scientists and engineers pulled off the mission—by slamming 2 tons of equipment otherwise destined to become space junk into the moon's south pole and then analyzing the dust plume it kicked up.

Yet the Lunar Crater Observation and Sensing Satellite, or LCROSS, mission began as an afterthought. When the leaders of NASA's \$491 million Lunar Reconnaissance Orbiter (LRO) found themselves with an extra 1000 kilograms of payload capacity, they sent out a call for shoestring proposals for a companion mission. Led by principal investigator Anthony Colaprete, a team from NASA's Ames Research Center proposed using the Atlas V launch rocket's empty upper fuel stage to impact the moon. Northrop Grumman would turn the rocket's hot-tub-size payload ring into a makeshift spacecraft that would trail in the stage's path, gathering data via instruments bolted to its six satellite ports.

The team came in under its \$80 million budget—and the mission was a headline-screaming success. Essentially, says Colaprete, “we reached out and touched the water.” The spacecraft calculated a 4 percent moisture concentration in the plume, double that of the Sahara. “We take that for granted here on Earth, but 1 to 2 percent water on the moon or an asteroid is potentially a lifeline,” he says. “From an exploration standpoint, we realize there are a wealth of resources that we can take advantage of. Suddenly, the moon is a more interesting and active place.”



## Cellphone-Enabled Healthcare

**Innovator:** Aydogan Ozcan, University of California, Los Angeles

**Brilliant Idea:** A cellphone microscope that can diagnose disease cheaply and effectively anywhere in the world.

Aydogan Ozcan hopes to make microscope lenses obsolete. “Microscopes are analog technology,” says the 31-year-old electrical engineer. Bulky and expensive, they rely on finely polished curved glass to refract and focus light. By hacking a cellphone’s software to perform the same function, Ozcan has brought an invention with Renaissance-era origins into the 21st century.

Ozcan’s cellphone microscope focuses LED light on a slide positioned over the camera’s image sensor. The sensor converts light bouncing off and around a sample of, say, blood cells into electrons and records them as a digital hologram. Image-processing software analyzes the hologram once it’s uploaded to a computer. **One application, which will be field-tested in Brazil this year, identifies red blood cells misshaped by the malaria parasite—the same thing a technician searches for using a standard microscope. Unlike a scan by a trained human eye, however, software analysis is instantaneous.** Future apps could screen for disease-causing parasites in drinking water and help monitor the health of HIV patients by counting T-cell levels in their blood.

“The key to everything is the cellphone,” Ozcan says. In 1990, fewer than 12.5 million people worldwide had them; today, 4.6 billion do. While conventional lens-based microscopy has essentially plateaued, fierce competition causes cellphone-camera technology to advance rapidly even as prices plummet. Eventually, Ozcan believes, point-of-care facilities in the U.S. will begin replacing expensive and time-consuming lab procedures with cellphone-based diagnostic tools. “Once insurance companies start to accept this,” he says, “we will have better, more affordable healthcare and better quality of life.”



# EARTHQUAKE-PROOF BUILDINGS

**Innovators:** Gregory Deierlein, Stanford University; Jerome F. Hajjar, Northeastern University  
**Brilliant Idea:** A replaceable, building-wide system to help hospitals, apartment buildings and office towers survive severe seismic shaking.

For decades, the goal of seismic engineers has seemed straightforward: Prevent building collapse. And so they add steel braces to a skyscraper's skeleton or beefier rebar to concrete shear walls. After absorbing the brunt of seismic shaking, however, the compromised structures often must be demolished. "The building, in a sense, sacrifices itself to save the occupants," says Gregory Deierlein, a Stanford University

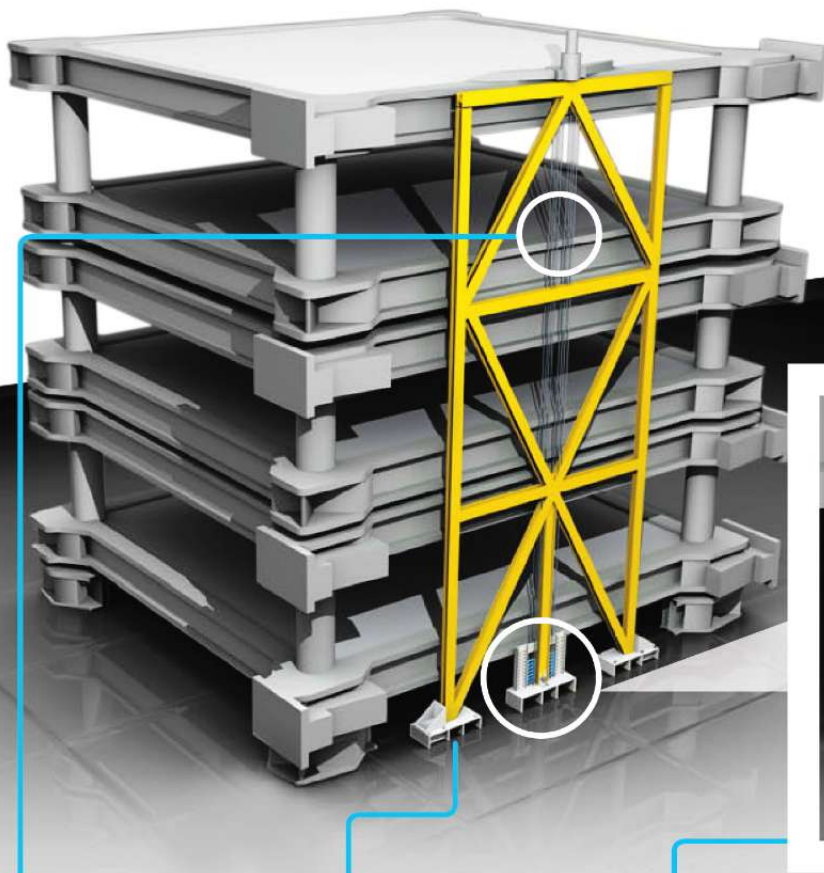
civil and environmental engineer. A team Deierlein led with Jerry Hajjar, a Northeastern University engineer, hopes to change that, designing a system that protects both people and the structures they live and work in.

Last fall, the engineers successfully tested a 26-foot-tall, three-story, steel-frame building outfitted with the new system, built atop the E-Defense shake table—the

world's largest earthquake simulator—in Miki City, Japan.

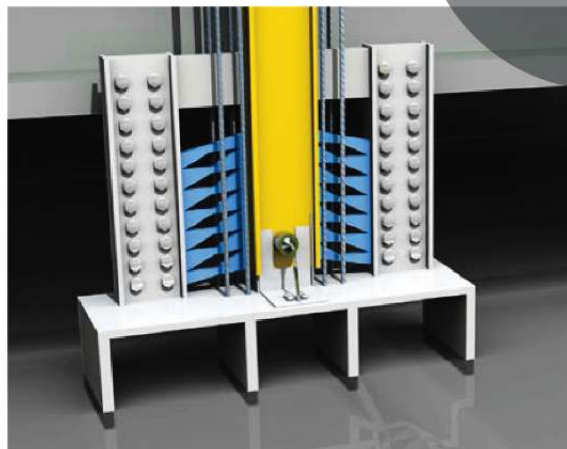
**Steel "fuses," not structural elements, absorbed the shock of an earthquake greater than magnitude 7, and cables pulled the building back into plumb once the shaking stopped.**

After an earthquake of that scale, the deformed fuses could be replaced in about four days—while the building remained occupied. Jim Malley of the San Francisco firm Degenkolb Engineers calls the system the next step in the evolution of green building. "As structural engineers," he says, "our sustainable design is the ability not to have to tear buildings down after earthquakes, but to use them for hundreds of years."



Elastic high-strength steel cables run down the center of the system's frame. The cables control the rocking of the building and, when the earthquake is over, pull it back into proper alignment.

A steel frame situated around a building's core or along exterior walls offers structural support. The frame's columns, however, are free to rock up and down within steel shoes secured at the base.



Steel fuses (in blue) at the frame's center twist and contort to absorb seismic energy. Like electrical fuses, when they "blow out" they can be replaced, restoring the structural system to pre-earthquake conditions.

By combining the expertise of their respective labs, chemist Karen Brewer (left) and biologist Brenda Winkel created a cancer-fighting “supramolecule” composed of three smaller molecules: One binds to the DNA of cancer cells, a second absorbs light, and a third delivers a drug that cleaves the DNA.

## Curing Cancer Painlessly

**Innovators:** Karen Brewer, Brenda Winkel, Virginia Tech; Roger Dumoulin-White, Theralase Technologies

**Brilliant Idea:** Light-activated compounds that cause deep-seated, fast-growing cancer cells to self-destruct.

Two Virginia Tech scientists may have invented the future of cancer treatment—a way to eradicate tumors without the harmful side effects of chemotherapy, radiation or a surgeon’s scalpel. They’ve built what chemist Karen Brewer calls a “molecular machine” that seeks out fast-replicating cancer cells and becomes lethal only when exposed to light.

Other photodynamic therapies rely on drugs that grab oxygen molecules from nearby tissue, so they are powerless against dense, fast-growing cancers—such as breast, brain, lung and prostate—with hypoxic, or oxygen-free, cores. “I really wanted to come up with something completely different, a light-activated drug that would not require oxygen,” says Brewer, an expert at building light-triggered on/off switches for chemical compounds. Biol-

ogist Brenda Winkel helped develop a DNA-targeting compound to attach to the trigger. Then, Toronto-based Theralase Technologies licensed it for use with its own deep-penetrating super-pulsed laser. “This shows promise in terms of getting deeper-seated tissue,” says National Cancer Institute program manager Rosemary Wong. “It would allow you to address a number of different cancers.”

The new therapy has recently begun Phase II trials, part of a seven-year road map for Food and Drug Administration approval. “Cancer is really just cells that have lost the ability to die,” says Theralase president Roger Dumoulin-White. “With the help of a compound and a light source, we’re granting that cell the ability to bow out gracefully. We’re fixing what’s really broken versus trying to cut it out.”





## Next Generation Award

## The Power of Play



**Innovators:** Jessica Lin, Jessica Matthews, Julia Silverman, Hemali Thakkar, Harvard University  
**Brilliant Idea:** A soccer ball that can power an LED light, providing clean energy in developing countries.

Small-scale, hand-cranked generators that power lights and radios are practical in places where there's no electricity. But they're not a whole lot of fun. Four undergraduate students at Harvard University decided to harvest the kinetic energy of soccer, the world's most popular sport, instead. After just 15 minutes of play, their sOcket ball could provide families in sub-Saharan Africa—where less than 25 percent of the population has access to reliable electricity—with 3 hours of LED light, a clean, efficient alternative to kerosene lamps.

The mechanics are straightforward: When the sOcket rolls, a magnetic slug slides back and forth inside an inductive coil in the ball, generating power that is stored in a capacitor. Field-tested in South Africa during the World Cup, sOcket 2.0 has an embedded DC jack and weighs only 5 ounces more than a FIFA-regulated ball. A future version should hold enough juice—3.7 volts at a capacity of 600 milliamps per hour—to charge a basic cellphone. The women partnered with a manufacturer in Cape Town and hope to subsidize developing-world discounts with sales in the U.S.

*Julia Silverman, Jessica Lin and Jessica Matthews (left to right). "We're not expecting these soccer balls to light an entire city," Matthews says. "But when a kid sees what happens when he plays with one, he might start to rethink things other than soccer. He might rethink the way his village gets energy."*



ILLUSTRATION BY DOGO (SOCKET BALL)

## Redefining Magnetism

**Innovator:** Larry Fullerton, Correlated Magnetics Research  
**Brilliant Idea:** Magnets printed with multiple poles, opening the door to myriad applications.

Larry Fullerton set out to invent a self-assembling magnetic toy that would fuel his grandchildren's passion for science. Instead, he invented a way to manipulate magnetic fields that redefines one of the fundamental forces of nature.

**Fullerton's breakthrough tramples the long-held assumption that magnets have two opposing poles, one on each side. He found that if he used heat to erase a magnetic field, he could then reprogram material to have multiple north and south poles of differing strengths.** "People look at magnets as having a north pole and a south pole. That limits your thinking," he says. "I came along from the field of radar and said, 'Hey, that's not a magnet—it's a vector field!'"

To program the magnets, Fullerton invented a device—picture a printer whose head emits 200,000-amp bursts of electricity rather than ink—that creates magnetic pixels he calls "maxels." Using the printer and some vector math, Fullerton is now learning how to produce magnets that exhibit different behaviors. The practical applications appear limitless: from precision switches and a new generation of fasteners to robots that can scale walls without touching them.



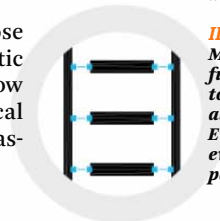
### SNOWBOARD BINDINGS

Two magnets tightly attract when aligned but repel when twisted more than 45 degrees, easily clicking on and off. Other apps: cycling cleats, pick-proof locks, standard prosthetic-limb fittings.



### SPINAL IMPLANTS

Magnetic discs attract and repel simultaneously, offering friction-free cushioning for bones of the spine. Other apps: bearings for energy-storing flywheels, assembly-line arms.

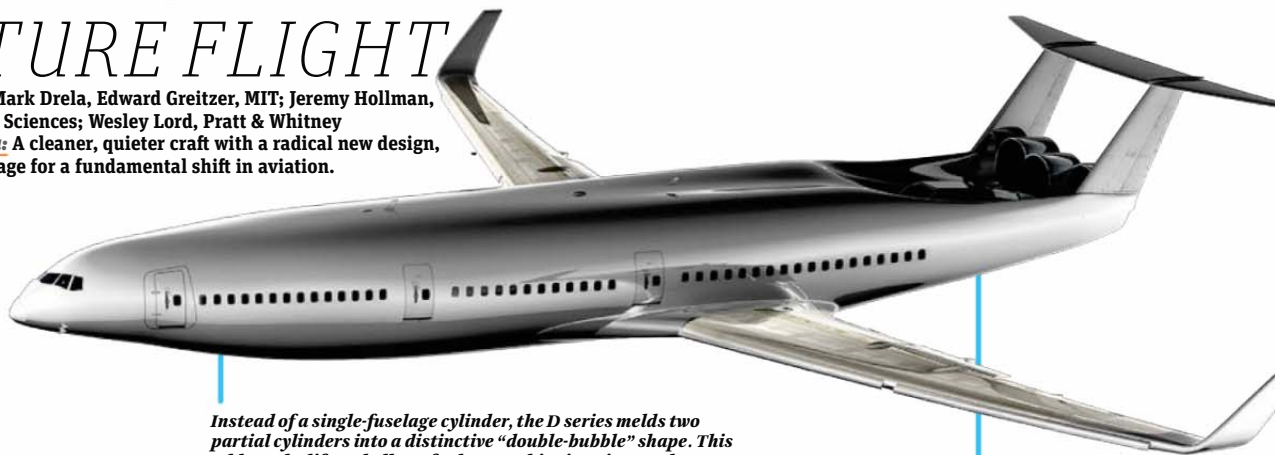


### IDIOT-PROOF ASSEMBLY

Magnets on the joints of furniture or toys click together only when correctly aligned, making Christmas Eve easier for dads everywhere. Other apps: car parts, aircraft machinery.

## FUTURE FLIGHT

**Innovators:** Mark Drela, Edward Greitzer, MIT; Jeremy Hollman, Aurora Flight Sciences; Wesley Lord, Pratt & Whitney  
**Brilliant Idea:** A cleaner, quieter craft with a radical new design, setting the stage for a fundamental shift in aviation.



Instead of a single-fuselage cylinder, the D series melds two partial cylinders into a distinctive "double-bubble" shape. This adds to the lift and allows for longer, skinnier wings and a smaller tail, reducing drag.

Boeing's 737 is the best-selling jet airliner in history: Today, it carries 29 percent of all U.S. domestic air traffic and is responsible for 25 percent of the industry's fuel use. **A reinvention of this commercial workhorse, called the D series, could burn 70 percent less fuel, emit 75 percent less nitrogen oxide and dampen noise from takeoffs and landings.** In short, it could transform air travel into a more environmen-

tally benign practice.

Significant tweaks to the 737's basic tube-and-wing design add up "like compound interest" on the craft, says MIT aeronautics and astronautics professor Edward Greitzer. The MIT-led team, which includes two commercial partners, developed the D series in response to a \$2.1 million NASA research program challenging engineers to design aircraft for 2035, by which time air travel

The engines sit at the top rear of the fuselage, where they draw in slower-moving air that passes over the plane, using less fuel for the same amount of thrust—a technique known as boundary layer ingestion. To mitigate the engine stress this creates, the plane would travel about 10 percent slower than a 737; the researchers anticipate making up this time through quicker loading and unloading via the plane's second aisle.

is expected to have doubled. The team is one of only two in negotiations with NASA for Phase II funding. "How can the airline industry grow and, at worst, remain neutral in its

impact on the environment?" asks project manager Ruben Del Rosario of NASA's Glenn Research Center. "We're trying to invest in technology that can decrease its impact."



# D

## DIGITAL SIGHT FOR THE BLIND

**Innovators:** Department of Energy Artificial Retina Project team, led by Mark Humayun, University of Southern California; Second Sight Medical Products.

**Brilliant Idea:** An artificial retina that transforms a camera feed into electric pulses that stimulate the optic nerve, providing rudimentary vision for millions of people with degenerative retinal diseases.

BY JENNIFER BOGO

BARBARA CAMPBELL IS going to see *Waiting for Godot*. A lifelong New York City resident, she loves the theater and has been attending Broadway shows for nearly 40 years, ever since she was a teenager growing up in Queens. During that time, her vision has steadily deteriorated. At first, she could distinguish the actors onstage without a problem. Then, the details began to blur, so she started using a small telescope to see their faces. Eventually, about 10 years ago, she realized that a production of *Fosse* had faded into a solid whitish blur, which is all she sees when she's facing a stage or walking up a street or getting a plate of fettuccine at an Italian restaurant, as she is now.

"This looks delicious!" Barbara says, in an unmistakable New York accent, as the waiter sets her food on the table. Barbara, now 57, still thinks and talks in the language of the sighted, which is important for the clinical trial she's about to embark on tomorrow. She needs to be able to articulate exactly what she's seeing, if she sees anything, once she becomes the 25th person in the

world to receive the Argus II artificial retina.

In a healthy human eye, 125 million photoreceptors at the back of the retina act like the world's most sophisticated digital camera, functioning in a range of light conditions separated by 10 to 12 orders of magnitude. For example, when navigating through the woods on a moonless night, the eye's rods can pick up a single photon, damping the "noise" of surrounding cells in order to amplify it. And when gazing down the beach on a dazzling summer day, the eye's color-sensitive cones rapidly adapt to a flood of sunlight. Barbara has retinitis pigmentosa, a disease caused by any one of 100 different gene defects that trigger the deterioration of those photoreceptors and interrupt the complex sequence of image processing that follows.

"My sixth grade teacher first noticed it," Barbara tells me—as a child, she had trouble filling in the bubbles next to answers on standardized tests.

"I don't think either of my parents really understood what it meant. Every few years it would get a little worse and a little worse and a little worse." In her 30s, Barbara finally started using a white cane—but only after she'd fallen down an open manhole. You tripped over it? I asked. "No, I went *into* it. There was a ladder so I was able to climb out," she says. "It was right next to a restaurant that had tables on the sidewalk. Everybody was like, Oh my God, she just went down the hole! They thought I just wasn't paying attention." She gets around the city perfectly well now—she took two subways and walked several blocks to meet me at the restaurant—but when she learned about the Argus II clinical trial, she enthusiastically applied.

In the morning, a surgeon at NewYork-Presbyterian Hospital will make an incision in Barbara's left eye and lift the saran-wrap-like membrane that covers it, called the conjunctiva. He'll then suture a small electronics package, about the size of a watch battery, to the outside wall of the eye and secure it with a piece of silicone rubber that wraps around the eye's equator. Next, he'll thread a thin cable through an incision in the wall; the cable connects the electronics to an array of 60 electrodes. After removing the vitreous humor that fills the inside of the eye—a material that's essentially Jell-O, minus the sugar and food coloring—the surgeon refills the eye with fluid so that he can manipulate the array onto the retina, tacking it in place with what is perhaps the world's tiniest pushpin. The whole procedure will take 4 to 5 hours.

Barbara seems unperturbed. In fact, she's

*Mark Humayun's grandmother lost her vision, changing the course of his career. "I ended up going into ophthalmology to do this project, to restore sight to the blind."*





looking forward to it. As a rehabilitation counselor for the New York State Commission for the Blind, she understands the artificial retina won't magically give her perfect eyesight. But what it will do is astounding nonetheless: send electric pulses that bypass the retina's damaged rods and cones to jump-start cells that are still viable. The eye, after all, is a small, delicate organ. It's warm and salty—a corrosive environment—and its tissue is extremely sensitive to temperature variation. Plus, the eye moves, and it moves briskly. Successfully implanting complex, wireless, biocompatible electronics in the eye is an extraordinary achievement. Bringing even rudimentary vision to someone who's completely blind is historic.

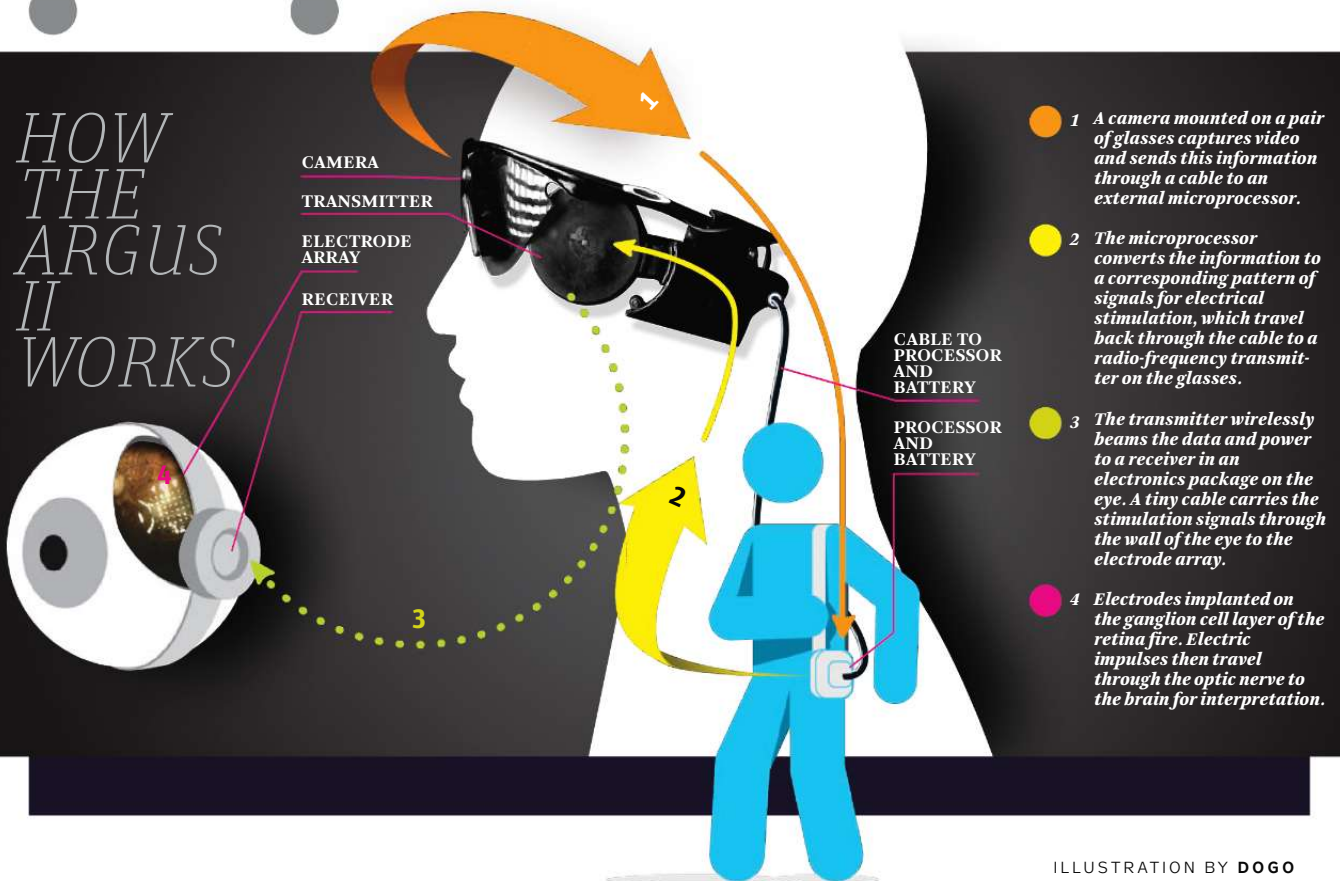
"I really have nothing to lose," Barbara says, looking slightly above and beyond my right shoulder. She leans forward and feels for the edge of her plate. We've met only 20 minutes ago, but she offers me some of her pasta, which I readily accept—it is delicious. "I feel I'm very prepared for this," she says matter-of-factly. "I understand I'm not going to be seeing with my eye, I'm going to be seeing with electronics. There's no way it will look like whatever I saw before."

The Argus II implant that Barbara will be receiving is the second generation of the device; the first had only 16 electrodes. Information gleaned from this clinical trial will be used to improve the 60-electrode version, which will be commercialized, first in Europe, as early as December. But even as the trial continues, a much larger effort, involving six national

labs, four universities and a commercial partner, Second Sight Medical Products, is developing technologies that will enable third- and fourth-generation models using as many as 1024 electrodes—which could provide enough detail to read 24-point font and recognize faces. There are 100,000 people in the U.S. with retinitis pigmentosa and 10 million with degenerative retinal diseases. "I'm optimistic," Barbara tells me. "Whatever happens, somebody will benefit."

**TWO WEEKS LATER, I MEET BARBARA IN FRONT OF HER** apartment on New York's Upper East Side. We're traveling together to her first weekly appointment at Lighthouse International, a nonprofit that conducts research to benefit people with low vision. On the train, she tells me the surgery was long, but painless, and that the doctors seem pleased. As we emerge from the station, I pause, uncertain. "Bloomingdale's should be behind us," she says. "Pottery Barn is on the right. Lighthouse is about a third of the way up the street."

The main goal of today's appointment is to confirm which of the array's electrodes are working properly. Inside the dimmed office, a Second Sight technician hands Barbara a battery-powered microprocessor about the size and heft of a first-generation iPod. It will take information from a camera mounted on sunglasses and convert it to a signal, which is beamed wirelessly to a receiver in the electronics package on Barbara's eye. The receiver then sends a corresponding





ing,” Humayun says. “Each electrode can’t just ping the spot.” Software in the external microprocessor converts the visual feed into signals that should convey the correct shape—a doorway, say, or a lamppost. But each subject must also train to better interpret that information. “If you’ve been blind, your brain doesn’t just sit there twiddling its thumbs,” Humayun says. “It ends up taking over functions such as hearing and maybe even touch. When you replace that lost function

to the brain, those areas have to regroup, reorganize and begin to relearn.”

pattern of electric pulses to the electrode array.

Typically, when light passes through the transparent tissue of the retina and strikes photoreceptors, they initiate electrochemical signals that propagate forward through a layer of bipolar cells to ganglion cells. Millions of nerve fibers running from the ganglion cells dive through the eye’s “blind spot” and form the optic nerve that carries impulses to the brain. The electronic array sits like a postage stamp on the ganglion layer, stimulating the cells directly with a small amount of electricity. This produces phosphenes, the same sensation of light created by rubbing one’s eyes.

The technician touches the keyboard of a laptop—today it will be standing in for the camera, sending information to stimulate specific electrodes—and it emits a loud *bloop*. “Can you see that?” she asks Barbara. “Yes, it was like a flash,” Barbara responds.

Eighteen years ago, a blind patient saw a similar flash of light when Mark Humayun, an ophthalmologist and biomedical engineer at the University of Southern California’s Doheny Eye Institute, placed an electrode directly on the person’s retina during surgery. Until that moment, no one knew whether an optic nerve that had gone unstimulated for decades could still carry a signal to the brain. “The mantra was, if you don’t use it, you lose it,” Humayun says. His discovery made the eye a candidate for neural prosthetics—devices that interface with the nervous system to restore function lost to disease or injury. At the time, another neural prosthetic was just gaining traction: cochlear implants, which bypass damaged cells in the inner ear to directly stimulate the auditory nerve.

Stimulating the optic nerve, however, is much more complex. Besides involving millions of points that create a picture, synapses that communicate across each layer of the retina play an important role in honing and sharpening images—a step the electronic array skips. “You have to re-create that process-

*Barbara Campbell trains to identify letters using the artificial retina with Aries Arditi at Lighthouse International. “I refer to it as a device, but I feel it’s really part of me,” she says. “It’s on me all the time.”*

**FOUR MONTHS AFTER BARBARA’S** surgery, we’re back at Lighthouse International for an appointment in which she will try to identify letters of the alphabet. Barbara uses the camera now; it’s embedded discreetly in a pair of sunglasses. Her face is lit by the glow of an LCD screen in the darkened room, and I can see a white, 10-inch “L” reflected in the lenses. Barbara scans her head methodically, left and right, up and down, because the visual feed is coming from her glasses, not her eyes. “This could be an ‘L,’” she says tentatively.

“That is an ‘L!’ Wow, very nice,” responds Aries Arditi, a principal investigator and senior fellow in vision science at Lighthouse. Barbara laughs: “Beginner’s luck.”

After a few more letters, Arditi has her take a timed test. It’s a control, with the device turned off. Barbara rattles off 10 letters at random as they appear on the screen, sometimes a beat before that, and gets them all wrong. Now, the real test: “Take as much time as you want,” Arditi says. Barbara spends a few minutes studying each letter. Her answers gradually get more confident, and she misses only three out of 10. “I only got three wrong?” Barbara asks. “Whoa! I’m impressed!”

The following week she gets them all correct. “Barbara’s big advantage is Barbara,” Arditi tells me later. “She is really very good at exploiting what very minimal information she does have. The fact that she can recognize letters is astounding. She’s not going to be reading the newspaper anytime soon, but any bit of visual information you get is helpful.”

As a sighted person, I still don’t understand exactly what

CONTINUED ON PAGE 129



# THE YEAR'S 10 MOST TRANSFORMATIVE PRODUCTS

WHILE MANY GREAT INNOVATIONS MAY LANGUISH IN LABS, A SMALL NUMBER MAKE THAT CRITICAL LEAP INTO CONSUMER PRODUCTS THAT WE USE EVERY DAY. WITH THIS YEAR'S BREAK-THROUGH PRODUCT WINNERS, WE CELEBRATE THOSE EQUALLY MEANINGFUL ACHIEVEMENTS, STARTING WITH TWO CARS POISED TO CHANGE AMERICANS' PERCEPTION OF THE AUTOMOBILE.

## AERODYNAMIC DESIGN

Extending the EV's range means minimizing drag, which can lead to bland shapes. "We didn't want the automotive equivalent of Brussels sprouts," says Bob Boniface, the Volt's lead designer. So engineers added details such as a gently sloping rear hatch, a flat bottom and small creases and fins that manage airflow. The result is GM's most aero-efficient car since the EV1.

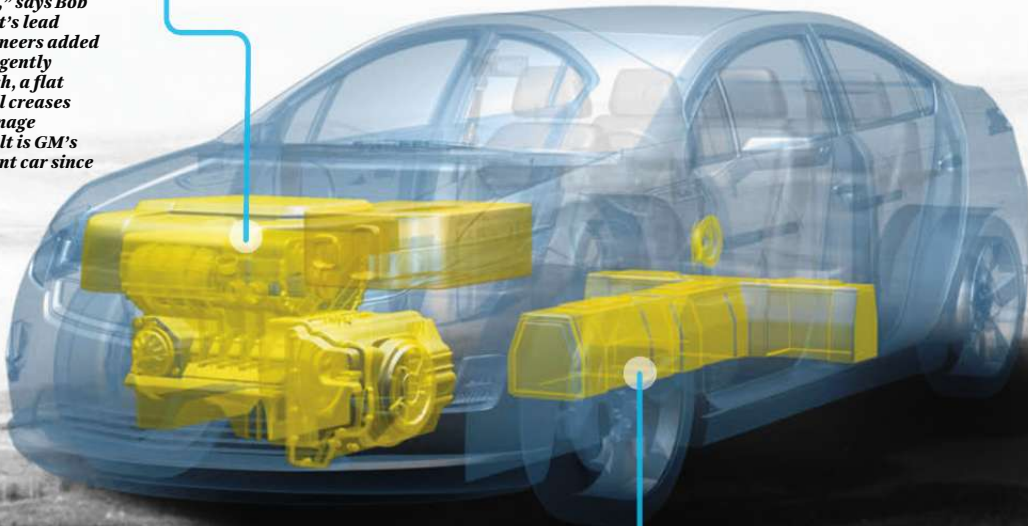
## POWERTRAIN

When the Volt's battery pack is discharged, the 1.4-liter gas-powered four-cylinder engine kicks on to spin the 74-hp generator. The engine doesn't top off the battery but simply runs long enough to maintain performance. The generator and 149-hp traction motor are connected to the wheels via a planetary gearset in a way that's similar to the Toyota Prius's transmission. This arrangement allows both motors to power the wheels, a strategy that keeps each motor in its most efficient—and refined—operating range.

## Chevrolet Volt

**Brilliant Idea:** A series hybrid that augments a battery pack with an onboard gas engine, easing range anxiety and paving the way for EV adoption.

It's an EV early adopter's worst nightmare: running out of juice, miles from the nearest charging station. With the Volt, Chevrolet is intent on squelching those fears. When the car's 16-kilo-watt-hour battery pack becomes depleted, the car automatically switches to a gas engine—a transition that is remarkably smooth (it's nearly impossible to discern on the road). And while the Volt may not be as fun to drive in the conventional sense as, say, a Corvette, there's still a



## USER INTERFACE

Two 7-inch WVGA displays (one of which is a touch-screen) provide access to basic functions, vehicle information and a graphical efficiency coach. A smartphone app allows users to schedule charging and precondition the cabin while the car is plugged in.

## BATTERY PACK

The 300-volt lithium-ion battery pack is composed of 288 cells, grouped vertically like files in a drawer. To extend battery life, the pack never fully charges or depletes. A 250-micron-thick, sponge-like membrane separates the plates and holds the organic carbonate electrolyte through which the charged lithium ions flow. A dedicated liquid-cooling circuit maintains the pack's temperature to within 2 degrees.

sense of occasion behind the wheel. It is smoother and quieter than a Cadillac, plus in-dash screens add the gee-whiz element of revealing the car's inner workings. For a plug-in series hybrid, there's a lot of hardware—a gas engine, a large battery and electric motors—and clever ideas under the hood, pushing the price to \$41,000 (\$33,500 after the federal subsidy), a princely sum for a small car. But the Volt is more than the sum of its cutting-edge parts: It's a dramatic reinvention of the great American car, without sacrificing the great American road trip.

### USER INTERFACE

The Leaf's digital display and navigation system plot the most efficient routes and suggest ways to extend range—for example, by reducing the a/c. Drivers will also be able to track their performance online and compare themselves to other Leaf owners.

## Nissan Leaf

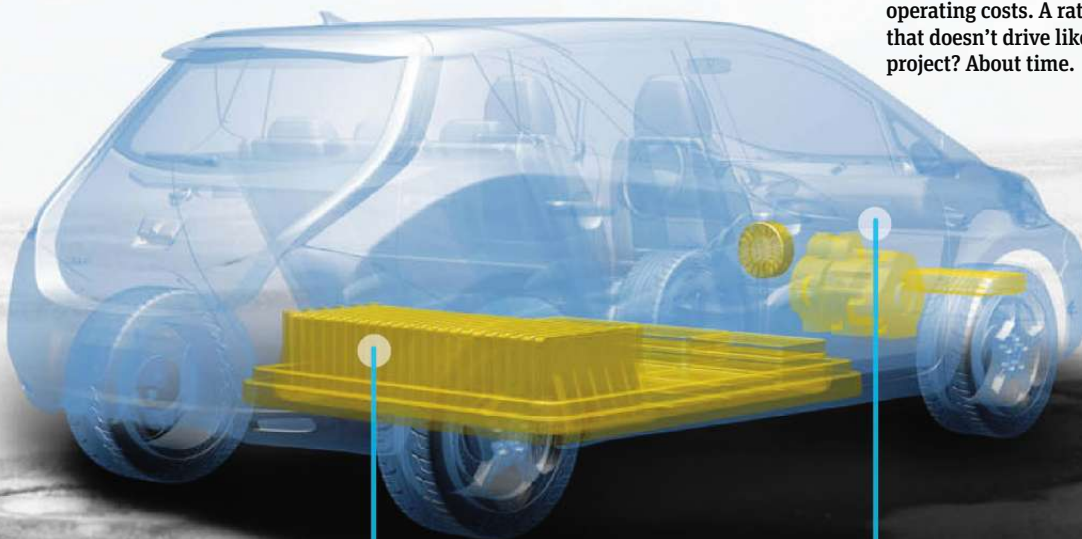
**Brilliant Idea:** A pure EV with space for five, a moderate price and enough range for most tasks—plus, an operating cost that's irresistibly low.



### CHARGING

Two plugs are located in the nose: a standard Level II 220-volt charger that fills the batteries in about 8 hours and a Level III quick charger that hits 80 percent in 30 minutes. The juice needed for 100 miles runs about \$3—less than half of the cost of gas for the same trip.

It's not the first pure EV, but the Leaf is hitting the mainstream like none of its predecessors. At \$33,720 (\$26,220 after the federal rebate), the Leaf costs the same as an average car and offers a 100-mile range—enough to cover the needs of the vast majority of commuters and errand runners. More than 13,000 U.S. buyers have already plunked down \$99 deposits, and Nissan hopes to soon move 150,000 units a year worldwide. The car is eerily quiet to drive. "The vehicle is equipped with a sound generator just so people can hear it coming," says Paul Hawson, product planner for the Leaf. But the real triumph lies in its family-car practicality and normalcy. And since electricity is cheaper than gas, the Leaf delivers lower operating costs. A rational EV that doesn't drive like a science project? About time.



### BATTERY PACK

With no gas-engine backup, the Leaf's 24-kilowatt-hour lithium-ion battery pack is both larger and uses a greater percentage of its capacity than the Volt's pack does. Although both companies are tight-lipped about details, the Leaf's 192 cells have a slightly different chemistry. They're also stacked horizontally, like books on a table, to form a compact pallet under the floor, freeing up interior space for five passengers.

### TORQUE

While the Leaf's electric motor produces only 107 hp, it offers a peak 207 lb-ft of torque at 0 rpm. In other words: Unlike a gas car, it can pop off the line with an immediate and steady stream of power. While braking, the motor also charges the battery.



## BREAKTHROUGH: PRODUCTS

*Sony Alpha NEX-5 Camera (\$700)*

Technically speaking, the 14.2-megapixel Sony Alpha NEX-5 isn't a digital SLR. But it has all the best parts of the bulky black boxes—including the ability to swap lenses and a high-quality image sensor—in a package that is far smaller. In fact, it's the smallest interchangeable-lens camera yet. The NEX-5 even trumps an expensive SLR in one key respect: It is so adept at low-light shooting that Sony's engineers decided to design the camera without a built-in flash.

*Trane ComfortLink II (\$300)*

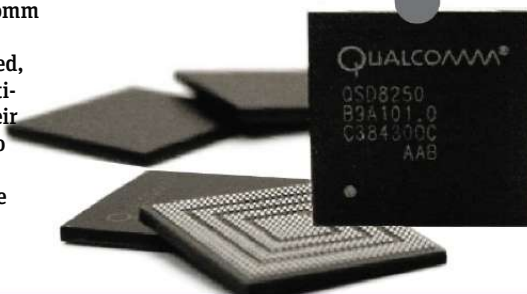
It seems almost unfair to compare standard thermostats to Trane's ComfortLink II. When planning HVAC schedules, the device's 7-inch touchscreen interface eclipses the competition for ease of use and clarity of information. That's key, because the device has so much data to share. It gathers online forecasts and fires up heating and cooling equipment as the weather changes. It also remembers a house's HVAC history, allowing users to compare costs from year to year. But the best features could be yet to come: Trane claims the system could eventually be used to measure specific machines' performance, combining that with information gathered from local utilities to project costs of a home's HVAC operation over time.

*Stihl HSA 65 Cordless Hedge Trimmer (\$500)*

Two-stroke, gas-powered tools are famously polluting and loud, but electric variants typically lack the power or durability to really be practical. The 36-volt lithium-ion Stihl HSA 65 Cordless Hedge Trimmer—the first product to be introduced in a new line of battery-powered yard tools by Stihl—is poised to convert those homeowners demanding a pro-level cut. A single charge provided more than enough power to completely trim and shape a good-size yard during our tests. And because the trimmer can be turned off and on with the flip of a switch, it is also more convenient than gas-fueled models: There's no temptation to idle it.

*Qualcomm Snapdragon Processor*

While today's app-hungry superphones require almost as much speed as a desktop, the chips that power PCs consume enough energy to drain a phone battery in minutes. Enter the Qualcomm Snapdragon, a processor that offers phones (such as the EVO 4G) more than 1 GHz of speed, as well as almost-all-day battery life. Competitors Nvidia and Apple have followed with their own 1-GHz chips, but Qualcomm continues to push the envelope, with 1.3-GHz processors coming out this year and upcoming dual-core mobile chips that run at 1.5 GHz.



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### Bosch Axial-Glide Miter Saw (\$700)

Typical compound-miter-saw blades are stuck on rails. For the Bosch Axial-Glide Miter Saw, the company's engineers looked at the tool's limited range of motion and envisioned the saw as it *should* have been designed. They replaced the rails with a series of six hinges so that a pair of triple-jointed limbs on the 12-inch, dual-bevel saw articulate like scissor jacks, gracefully and intuitively snapping into position to chop even at an odd compound angle. And because rails tend to protrude from saws, getting rid of them reclaims about a foot of precious bench-top real estate.



### DeLorme Earthmate PN-60w With SPOT Communicator (\$600)

For sure, many adventurers head into the wild precisely to go where cellphones cannot. But being truly incommunicado can be dangerous when a hiking trip is visited by disaster. DeLorme's Earthmate PN-60w with SPOT Communicator not only provides detailed topographical maps and GPS guidance in the backcountry, it also lets explorers send SOS messages with embedded coordinates via satellite if they're in trouble—or Facebook updates if they're not.



### GoPoint Technology GL1 and App (\$100)

Modern cars rely on sophisticated computers to operate their engines and internal electronics. To access these computers, owners typically need to use a scan tool—a device that can cost thousands of dollars. By using an iPad, iPhone or iPod Touch as a window into a car's computer, the GoPoint scan tool and its accompanying app offer the kind of diagnostic info that usually requires a trip to the mechanic to retrieve. The intuitive interface allows DIYers to view trouble codes, turn off the Check Engine light and monitor every electrical signal that goes through the computer in real time. As a result, consumers can either save a trip to the mechanic or go to the shop armed with information that could protect them from fraud. Need more proof that this is the future of DIY car maintenance? Other software developers are already releasing apps that piggyback on the cable, including one that tracks fuel economy.



### Sprint EVO 4G by HTC (\$200)

By the time this issue drops, Sprint's 4G WiMAX network will be accessible in dozens of cities through several handsets. But it all started in June with the HTC-manufactured Sprint EVO 4G. We'd been waiting anxiously for 4G—in a nutshell, a cellular network that offers Wi-Fi-like data speeds. By comparison, today's often sluggish and overtaxed 3G networks seem even more ... well, sluggish and overtaxed. Competitors have promised their own 4G networks (most of which forgo WiMAX for the alternate LTE technology), but so far, Sprint's is the only one that is operational. As for the EVO, its power isn't confined to its 4.3-inch screen: It can also serve as a mobile hotspot, allowing up to eight Wi-Fi-enabled devices to tap into the network.



PROMOTIONAL

# POPULAR MECHANICS **BREAKTHROUGH AWARDS CEREMONY**

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This gala event will bring together 20 Breakthrough Innovators and Product Designers to receive their awards and discuss the future of technology

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Mechanics**



**LET'S  
TALK  
TORQUE**

**BY BEN STEWART**

HD diesel pickup trucks are the strongmen of the automotive world, the beasts that can tow and carry loads that would make lesser trucks slap the mat and tap out. And that work has recently become much more grueling, thanks to the ballooning weight of ever-larger fifth-wheel RVs, toy haulers and horse trailers. Tighter emissions regulations this year

mandating a steep reduction in oxides of nitrogen required all three Detroit makers to update their heavy-duty lineup with new or improved diesel engines. These engines are not only cleaner than ever—thanks to sophisticated engine controls and exhaust after-treatment systems—they're stronger too,

packing up to 765 lb-ft of torque. That's what

we call exceeding expectations. It's the perfect opportunity to test the new rigs from Ford, GMC and Dodge. Let's

see how they stack up.

**PHOTOGRAPHS  
BY TODD HIDO**

The pie-size 6.7 Power Stroke badge denotes the new diesel engine, a powerplant that barely noticed the Coachmen Apex travel trailer.



## TESTING PROCEDURE

Our exhaustive week-long test included acceleration, handling and a real-world fuel-economy run that took us along Michigan's rural backroads and Detroit's city streets. Since towing is one main reason folks buy these trucks, we also hitched up 10,000-pound test trailers and then measured acceleration and fuel economy again.

FIRST  
PLACE

## Ford F-250 Super Duty Lariat Crew Cab 4x4

THE FORD'S MENACING, CHROME-PLATED MAW AND HUSKY big-rig styling make it look like an Autobot on the set of *Transformers 3*. Over-the-top machismo? Perhaps. But the true beauty of this \$59,475 Ford has nothing to do with its styling. As butch as it might look, this heavy hauler is really just about as good-natured and easy to live with as an F-150. The ride quality of our 7800-pound Lariat was incredibly smooth over any terrain. It not only rides better than the other two, the new Super Duty glides over broken pavement better than some light-duty trucks. And that's surprising considering the Duty still uses beefy solid axles at each end of the chassis. The secret? According to chief engineer Chris Brewer, eliminating two leaves from the rear spring packs along with retuned shocks.

Equally impressive is the steering, which one could twirl from lock to lock with all the muscle of a single finger. Yes, some testers prefer steering with a bit



more heft. But the usefulness of the featherweight effort was evident in both the tight city parking spaces and when backing our trailers—it's a real fatigue fighter. On the highway, that steering does have a large dead spot on center, but, hey, this is a pickup truck, not a Porsche.

Ford's outgoing and outsourced 6.4-liter Power Stroke was plagued by poor reliability. So Ford brought the operation in-house and created an all-new 6.7-liter V8 with a beastly 390 hp and 735 lb-ft of torque paired with a new six-speed automatic. (Since our test, Ford has upped the engine to 400 hp and 800 lb-ft of torque.) To meet the 2011 emissions requirement, the Ford uses a 5-gallon urea diesel exhaust fluid (DEF) tank that can last up to 7500 miles between fill-ups.

The new Power Stroke certainly packs a wallop, but at the track, the Super Duty ran a truck length or two behind the GMC in just about every speed contest, a result that might have been different if we had had the latest version. Yet away from the stopwatch, the two felt more evenly matched than the numbers suggest. The Ford's throttle response is razor sharp and the torque is nearly instantaneous. Better still, the Ford's diesel was the quietest of the three models tested, at full throttle, at idle or on the highway. While towing the load, the Ford was also the thriftiest fuel user.

Slide behind the Ford's big steering wheel and it feels like you've got a command center at your fingertips. The dash is expansive and useful, with toggle switches ready to be wired up to your favorite accessories. The center console packs a hidden compartment and is reconfigurable to accommodate just about anything. And we dug the new Productivity Screen, a customizable system that provides checklists ranging from trailer and off-road setups to fuel-economy performance and the temperature of vital components. Smart. Flip up the rear seat and there's a handy, lockable storage bin. And like Super Duties of the past, our truck came with a deft exhaust brake and unique features like the handy tailgate step, power extendable towing mirrors and even an electrically locking rear differential.

This was a close contest, but the Ford's unmatched mix of comfort and smart, work-friendly features helped it edge out the competition. There's a reason Ford owns 50 percent of the heavy-duty truck market.

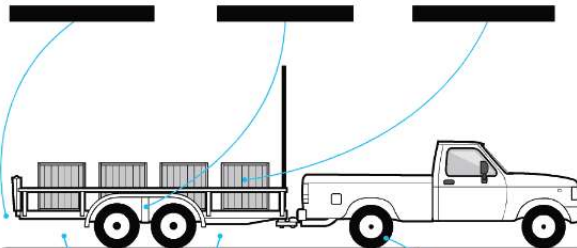


## THE ABC'S OF TOWING

Trailer lights are notoriously finicky, so check them before every trip.

Many states require trailer brakes for loads of more than 7500 pounds.

Adjust cargo so roughly 10 percent of the total trailer weight rests on the tongue.



Adjust the hitch height so the trailer is level to within about 2 inches.

Remember that the load a tire can carry is directly proportional to air pressure, so use the high-load pressure setting.

*For towing tests, we used a test trailer that was ballasted to 10,000 pounds and equipped with a wind deflector to simulate aero load.*

When towing trailers that weigh more than 7500 pounds—such as this loaded Airstream—we've found that the beefier suspension and running gear of HD trucks provide greater stability and comfort than their light-duty brethren.



## GMC Sierra 2500HD 4WD Crew Cab SLT

### SECOND PLACE

ONE WOULD NEVER MISTAKE A nearly 4-ton diesel pickup for a muscle car. But in this group, the \$60,345 GMC could just as easily have had a “Z28” badge plastered on its flanks—it was quick, hitting 60 mph in under 8 seconds. Credit the reworked Duramax diesel, which develops 397 hp and a Kenworth-crumbling 765 lb-ft of torque. Oh, and the GMC provided the best unladen fuel economy—

nearly 18 mpg. Not bad for a 7700-pound truck. GM says it can travel upward of 680 miles on its 36-gallon tank, if you're easy on the throttle. To meet the 2011 diesel emissions standard, the GMC uses a urea-based DEF housed in a 5.3-gallon tank that must be refueled approximately every 5000 miles. And GM provides several warning messages as the fluid is used up.

The Sierra's bodywork may look just like last year's model, but under the skin there's a new fully boxed frame and independent front suspension that's built to carry 25 percent more weight than last year's truck. When the road started to bend, the GMC's retuned suspension and our model's blingy 20-inch wheels and low-profile tires helped it handle more like a light-duty truck, with the most precise steering of the group. On rougher roads around Michigan, with the bed empty, the GMC generally delivered a bumpier ride than the soft Ford but a smoother one than the Dodge. And on the deepest and sharpest impacts, the

GMC bucked harder in the rear than either one.

Out on the open highway, the Sierra's mammoth motor provided easy cruising and ridiculously effortless passing power. Unlike those of the Ford and the Dodge, the GMC's dash has a low cowl for excellent visibility, and the interior is a carbon copy of the ones used in light-duty pickups and SUVs. The atmosphere inside is very carlike, which is one reason the GMC drives smaller than it actually is. One thing that's not so carlike: the air conditioning. We tested during a 90-degree heat wave, and the GMC's automatic system labored harder than the others to keep the cabin cool.

Hitched to a trailer, the GMC was more than a second quicker to 60 mph than the Ford and more than 4 seconds sprightlier than the Dodge. That, folks, is significant. In our informal 15 percent grade towing test, the GMC accelerated smartly up the hill. On bumpy roads with that trailer, the Sierra's ride nearly equaled the Ford's, and the setup felt exceedingly stable at freeway speeds. We also liked how the GMC's exhaust brake helped slow our load on steeper grades without heavily relying on those massive 14-inch disc brakes. Used as a passenger hauler, the GMC has rear seats with contours not unlike those of a bucket seat but offering less comfort than the Dodge.

Only a few details kept the GMC from the gold medal, but its potent and efficient powertrain and sharp handling make the Sierra HD easy to fall for.



# SPEC CHART

**FORD F-250  
SUPER DUTY  
LARIAT  
CREW  
CAB 4X4**

**GMC  
SIERRA  
2500HD  
4WD CREW  
CAB SLT**

**DODGE  
RAM 2500  
LARAMIE  
CREW  
CAB 4X4**

BASE PRICE	\$45,070	\$45,555	\$43,400
AS TESTED	\$59,475	\$60,345	\$55,150
POWERTRAIN	390-hp/735 lb-ft 6.7-liter turbo diesel V8, 6A	397-hp/765 lb-ft 6.6-liter turbo diesel V8, 6A	350-hp/650 lb-ft 6.7-liter turbo diesel I6, 6A
SUSPENSION (F/R)	live axle, coil springs/live axle, leaf springs	independent torsion bars/live axle, leaf springs	live axle, coil springs/live axle, leaf springs
WHEELBASE (IN.)	156.2	153.7	148.9
LENGTH (IN.)	246.8	240.0	237.4
AXLE RATIO	3.55:1	3.73:1	3.73:1
BRAKES (F/R)	13.66-inch disc/13.39-inch disc, ABS	13.97-inch disc/14.17-inch disc, ABS	14.17-inch disc/14.10-inch disc, ABS
CURB WEIGHT/GVW	7830/10,000	7700/10,000	7380/9600
PAYLOAD (GVW-CURB)	2170	2300	2220
TOWING CAPACITY (BALL HITCH/FIFTH WHEEL)	14,000/15,700	13,000/16,700	NA/12,600
TIRES (F/R)	LT275/70R18	LT265/60R20	LT265/70R17
ACCELERATION (SEC)			
0-30 MPH	3.12	3.02	3.07
0-60 MPH	8.49	7.77	9.10
40-70 MPH	6.19	5.91	7.17
QUARTER-MILE	16.23 at 86.64 mph	15.75 at 87.72 mph	16.65 at 82.93 mph
BRAKING (FT)			
30-0 MPH	36.57	38.99	37.59
60-0 MPH	147.33	151.91	153.85
ACCELERATION (SEC, WITH 10,000-LB TRAILER)			
0-30 MPH	6.66	6.07	6.94
0-60 MPH	19.94	18.73	23.04
40-70 MPH	18.47	17.90	21.90
QUARTER-MILE	22.28 at 63.64 mph	21.48 at 63.76 mph	22.80 at 60.01 mph
SOUND LEVELS (DBA)			
IDLE	59.7	62.3	60.1
FULL THROTTLE	67.5	73.4	73.6
55 MPH	67.0	71.2	68.0
LANE CHANGE (MPH)	41.07	47.09	45.82
SKIDPAD (G)	0.69	0.73	0.70
PM FUEL ECONOMY (MPG)	16.68	17.99	15.42
PM FUEL ECONOMY WITH 10,000-LB TRAILER (MPG)	7.49	6.78	7.08

## Dodge Ram 2500 Laramie Crew Cab 4x4

THERE'S A HEAVY-HAULER AUTHENTICITY TO A Cummins diesel-powered Dodge Ram (a truck that after this year will be known only as Ram). Fire up the 350-hp 6.7-liter inline six and you can feel the heft and torque of this 1300-pound engine as you prod the throttle. It feels and sounds more big-rig than the other two. A version of the B-Series Cummins has lived under the hood of every diesel Dodge pickup for the past 21 years. Its reputation is legendary, and that builds serious loyalty. However, the Ram's 650 lb-ft of torque is down by 85 lb-ft to the Ford and over 100 lb-ft to the GMC. And so our \$55,150 Ram trailed the other two in every one of our speed contests and delivered fewer miles per gallon too.

Though the Dodge was slower than the other two, it was more adept at slowing a load—without using the left pedal. The Dodge's exhaust brake felt more powerful than those in the other two trucks in both our 7 percent and 15 percent grade evaluations. That means you can ease off the throttle with a heavy load and let the exhaust brake





Even the Ram's charismatic engine and well-designed exterior—the best-looking of the bunch—weren't enough to vault it to the top.



### THIRD PLACE

slow the rig—saving your brakes.

But the Dodge has a hidden advantage when it comes to servicing. The 6.7-liter Cummins met today's tough emissions standard early—back in 2007—and did so without the use of DEF (at about \$2.75 a gallon). Instead, Dodge uses a nitrogen oxide absorber catalyst. The upside for the truck owner? You won't have those scheduled emissions-related service costs.

The Dodge's bodywork was new for the 2010 model year, but the basic bones of the chassis date back to 2007. That resulted in a ride that was noticeably rougher and less sophisticated than the other two. Strapped to our test trailer, the Dodge required more steering correction

than the others on the highway. And we were surprised that this truck isn't available with the security of traction or stability-control systems.

Slide into either the Ram's front seats or the rear ones and you'll find better all-day comfort than in the other trucks. And like the Ford, our Ram had both heated and cooled seats—an option we would certainly order on our own truck. Our Laramie's dash was trimmed in soft-touch material that looked very upscale, making for the most luxurious interior of the group.

Pampering aside, the Dodge is, in many ways, an honest old-school work truck. It's a trait we can appreciate. But in this group, its level of civility, power and chassis refinement felt a half-step behind the competition.

PM





UNACCEPTABLE RISK  
A POPULAR MECHANICS INVESTIGATION

# TREACHEROUS WATERS

BY KALEE THOMPSON  
PHOTOGRAPH BY JAMES WORRELL





YEAR AFTER YEAR, COMMERCIAL FISHING RANKS AS AMERICA'S MOST LETHAL JOB. BUT DESPITE THE SPECTACULAR SCENES CAUGHT ON TV, THE REAL CATCH DOESN'T HAVE TO BE DEADLY.



***IT WAS AFTER MIDNIGHT ON OCT.***

22, 2008, when lifelong Alaska fisherman Guy Schroder was woken up in his bunk on board the F/V *Katmai*. “Guy, we’ve got problems,” crewman Carlos Zabala told the 50-year-old deck boss. “We’ve lost steering.”

Schroder rushed up to the wheelhouse of the 73-foot factory cod boat, a vessel he had been working on for just a few months. The captain was at the helm, struggling to control the converted shrimp trawler in 30-foot seas. Outside the wind was blowing close to 100 mph. Schroder noticed that a watertight door at the ship’s stern had been







## UNACCEPTABLE RISK A POPULAR MECHANICS INVESTIGATION

left open, allowing crashing seawater to flood into the ship's processing space. He could tell that the motors were already underwater.

As the captain issued the order to abandon ship, Schroder scrambled to pull on a full-body neoprene survival suit and to help launch one of the *Katmai's* two life rafts. By the time the vessel capsized just minutes later, seven of the ship's 11 crew members had made it inside Schroder's raft, a circular, tent-like shelter that had been manufactured almost three decades earlier.

"Then, *ka-whoom!*" the fisherman later recounted for Coast Guard investigators. "Everybody got knocked and thrown in all directions. It was pitch black—and *ka-blam!* Another wave came, and it flipped the raft upside down." All seven men ended up submerged in the 43 F ocean, fighting to make their way back to the overturned raft. "Now you can't see the raft's light," Schroder recalled. "All you can hear is screaming, and crying for help."

### THE DANGERS OF COMMERCIAL

fishing are the stuff of modern legend. Fans of the blockbuster book and film *The Perfect Storm* and popular reality-TV shows like *Deadliest Catch* and *Swords: Life on the Line* would hardly be surprised by the fact that nearly every year the Bureau of Labor Statistics ranks commercial fishing as America's most lethal job. Adjusted to the size of the workforce, the 2008 fatality rate for U.S. fishermen was five times that of truck drivers, eight times that of police officers and 19 times that of firefighters.

Tragedies at sea are often viewed as uncontrollable acts of God. Until a couple of decades ago, marine-supply stores offered steel-soled boots as standard gear: Inevitable death at sea was so ingrained in many fishermen's attitudes that, when the worst happened, they just wanted to sink quickly to the bottom. The truth is that—except in the popular imagination—an "angry ocean" is almost never the primary cause of fatal accidents. Instead, the industry's high mor-


talidity rate is the result of an unromantic but entirely preventable mix of flawed decision-making, inadequate survival training, poorly maintained safety equipment and a lack of government oversight that allows U.S. fishing boats to sink at the rate of one every three days.

Between 1992 and 2007, a staggering 1903 American commercial fishing vessels sank, according to a comprehensive Coast Guard report. As a direct result, 507 people died, accounting for more than half of the 934 commercial fishing deaths during that 16-year period. Most of the remaining fatalities were due to falls overboard or a variety of grisly equipment-related accidents.

It's no coincidence that the number of lost boats and lives is far higher for fishing than for any other type of waterborne industry. Passenger ferries, cargo ships and virtually all other commercial boats are held to much higher regulatory standards. All but the largest factory-style fishing vessels remain uninspected, which means that ensuring a boat's seaworthiness—including the strength of its hull, the stability of its design and the integrity of its watertight compartments—is solely up to the ship's owners. The only federal law governing fishing-boat safety mandates survival equipment for *after* an accident occurs.

"The level of fishing vessel safety standards is analogous to requiring parachutes for an airplane crew, but only marketing voluntary measures to encourage a mechanically sound aircraft and a competent pilot and crew," the authors of a 1999 Coast Guard-commissioned report on fishing fatalities wrote. "It's tragic," says Richard Hiscock, a fishing-policy expert and former fisherman. "We've been trying to get fishing vessels inspected since the 1940s. If you stop to think about how many families would not have been torn apart had we done that, it's mind-boggling."

Hiscock helped to draft legislation, now languishing in Congressional committee, that is crucial to lowering fishing's unacceptable death toll. If the bill passes, the new regulations would



The 73-foot *Katmai* in Seattle's Ballard Locks. On Oct. 22, 2008, a series of human and structural failures caused the factory cod boat to flood and sink in the Bering Sea.

require Coast Guard inspections for all fishing boats more than 50 feet, as well as stronger construction requirements for new boats, more stringent regulations for officer licensing and mandatory crew training. Meanwhile, boats keep sinking.

### IN MARCH 2009, THE 71-FOOT

scallop *Lady Mary* sank 65 miles off the New Jersey coast, taking the lives of six of the seven men on board. Although the Coast Guard investigative report has yet to be released, it's evident that, as in the majority of vessel losses, a cascade of human errors and events contributed to the death toll on the scalloper, which was part of a fleet that—along with the north-east groundfishery, the Gulf of Mexico shrimp fishery and the Dungeness crab fleet in Oregon—has recently proven even more deadly than the infamous Alaskan fisheries. "One of the biggest commonalities comes down to just being lazy with your operations," says Coast Guard Commander Kyle McAvoy.

Take the case of the *Alaska Ranger*, a 184-foot trawler that sank in the Bering Sea in 2008. The ship flooded from the



## INDUSTRY SAFETY: HOW TO IMPROVE THE ODDS



### Problem:

By the time the general alarm sounded on the *Alaska Ranger* in March 2008, flooding that started in the rudder room had spread to the trawler's second level. The crew quickly realized it was too late to control it and abandoned ship. Of the 47 people on board, 42 survived. As in many deadly sinkings, the *Alaska Ranger* was doomed in part by its lack of watertight integrity.

### Solution:

Quick-closing watertight doors—dogged with a single turn of a wheel or push of a lever—would be a lifesaving upgrade from the cumbersome models on many ships. Proper maintenance and training is critical. According to surviving *Alaska Ranger* crew members, there was a company culture of leaving watertight doors open at sea. Wheelhouse alarms that alert officers to doors left ajar can act as an important backup.



### Problem:

Seas were calm on the night in July 2009 that a crew member on board the 60-foot Texas shrimp trawler *Wylie Milam* discovered that 47-year-old Juan Lara was missing. A 51-hour Coast Guard search that covered 2000 square nautical miles failed to find him. Lara was one of 155 U.S. fishermen who died after falling off their vessels between 2000 and 2009—more than half were alone on deck at the time.

### Solution:

A handful of marine-supply companies now manufacture compact, wireless sensors designed to be worn in a pocket or clipped to work gear. The sensors activate automatically if submerged in seawater and set off an alarm in the wheelhouse, alerting crew mates to the emergency. For a solo sailor, some models will kill a boat's engine after a fall into water—often a fisherman's only hope of getting back on board and out of the ocean alive.



### Problem:

When Yasumi Abe got tangled in a net and was pulled overboard from the Bering Sea groundfish trawler *Alaska Warrior* in July 2009, he was not wearing a personal flotation device (PFD). In fact, not one of the 155 man-overboard deaths in the past decade involved a PFD. The crew spotted Abe, clinging to the net, but he quickly vanished. The shock of cold seas often causes victims to suck in water and sink.

### Solution:

With adequate flotation, most people can survive at least an hour, even in the coldest waters. For a recent field study, more than 250 fishermen tested modern PFDs. The winners? The Mustang Survival Inflatable Work Vest, which blows up automatically with water pressure, and the Regatta Fisherman's Oilskins, a European-made rain-gear brand with foam built into the bib of the coveralls. Both were deemed easy to get on, easy to clean and unobtrusive to wear.





bottom up, and when the rising water shorted out the electrical system, the massive boat shifted into reverse. Though it was possible to kill the engines from the wheelhouse, the ship's officers weren't trained to do so. As a result, the crew was forced to enter the life rafts from a moving vessel. More than half failed—and five ultimately died.

Operator error also played a significant role in the loss of the *Big Valley*, an Alaskan crab boat that went down in 37 F seas in January 2005. Though the Coast Guard had a mandatory dockside inspection program for Bering Sea crabbers, the *Big Valley's* captain dodged his examination and left port with almost twice as many pots piled on deck as his ship could safely carry, which left the boat top-heavy and unstable. It capsized and sank. Just one of the six men on board survived—a crew member who had chosen to sleep with his own personal survival suit stowed safely by his bed.

As for the New Jersey scalloper *Lady Mary*, survivor testimony and examination of the wreck indicate that flooding started in the stern and spread quickly, most likely as a result of compromised watertight boundaries in the vessel. “Once you get progressive flooding, you’re in trouble,” McAvoy says. “What would prevent that? It’s training, maintaining your watertight hatches, the crew knowing to keep watertight doors shut in certain conditions—somebody making sure they’re keeping them shut.”

Though further Coast Guard oversight of fishing fleets could eliminate many of the egregious structural and mechanical problems that sink a lot of ships, improving the attitudes, traditions and safety culture among fishing-boat officers and their crews is just as critical. After the *Lady Mary* disaster, lawyers for the ship's owner (whose two sons, one of them the boat's captain, died when it sank) argued that a passing cargo ship hit the vessel. No obvious physical evidence of such a collision has been found. But even if another vessel *was* involved, it's hard to explain how an alert captain or watch stander would not

have spotted an approaching container ship in time to make an adequate mayday call. That is, until you consider that autopsy reports found both the captain and his brother had marijuana in their systems when they died.

## AN INEXORABLE PROGRESSION

of errors doomed the *Katmai*, the Coast Guard's Marine Board of Investigation found. Any one of them would have placed the ship and its crew in harm's way; together, they were a death sentence. Though the *Katmai's* captain had received a weather forecast of hurricane-force winds and 24-foot seas more than two days before the disaster, he delayed the decision to head for shelter. The onboard weather fax that would have delivered regular updates and satellite images of the worsening conditions was down. It was out of ink and set to a frequency in Hawaii, the captain later told investigators.

Though the *Katmai* had watertight doors, they were not in good condition, and the crew often left them open at sea. A crack in the hull had been repaired improperly. That breach, the Coast Guard investigation determined, might have been the source of the initial flooding. And like dozens of other boats now decaying on the ocean floor, the *Katmai* had been converted for a new type of fishing without an updated stability report, prepared by a qualified marine architect, that would have advised the crew on how to safely load the boat. (For boats less than 79 feet, there is no requirement for such a report, though there should be.) The ship's final report dated back two conversions, to 1996, and assumed a maximum 60,000 pounds of fish in the hold. At the time of the sinking, there were 120,000 pounds of cod on board and at least 16,000 pounds of cod pots on deck.

“There was guidance on board for the captain to follow,” says Coast Guard Cmdr. Malcolm McLellan, whose report on the *Katmai* disaster recommended that captains be licensed and that they be required to undergo stability train-

## YOUR SAFETY AT SEA



Some of the hazards that make commercial fishing so dangerous can also prove deadly to anyone who spends time on the water.

More than 700 Americans died in recreational boating accidents last year—many of them preventable.

**1. Wear a life jacket.** Coast Guard studies show that nine out of 10 drowning victims weren't wearing a personal flotation device. Of those who drowned with a jacket on, many wore models that didn't keep their heads out of the water.

**2. Invest in a marine radio.** A cellphone isn't reliable at sea. A quality radio costs about \$100, provides weather updates, can be synced to your boat's GPS and has a button that lets you send an automatic mayday call.

**3. File a float plan.** Be sure to let someone know where you are headed and when you'll return—then stick to it.

**4. Stay sober.** Excessive drinking impairs judgment and depth perception, leading to 16 percent of all fatal boat accidents.

ing. “He knew he exceeded that. He doubled it. As they say, fishing was good, and they just put it in the hold.”

## THE SECOND WAVE THAT HIT

Guy Schroder's life raft took the roof with it. Several men were thrown right through the protective covering, which also serves as a beacon to searchers above. Though the lost canopy had been bright orange, the rest of the raft was gray and black, making it even more difficult for the ejected fishermen to find their way back to the shelter as they fought through raging, three-story waves.

“You got these huge, breaking seas that are just taking everything out with them,” Schroder recalls. “Our raft had little or no ballast bags. We were getting thrown out of it all night and somehow



Cmdr. Malcolm McLellan, a Coast Guard investigator, examines the strobe light on a neoprene suit recovered from the *Katmai*. Issuing fishermen personal survival suits would ensure a good fit, reducing exposure to fatally cold water.

finding it again in the pitch dark. I'm not just talking about three or four flips; I'm talking about all night long for hours and hours."

Despite the obvious shortcomings of the *Katmai*'s survival gear, the equipment was perfectly acceptable by legal standards. "It's crazy," says Jennifer Lincoln, an injury epidemiologist and commercial fishing safety expert with the National Institute for Occupational Safety and Health. "A 1980 life raft should not be able to be used in 2008 and meet regulations."

That single federal law governing commercial fishing boats—the Commercial Fishing Industry Vessel Safety Act of 1988—mandates that ships carry life rafts, fire extinguishers, signal flares and a registered emergency position-indicat-

ing radio beacon (EPIRB). In cold waters, a full-body neoprene survival suit is required for every person on board. Modest as it is, the law has had a big impact. After its implementation in the early 1990s, the death rate among shipwrecked crewmen fell by close to 50 percent.

Still, the law contains significant blind spots. Many of the survival suits ships carry today are the same ones owners bought when the 1988 law went into effect. Neoprene stiffens and deteriorates as it ages, becoming prone to rips, holes and split seams—any of which can be fatal in frigid northern seas. The suits need expiration dates, Lincoln argues. They should also be equipped with small but powerful strobe lights and personal locator beacons with GPS. As for life rafts? They should meet the stan-

dards set by the international Safety of Life at Sea (SOLAS) treaty, meaning large ballast pockets, a reliable sea anchor and doorway ramps to help people board the raft from the water.

Then there's training. "Fishermen have to know how to use their equipment," says Lincoln, who has found an association between survivors and those who have completed formal safety courses. "If you are going to go fish, at a minimum you should have an 8-hour marine-safety class on cold-water survival."

### **SIXTEEN HARROWING HOURS**

passed before an HH-60 Jayhawk helicopter spotted the life raft with Guy Schroder and just three other fishermen remaining inside. Coast Guard rescuers airlifted the men from the mangled raft, which by then had also lost its floor and resembled a giant, battered black inner tube. It had drifted 35 miles from where the *Katmai* went down.

A couple of hours earlier, the rescue crew had found a body in the waves, still outfitted in a neoprene survival suit. Two good Samaritan fishing vessels eventually recovered four other men—also with no vital signs. The four fishermen in Schroder's raft were the only members of the 11-person crew to make it out of the Bering Sea alive.

"I told them, if you lose the raft, you're out of the pool," Schroder says of the guys who were thrown into the sea and never found their way back, including his friend Carlos Zabala. "You only have a few hours in those conditions. You're swallowing a bunch of big greeners. There's no way you can breathe," he says. "You just can't. You can't do it."

Unless, that is, your life raft is, in fact, a sturdy, reliable shelter. Or, better yet, the regulatory and cultural safeguards are in place to ensure your boat never sinks in the first place. **PM**

*Kalee Thompson wrote about the Alaska Ranger in her book Deadliest Sea: The Untold Story Behind the Greatest Rescue in Coast Guard History, published in June.*





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diy

# Home

## We Came, We Sawed

IT'S A BAD DAY FOR LUMBER, AS WE PIT 11 SAWS AGAINST EACH OTHER AND OUR STOPWATCH. *BY ROY BERENDSOHN*

➔ **The circular saw** is the great American power tool. It's used for everything from houses, decks and sheds to smaller jobs, such as cutting the form lumber for a concrete walk or the parts for garage shelves. To test this year's crop, we gathered 11 tough saws—the heaviest-

INSIDE

×

PAINTING CABINETS + CHAIN-SAW BENCH + FOYER-SHELF PLANS



## PM DIY HOME /// CIRCULAR SAWS

duty models offered by their manufacturers—and fitted them all with Irwin's Marathon blade (a rugged pro-quality cutter with a dense carbide tooth). Then PM testers put the saws to work, exam-

ining cutting power and blade adjustment, while also looking at more subtle features, such as grip design. (Many better grips are enhanced with a coating of rubber, called an overmold, for comfort during long days of cutting.) Finally, the testers timed each saw by pushing it across a length of LVL header, a 1¾-inch-thick piece of plywood designed

to carry the load above a window or door. These headers are particularly difficult to cut. By the end of the test, we'd learned that any of these saws will work well for a DIY builder, especially when equipped with a topnotch blade. But the most demanding users should consider our two top performers, which stood out for their power and speed.

### ● Test Results

#### BOSCH CS20

**PRICE:** \$150  
**AMPERAGE:** 15  
**WEIGHT:** 10 pounds  
**HEADER TEST:** 2.68 seconds

**Likes:** We like the fact that this is a framing contractor's saw. It was the only tool with a swing-out hook to hang it off a rafter, another plus. It has no cord to damage, an innovation unique to Bosch—you run an extension cord into its handle. Depth and angle markings are clear and easy to read, and everything is easy to adjust. Its construction is typically Boschian (rugged, that is).

**Dislikes:** Nothing noted.

#### CRAFTSMAN 320.27311

**PRICE:** \$130  
**AMPERAGE:** 15  
**WEIGHT:** 19.3 pounds  
**HEADER TEST:** 2.95 seconds

**Likes:** The Craftsman handles well, has reasonable power and offers excellent visibility of the cut line. The markings for cut depth and angle are also easy to see.

**Dislikes:** The Craftsman is just too darn heavy.

#### DEWALT DW368

**PRICE:** \$130  
**AMPERAGE:** 15  
**WEIGHT:** 9.5 pounds  
**HEADER TEST:** 2.65 seconds

**Likes:** If there's one thing DeWalt excels at, it's building tools for carpenters. This bread-and-butter cutter is an exemplar of the company's tool-building approach. It's extremely rugged, light and powerful, and it slips nicely into your hand. DeWalt skips the typical rubber-molded-grip surface on the handle, favoring its trademark pebbled grip—the best alternative to an overmold that we know of.

**Dislikes:** The stamped-steel adjustment levers are rugged but outdated. Both are uncomfortable and too small. The cut-depth pointer is nearly invisible.

Rating



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## HITACHI C7BMR

**PRICE:** \$130  
**AMPERAGE:** 15  
**WEIGHT:** 10.5 pounds  
**HEADER TEST:** 3.08 seconds

**Likes:** This saw's good balance and well-shaped grip with plentiful rubber overmold make it comfortable to use, especially as the day grows long and fatigue builds.

**Dislikes:** First, the Hitachi needs more power. Also, there's too little room around the trigger, and the trigger's edges are uncomfortable; they need to be rounded.

## MAKITA 5007MG

**PRICE:** \$150  
**AMPERAGE:** 15  
**WEIGHT:** 10.6 pounds  
**HEADER TEST:** 2.1 seconds

**Likes:** From its gutsy cutting power to its smoothly sliding magnesium shoe, this is a saw a contractor could love. The silver-on-black cutting-depth gauge is easy to see and the arm that supports the cutting-depth hinge is robust enough to handle rugged use.

**Dislikes:** The trigger opening is too small, especially for cold-climate users—the fit is too snug for anyone wearing gloves.

## MILWAUKEE 6394

**PRICE:** \$180  
**AMPERAGE:** 15  
**WEIGHT:** 10.6 pounds  
**HEADER TEST:** 2.01 seconds

**Likes:** For readers who value power above all else, this is your saw. You could stall any of these tools if you really tried, but the Milwaukee was stubbornly tough. As for comfort, it was the only saw with a tilt-adjustable handle—a major benefit. A saw's cord is always the first thing to get damaged, so the easily replaceable cord should be a hit with pros and amateurs.

**Dislikes:** The Milwaukee's depth adjustment was sticky.

## PORTER-CABLE PC15TCSMK

**PRICE:** \$100  
**AMPERAGE:** 15  
**WEIGHT:** 9.5 pounds  
**HEADER TEST:** 2.97 seconds

**Likes:** The circular saw has been a staple for Porter-Cable since 1929, when the company introduced its first, and this model seems to live up to that heritage. It handles nicely and cuts with more than enough power to see a homeowner through most jobs.

**Dislikes:** The black cut-depth pointer is all but unreadable.

Rating

**RIDGID R32021**

**PRICE:** \$100  
**AMPERAGE:** 15  
**WEIGHT:** 10 pounds  
**HEADER TEST:** 2.82 seconds

**Likes:** This saw has uncannily adept handling. It's reasonably light and it has great balance—all attributes that help it settle quickly on the cut mark. That feature alone makes it a good choice for anyone who has a lot of cutting to do and not much time to do it.

**Dislikes:** The button that locks the arbor to facilitate blade changing is too stiff.

**ROCKWELL RK3434**

**PRICE:** \$120  
**AMPERAGE:** 15  
**WEIGHT:** 9.5 pounds  
**HEADER TEST:** 2.37 seconds

**Likes:** It's light, it slides smoothly and its cut-depth and angle-adjust levers lock and unlock easily. The Rockwell proved to be among our fastest cutters.

**Dislikes:** Some refinements are called for. The override detent to tilt the shoe to 55 degrees is balky, the cut-depth arrow is invisible and the red plastic cut-line indicator could easily be wrecked by everyday use.

**RYOBI CSB142LZ**

**PRICE:** \$70  
**AMPERAGE:** 14  
**WEIGHT:** 11 pounds  
**HEADER TEST:** 2.71 seconds

**Likes:** For about the cost of a sack of groceries, you could be cutting framing lumber with this saw. It's reasonably quick, too.

**Dislikes:** The onboard wrench falls out easily, and while the bail handle does its job effectively, it also blocks the view of the blade from the left.

**SKIL HD5687**

**PRICE:** \$109  
**AMPERAGE:** 15  
**WEIGHT:** 10.8 pounds  
**HEADER TEST:** 2.69 seconds

**Likes:** Even in this complicated world, one filled with products that have been recklessly overdesigned, you can still walk into a hardware store, buy this saw and frame a house with your purchase. Sure, its shoe looks like a piece of cookware, and there are no rubberized grip surfaces, yet the Skil cuts reliably. Besides, looks don't count in house framing. Performance does. That's why we love this tool.

**Dislikes:** Okay, maybe we don't love its archaic inboard cut-depth lever.



## Classics:

Simple Do-It-Yourself Projects



# Hall Monitor

THIS ENTRYWAY CABINET IS THE CURE FOR LOST KEYS AND DELAYED DEPARTURES. *BY JOSEPH TRUINI*

➔ **You can have** a '67 Mustang in the driveway, a Gibson Les Paul guitar in your hand, and a date with destiny down at the roadhouse open mic—but if you can't find your car keys, you're staying home tonight. The cure for such episodes is this combination shelf and coat rack, which I designed and built for my own front hallway. Its

three cubbyholes provide more than enough space to store everything from car keys and harmonicas to a porkpie hat (if you're so inclined). For most of us, though, it means a place to stash gloves, sunglasses, dog leashes and mail. Coats hang below.

I mounted my minicabinet near the front door, but it would also be useful in a mudroom, breezeway, front hallway, enclosed porch or garage—any area in the home that begs to be transformed from a scene of confusion into a gateway for calm and quick exits to the outside world.

FOLDOUT PLANS



## THE PROCESS



1



2



3



4

## Building the Case

➔ **The heart of this project** is nothing more than an open box. Moldings and shaped edges help conceal that fact, as do subtle proportions.

I began by crosscutting the ends using a miter saw, but you could just as easily use a circular saw and guide. Next, I marked the arch on each end and cut it using a jigsaw [1].

After completing the ends, I ripped to width the upper and lower shelves, the key rail, the cubbyhole dividers and the laminated-pine shelf stock for the back. Note that the cubbyhole dividers are slightly narrower than the upper and lower shelves. This design element helps better define the inside of the case.

Next, I crosscut the upper

and lower shelves, the key rail and the back. Using a  $\frac{3}{8}$ -inch-radius cove bit and router, I cut the decorative edge on the bottom shelf [2], the key rail and the back.

Before assembly, all that's left is to crosscut the top and cut a cove molding for its front and ends.

One of my favorite ways to fasten furniture parts is to use pocket screws. For this project, I used a Kreg pocket-screw jig and the system's matching drill bit and drive bit. The jig firmly clamps a workpiece while you use the drill bit to bore a pilot hole at a shallow angle on the inside of the workpiece. By locating the holes on the inside of the case, the process eliminates exterior

fasteners and the need to join parts with carefully cut joints, glue and clamps. I bored four pocket-screw pilot holes in each shelf [3] and screwed them to the ends. Then I bored six pocket-screw holes in the back and attached it to the ends as well.

Since the dividers need to fit between the upper and lower shelves, you can't simply crosscut them to a given dimension. Instead, hold each divider between the shelves, mark its length, then crosscut it. Slide each divider into the case and fasten it. I used a pneumatic nailer and 1½-inch-long brads.

Finally, hold the back edge of the top even with the back of the ends and nail it to the ends with 1½-inch brads [4].

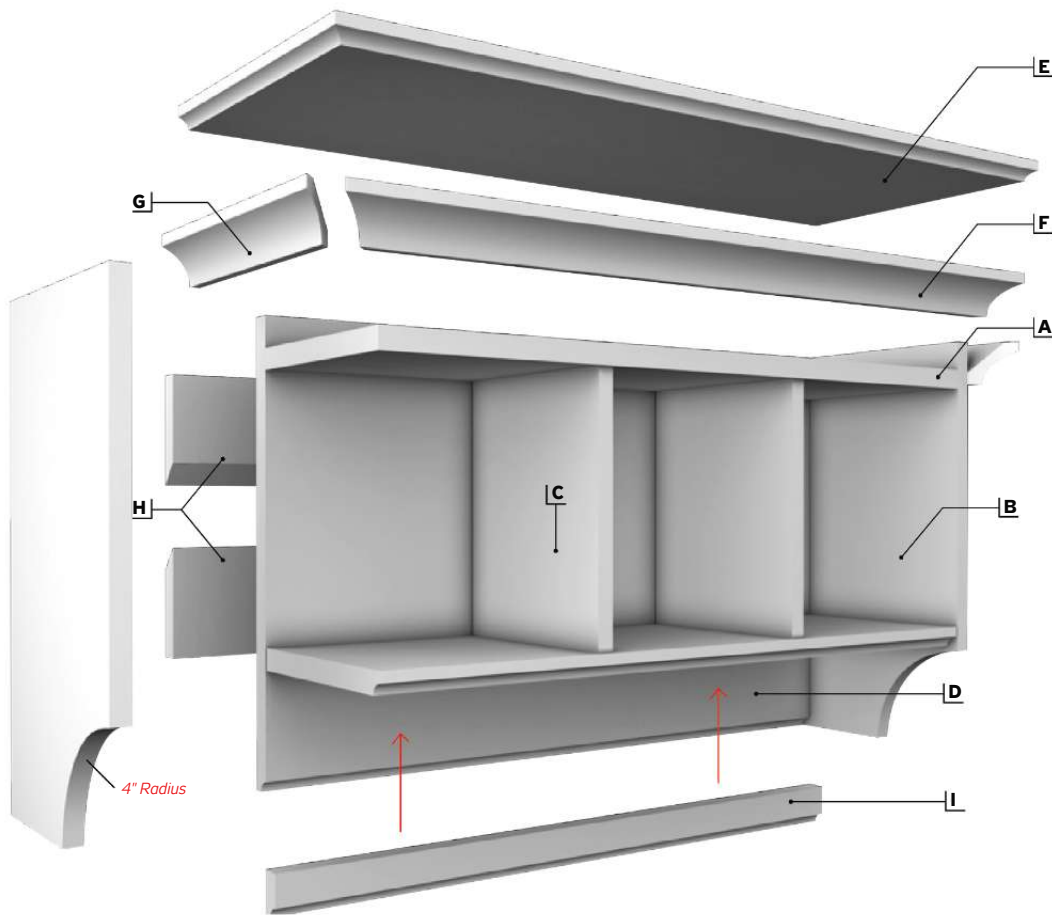


5

## Trimming the Cabinet

➔ **To trim the top**, lay a cove molding upside down on a miter saw (the molding's top rests on the saw table). Cut a miter and hold the molding against the cabinet; mark and cut the second miter. I fastened the front molding with a pneumatic pin nailer [5], but you could drill pilot holes and hammer in





## THE PLANS



$\frac{3}{4}$ -inch-long brads. Now cut a miter on the next piece of molding, butt it against the front molding and mark its length [6]; do this to the third molding as well. Nail these pieces to the case. Finally, lay the key rail inside the case [7], then drive  $\frac{1}{4}$ -inch drywall screws through the case back and into the rail. If

you choose, you can drive small screw hooks into the rail for hanging keys.

Now set nailheads if needed and apply wood filler. Sand the case with 100- and 120-grit sandpaper. I applied two coats of primer and one topcoat of latex semigloss. Then I installed the coat hooks.

## HOW TO HANG IT

The best way to hang a cabinet is with a French cleat. It's strong and it allows the cabinet to be easily removed when the room is painted. To make it, rip two pieces of wood at a 45-degree angle. Attach one to the cabinet back and one to the wall (H, in diagram at left). To attach the cleat to a wall, mark the stud locations and transfer them to the wall cleat. Bore pilot holes in the cleat, then hold it on the wall with a level. Draw a level line under the cleat and drive a screw into a stud. Hold the cleat on the line and drive a second screw. Drive the remaining four screws into the wall framing.

## Key No. Size and Description

A	2	$\frac{3}{4}$ " x $7\frac{5}{8}$ " x $36\frac{1}{2}$ " pine (shelf)
B	2	$\frac{3}{4}$ " x $9\frac{1}{4}$ " x 16" pine (end)
C	2	$\frac{3}{4}$ " x $7\frac{3}{8}$ " x $8\frac{13}{16}$ " pine (divider)
D	1	$\frac{3}{4}$ " x 16" x $36\frac{1}{2}$ " laminated pine (back)
E	1	$\frac{3}{4}$ " x $11\frac{1}{4}$ " x 42" pine (top)
F	1	$1\frac{5}{8}$ " x $40\frac{1}{2}$ " pine (front cove molding)
G	2	$1\frac{5}{8}$ " x $10\frac{3}{8}$ " pine (end cove molding)
H	2	$\frac{3}{4}$ " x 4" x $36\frac{3}{8}$ " pine (French cleat)
I	1	$\frac{3}{4}$ " x $1\frac{1}{2}$ " x $36\frac{1}{2}$ " pine (key rail)

Misc. items: glue, nails, drywall screws, pocket screws, hooks, sandpaper, primer, paint

## CONSTRUCTION AND MATERIALS NOTES

Parts Being Joined	Fasteners	Direction of Fasteners
Shelves and ends	$\frac{1}{4}$ -inch coarse-thread pocket screws	Through shelf into end
Shelves and cubbyhole dividers	$\frac{1}{2}$ -inch (18-ga.) brads or 4d finishing nails	Through shelf into divider
Top and ends	$\frac{1}{2}$ -inch (18-ga.) brads or 4d finishing nails	Through top into end
Cove moldings and case	$\frac{1}{2}$ -inch (23-ga.) headless pins or $\frac{3}{4}$ -inch brads	Through cove molding into case
Cleat and back	$\frac{1}{4}$ -inch coarse-thread drywall screws	Through cleat into back
Cleat and wall studs	3-inch coarse-thread drywall screws	Through cleat into studs
Back and key rail	$\frac{1}{4}$ -inch coarse-thread drywall screws	Through back into key rail





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## Painting Cabinets

**Q** We were thinking of repainting our kitchen cabinets—but only if we get better results than the paint job that’s on them now, which has drips and thin spots where you can see another color underneath. Should we bother? We plan on replacing the kitchen in another two or three years.

**A** If it were my kitchen, I wouldn’t put up with ugly cabinets for two or three years. There’s no need to. With today’s paints and tools, you can achieve a far better-looking kitchen in a

couple of weekends while spending less than \$200.

Begin by removing the doors and drawers or drawer fronts and taking off all door handles, drawer pulls, knobs

and hinges. Many older cabinet doors have handles or knobs centered along the side edge of the panel, a dead giveaway of an outdated kitchen. After you remove the hardware, fill the holes. When the painting is done, you can relocate the handles lower on the door for a more contemporary look.

Thoroughly clean the door and drawer surfaces with a cleaner-degreaser and do the same to any face frames and cabinet sides. Be particularly fastidious about cleaning cabinet surfaces that are near the kitchen range, because these will have more grease and dirt than surfaces farther away.

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### PM DIY HOME /// HOMEOWNERS CLINIC Q+A

Next, sand the surfaces to remove or reduce dents and scratches and to degloss the paint. After sanding, use a moist cloth or a tack cloth to thoroughly wipe off sanding dust.

Support the doors and drawer fronts on blocks of wood or small plastic Painter's Pyramids. Apply a primer. Primer not only improves topcoat adhesion, its uniform porosity and film thickness contribute to paint holdout—the ability of the paint to flow smoothly over the surface and cure to a uniform gloss and thickness. Prime all surfaces, front and back, and sand the primer if necessary to remove roller or brush marks. Wipe off sanding dust.

Next, apply the topcoat. To achieve a finish that's nearly as good as one that's sprayed, you should consider laying aside your paintbrush and using some of the new paint rollers available, particularly velour or foam varieties. Check with the paint store, though. Some paints are difficult to apply with these rollers, causing the roller to slide, for example. In other cases, the paint won't flow out, and you'll be left with a dimpled surface.

Other paints can be brushed or rolled, though rolling the paint will usually leave a smoother surface. For example, Insl-X CabinetCoat is an acrylic urethane enamel that's specifically formulated to provide an extremely smooth surface when applied with a foam roller or when using a fine-bristle synthetic paintbrush. Apply two topcoats of whatever paint you choose.

Finally, reinstall the doors and drawers using new pulls, handles and knobs. You'll be surprised at the results when you're done. It's one of the best investments of your DIY dollar.

### Rotten to the Core

**I know you've covered concrete steps, but what about wood? Four out of five stringers have rotted on my front steps. I only have**

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**beginner-level carpentry skills, so I was thinking of replacing them with precut pressure-treated stair stringers sold at a home center. Will those be any good?**

Sure. It's perfectly okay to use precut stair stringers—but they may not fit your space. For example, if the stairs have been built to land on the center of a concrete pad, and the precut stringers don't have exactly the same dimensions as those of the existing stairs, then they obviously won't land where you want them to. You also have very little control over the height of precut stringers—maybe a fraction of an inch or so.

When you cut stair stringers yourself, you have complete control over their height, horizontal run and the angle at which they meet the house. This ensures that you will end up with stairs in which the height of each step is the same and the stairs land where they should (the center of the pad).

That sounds daunting to the beginner carpenter, but it's really pretty simple in this case. For one thing, if the existing stairs have been built correctly (equal riser heights, comfortable and

level treads and a horizontal run that lands the stairs properly), then you can carefully demolish them and actually use one of the stringers as a pattern. You can also go to [popularmechanics.com](http://popularmechanics.com) and see our article "How to Build Your Own Stairs in 3 Easy Steps."

If you can use a circular saw, a hammer, a tape measure, a square and a drill driver, you can handle this project—and leave the precut stringers for folks who don't read PM.

**Lowdown on the Low Flow**  
**I live in rural Florida, and my water is supplied by a well. I have such low flow that my instantaneous water heater doesn't work properly, and I can't take a decent shower. My pump is set for 50 to 70 (the psi for the cut-in and cut-off pressures), if that makes a difference. The system works reliably, other than the low flow. Any ideas?**

The fact that your pump's pressure is set so high (50 to 70) indicates that your water system is designed more for pressure than volume. Pressure settings of 30 to 50 or 40 to 60 are more typical. When well-pump pressure is

high, volume tends to be low, because a well pump can't produce both characteristics to the same degree.

First, you need to get a well contractor out to your place to look things over. The contractor will investigate whether the pump you have is adequately sized and whether dirt or mineral buildup anywhere in the well system or in your home's plumbing is interfering with the well's flow.

Assuming everything checks out okay, one solution is to augment the existing well pump with a sophisticated two-part setup like the AquaBoost II by Goulds Pumps. The first part of this system consists of a storage tank at atmospheric pressure. It acts as a reservoir and is kept filled by the existing well pump. A float sensor in the tank triggers the pump when water in the tank drops below a predetermined level.

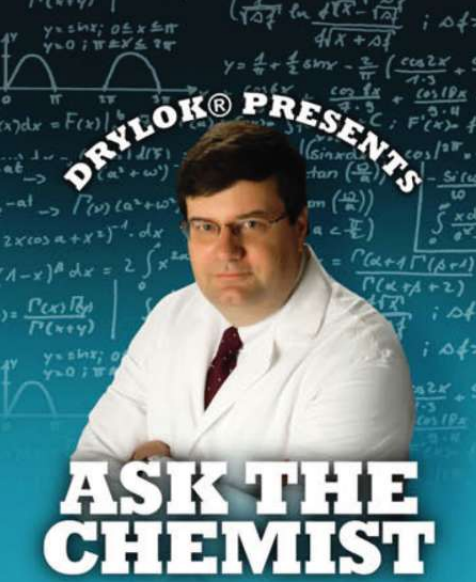
The other half of the system is a booster pump and its related components, including a transducer that converts water pressure to an electrical signal and a controller-rectifier. When someone in the home uses water, a transducer tells the pump controller-

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## PM DIY HOME /// HOMEOWNERS CLINIC Q+A

rectifier what the water-system pressure is.

The controller-rectifier has two functions. First, it turns on and operates the pump's variable-speed motor. Second, it rectifies the home's single-phase electrical current and turns it into three-phase. This type of current is far more electrically and mechanically efficient for operating motors, since the peak voltage of each phase is closer to the one next to it than in standard residential single-phase power.

The variable-speed motor and pump run constantly, so long as water is being drawn. The motor's variable speed adapts automatically to the demand, keeping water pressure constant. The greater the demand, the faster the motor spins and the bigger the booster pump's output.

## Mystery Microwave

**We've had two microwave ovens fail in our four-year-old house since it was built. Both were over-the-range types. The magnetron went on one, and we're not sure why its replacement has quit. Can a wiring problem be to blame?**

Anything's possible. Given that you haven't reported additional electrical issues (dimming lights, other erratic appliances, circuit breakers that frequently trip or problems that popped up after a lightning strike), I'd reason that the grid's power quality or electrical glitches inside the house are not to blame here. Still, any electrician or mechanically experienced person can check for under- or overvoltage and current flow on the 20-amp dedicated small-appliance circuit. This should be easy to do, especially in a new house in which the wiring hasn't been tinkered with. One caveat applies, however. Because checking this requires working on an energized circuit, it's no task for anyone who's uncomfortable with this kind of work.

My hunch is that you've had two unrelated component failures. The first was the magnetron. As to the second, my vote would be a circuit-board prob-

lem—all appliance components are the focus of relentless cost cutting these days, it seems, and circuit boards are no exception. I've seen more than my share of them with solder blobs, burns and broken parts. That's just what's visible—who knows what you'd find on these bad boards when you subject them to electrical testing.

## Down the Drain

**When I investigated why a bathroom sink in my home drains slowly, I discovered that its steel pipe drain is almost completely filled with rust. I've noticed that virtually every other fixture in the house (at least the ones I can see) have been replaced with PVC pipe. I'm inclined to try this job myself. Any tips?**

If the drain is that badly rusted, I wouldn't even bother putting a pipe wrench to it. Buy or borrow a reciprocating saw and cut away the drain components.

Next, make a couple of (or several) sketches of the drain's layout: one that shows the sink from above, including the center line of the drain in the sink; another that shows the sink and drain components when viewed from the side; and one that shows how the drain runs on the opposite side of the wall, including its relationship relative to floor joists. Yes, that's a lot of sketching, but you'll be glad you have them when you go to the plumbing-supply house or home center. It's amazing the details you can forget between your house and the store. If you can take a decent digital photo or two, that helps, as well.

From there, you'll need a PVC pipe saw to cut plastic pipe, a deburring tool, a half-round file or utility knife (to remove the rough edge left from cutting), the pipe itself, pipe fittings, primer/cleaner, glue and some disposable plastic gloves to keep the glue off your hands. **PM**

## ? Got a home-maintenance or repair problem? Ask Roy

about it. Send your questions to [pmhomeclinic@hearst.com](mailto: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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### Give Thanks →

for the Turkey Run swap meet in Daytona, where over 4800 pre-1980 cars are on display (and often for sale) from Thanksgiving through the weekend.

### Rake Leaves →

into the compost bin, where they’ll dry out wet food scraps. Or mulch the leaves and use them as moisture-retaining ground cover in plant beds. But keep them off the grass—the high acid in the leaves deters growth.

### Cull Herds →

as deer-hunting season begins in most states. Prevent one of 1.6 million yearly deer-vehicle collisions, stop stag starvation, spare a garden.

### Flush Coolant →

to make sure the car’s water and coolant are at the proper ratio at the end of a/c season. When winter hits, excess water in the system can freeze the radiator and potentially crack the engine block.

### Smoke a Bird →

on a charcoal kettle grill. Pile coals and hickory on one side, put a turkey breast and butter in an aluminum pan opposite, open the vents above the bird. Smoke and baste for 15 minutes a pound.

**Carver:** Jim Barnes  
**Location:** Williamston, MI  
**Chain Saws Used:** Jonsered 2159, Husqvarna 142  
**Ideal Trees:** catalpa, cedar

### CUT BENCH ENDS

**2 →** Barnes makes a pair of bench ends by crosscutting the remainder of a 6-foot log half into two 3-foot sections. “The seat height should be 18 inches in front and 17½ inches in back, to give a slight angle, which makes the bench more comfortable,” Barnes says. The seat meets the ends at their midpoints, making an armrest and a coaster big enough for a pitcher.

### CARVE MORTISES AND TENONS

**3 →** Barnes attaches the slabs to the ends with a fastener-free mortise and tenon. He marks and cuts horizontal and diagonal slots, aka mortises, on the bench’s ends, to accept the slabs for the seat and back. He measures the mortises and carves corresponding pegs, or tenons, into the seat and back slabs’ ends. The tenons are stout—Barnes saws and chisels away only about ⅜ inch of material, leaving the slabs more than 2 inches thick. When the tenons slide tightly into the mortised ends, the bench is finished—“held together with gravity and friction,” Barnes says.

### MILL SEAT SLABS

**1 →** “For me, it’s easier to stand the log on end to make vertical cuts,” Barnes says. He sinks a 6-foot log into a shallow hole and uses a chain saw to mill two 3-inch-thick slabs for use as a back and seat. To guide the cut, Barnes marks a line or follows a straight 2 x 4. Products such as the Accutech Micro Mill, the Beam Machine or the Alaskan Chainsaw Mill help control the tool. “Keep the tip of the saw through the log,” Barnes says, to keep sawn faces smooth and avoid kickback. He uses five different saws. For deep cuts, he breaks out a big 86-cc Jonsered with a 24-inch bar. For detail work, Barnes has a petite 42-cc Husqvarna with a 12-inch dime-tip carving bar and quarter-inch chain.





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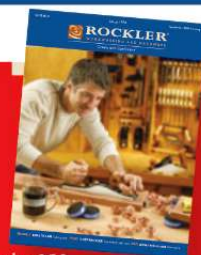
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## The Sting of Repair Bills

CARS HAVE NEVER BEEN CHEAP. BUT TODAY'S HIGH PRICES FOR LABOR AND PARTS CAN MAKE AN OLDER CAR TOO EXPENSIVE TO KEEP ON THE ROAD. **BY MIKE ALLEN**

➔ **Cost of ownership** is higher on newer cars, largely because they're more capable, far cleaner and fuel-efficient and far safer. That 1965 Mustang you used to fix for a few bucks doesn't come close to meeting today's government regulations, goes down the road like a tractor compared with a modern car and had few of the electronic doodads we now take for granted. Ultimately, however, we pay for the technology—a 1965 Mustang cost just \$2500—both initially and for repairs. Here are some examples of why fixing today's cars is so expensive.

INSIDE



STICKER SHOCK + THAR SHE BLOWS + OIL



## Onboard Computers

➔ All cars made since the universal introduction of OBD II diagnostics in 1996, and a few made before, have fairly sophisticated computers. The electronics manage the fuel-injection system, the ignition (usually replacing the entire distributor), the automatic transmission and much, much more. An example: Late-model Fords have a connection

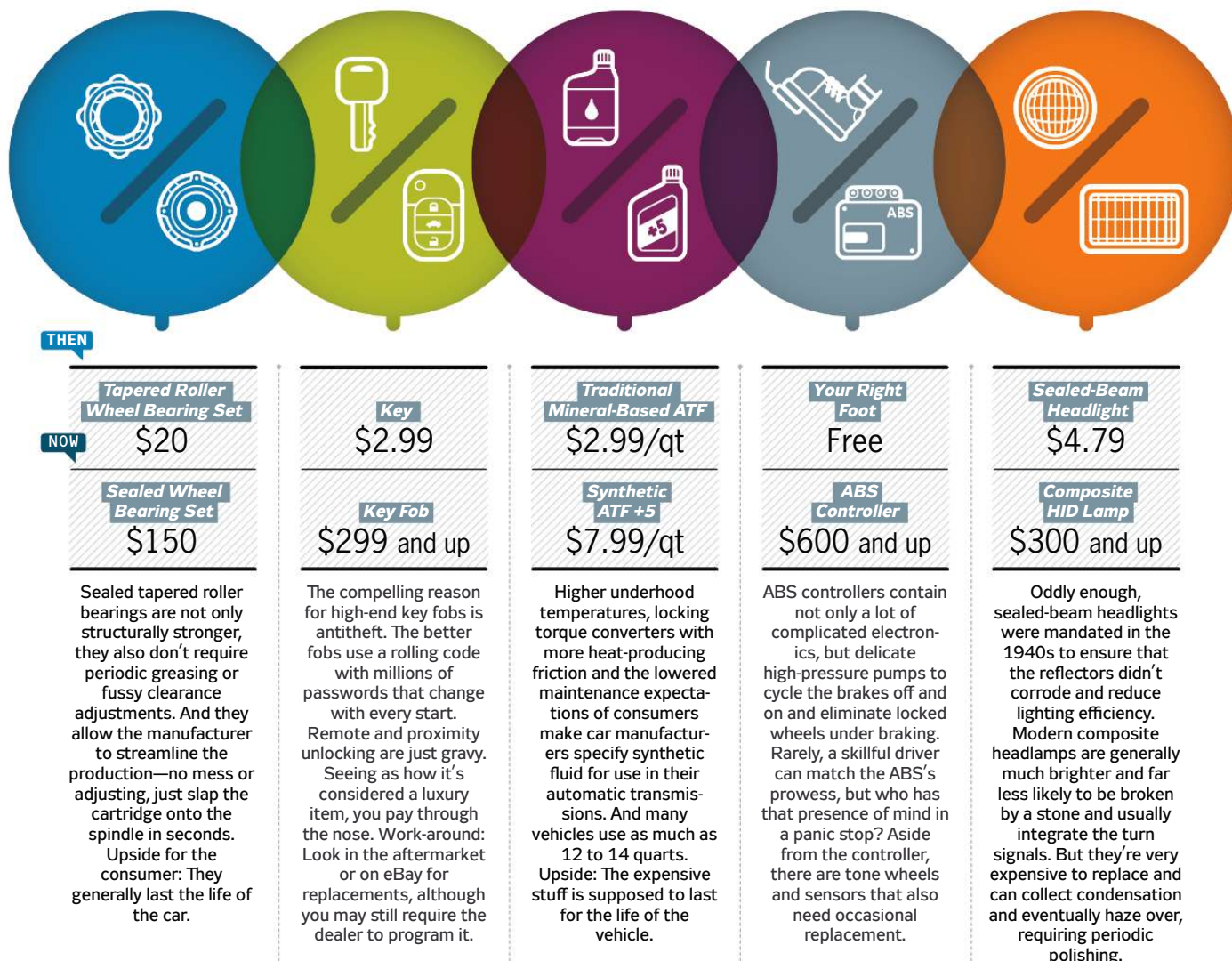
between the alternator and the computer. If the charging voltage is a tad low at idle, the computer will bump up the current in the alternator's field windings—to slightly increase the voltage—and possibly increase the idle speed to help charge the battery. The idle-air controller used to control the idle speed also replaces mechanical chokes. To boot, the throttle blades are actually operated

by a stepper motor, not a cable from the throttle pedal, which doubly performs the cruise control.

Why all this fuss instead of an old-fashioned, inexpensive-to-fix carburetor? One word: emissions. A new car emits less than a tenth of a percent of the tailpipe emissions—not counting CO<sub>2</sub>—of 40-year-old steeds. Thank the computer's constant, tight control of ignition timing and air-fuel ratio. That's the good news. The bad news: To diagnose many computer issues and its dozens of sensors requires a scan tool that is capable of accessing the thousands of manufacturer-specific trouble codes and data streams. A good one can cost \$7000. And in a busy dealership or shop, every technician will need one. Once the trouble codes and data stream are an

### ■ NEW AND IMPROVED

## The Price of Progress



open book the technician needs a reference to interpret them—an Alldata professional subscription is \$220 a month, Identifix \$140. Access to manufacturer-specific websites for service data costs up to \$20 a day. Shops used to be able to get all they needed from one fat *Motor* manual for \$40.

## Bodywork

➡ **Traditionally**, car bodies were built solely with mild steel, whether it was a body-on-frame car or a unit body, with stamped-steel panels spot-welded together. Repairing them was easy—hammer things more or less back to shape, slap on some Bondo and paint. Contemporary crash standards have changed all of that. A lot of car bodies employ high-strength steel to save weight. The panels are pre-crumpled to fold where intended in an accident.

And that means that the body is an integral part of the vehicle's safety system. Just heating bent parts up with the rosebud tip on an acetylene torch and cranking it back with a hydraulic Porta Power won't cut it anymore. Damaged pieces have to be carefully replaced with new factory panels and welded on with MIG or TIG welders. This takes longer and requires a much higher level of skill and training from body-shop technicians. Welding in a radiator-core support on a new luxury car after a front-end crash might take 6 to 8 hours, plus another 6 to 8 to remove and replace all the bolted-on pieces around it, compared with a total of 3 to 4 hours on cars of a generation ago. Then add in the thousands of dollars to replace the airbags, airbag sensors and harness.

## HVAC

➡ **An automotive** a/c technician used to ply his trade with no more than a set of pressure gauges, a vacuum pump and a voltmeter. Then we discovered that R-12 is a major greenhouse gas; technicians were no longer allowed to simply vent R-12. So they needed an R-12 recovery machine, which costs several grand. At the same time, the price of R-12 skyrocketed.

Then R-12 was replaced by even more expensive R-134a that required another expensive recovery device. A simple a/c service used to be less than

### ■ WHAT'S A MOTHER TO DO?

## Keeping Costs Down

**H**

ow can you minimize huge repair bills?

### **Keep your car properly maintained.**

➔ Replacing a timing belt at the recommended interval may cost a few hundred dollars, but if it snaps, the engine may be destroyed. A fresh set of brake pads is far cheaper than waiting until the backing plates destroy the brake discs, and so on.

### **Develop a relationship.**

➔ Since most independent repair shops charge about the same for an oil change as the quick-lube joints, pick

one and use it regularly. Then, when you need a repair, you're a regular and may get a more sympathetic ear. Plus, they'll be happy to point out needed maintenance that might save a bundle over episodic, catastrophic repairs.

### **Shop around.**

➔ Don't be afraid to ask for a second opinion on major items. A second mechanic may have a better, cheaper solution. Maybe. Some shops are more amenable to prioritizing necessary repairs until you can afford them. It's not unusual to find parts for far less at NAPA or over the Internet instead of paying full skid at the dealer.

### **Go beyond traditional sourcing.**

➔ Don't forget that some parts are interchangeable and that you may be able to find that intake valve guide for your Porsche cheaper in the VW parts catalog. Don't forget rebuilt, remanufactured or used parts. You'll certainly have more time than a busy shop owner to hunt down what you need. I just spent over a week, off and on, tracking down an odd air-conditioning part for my wife's car that at least four parts professionals couldn't source anywhere.

an hour's labor and included less than five bucks of R-12. Now a similar service on a modern machine takes 2 to 3 hours, and requires nearly a hundred bucks' worth of R-134a. The complexity of HVAC system controls has increased, forcing technicians to buy manufacturer-specific diagnostic tools.

## From the Other Side

➡ **We interviewed** several technicians from large, busy OEM dealerships, all of whom declined to be named. They universally blamed high repair costs on vehicle complexity and the crowded engine compartments of modern cars.

We then asked Bob Freudenberger, editor-in-chief of *Master Technician* magazine, former service technician and PM contributor, for his view.

"A technician's personal toolbox can cost as much as \$100K for a senior technician who's acquired a lot of capability-enhancing special tools.

"A building situated on a good loca-

tion on a highway can cost the shop owner \$2000 a month per bay, maybe \$1500 if the location isn't as good. Because most independent repair shop owners are technicians who thought they could do better, the shop is rented, not owned. A four-bay independent shop can realize maybe a half-million gross annually—but out of that there are salaries for the mechanics and parts guys, rent, heat and light, disposal of hazardous waste and trash, marketing and advertising, access to repair data and maybe a little profit. That's what keeps labor rates in the \$80 to \$120 an hour vicinity, even though the technician is making only a quarter of that.

"The shop owner is making a profit of 15 to 20 percent, certainly not a lot. Even the dealer, who often charges more per hour, is making a similar return on investment on his usually larger shop, with more bays and more employees and larger investment in parts inventory and special tools."

**PM**



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## Mod Engine Unplugged

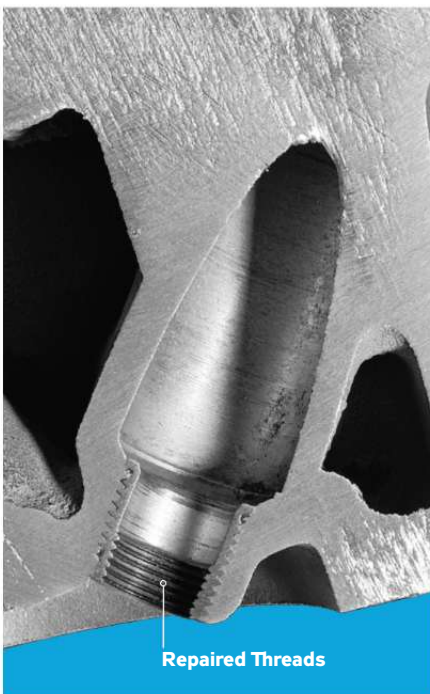
I was driving along at normal freeway speeds in my 2001 F-250 last week when it made a funny noise and started to run roughly. (If only I'd known what was to come, I would have left it in a bad neighborhood with the keys in the ignition.) Seeing as how I was on vacation, I took it to a local repair shop. The mechanic said that one of the spark plugs must have been tightened insufficiently the last time they were changed, because it had blown out of the cylinder head. On its way out, the errant plug damaged the coil for that cylinder and stripped the threads. He repaired the damaged threads and had me on my way

in a couple of hours for around \$200. An odd observation: The plugs have never been changed, because the truck has only 63,000 miles and the change interval is 100,000.

I returned home without incident, only to have the same plug blow out again. This time I took it to the dealer, who insisted on changing the rest of the plugs before getting me an estimate for the repair. Estimate: \$4440. Say what?! They want to remove the body from the frame to repair the stripped threads, which I find ludicrous and laughable and horrifying, needless to say. There has to be a cheaper way.

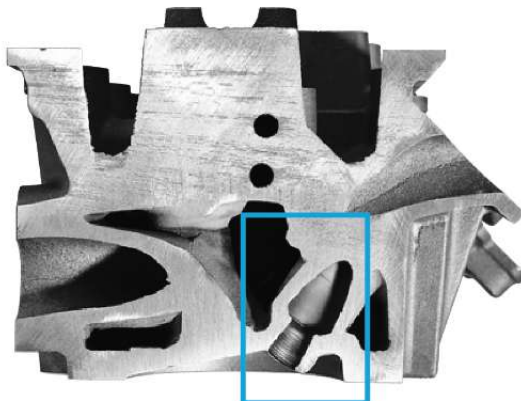


Stripped Threads



Repaired Threads

I sawed this Ford Modular V8 Cylinder head into three pieces (which took a couple of hours with a big band saw). It came from a 1999 Ford V10 pickup truck, courtesy of Jasper Engines, a national rebuilder of engines and transmissions. Jasper automatically puts threaded repair inserts in 100 percent of the heads they rebuild, heading off problems down the line.



**A** From the top: Ford 4.6, 5.4 V8 and 6.8 V10 OHC engines from 1999 through 2004, whether in trucks or the Mustang or Crown Vic, used a spark plug with only four threads securing it to the aluminum head. And a percentage of them have a habit of parting company with the head on their own, even plugs that have never been changed or removed since the engine was built at the factory. On its way north, the projectile plug can damage the coil-on-plug ignition coil and the nearby fuel rail or, occasionally I hear, put a dent in the hood sheet metal. Ford changed these engines over to a plug that uses eight threads after it became obvious there was a problem. And no, the warranty usually doesn't cover it



when it expires after 24,000 miles or two years. Ford has issued a Technical Service Bulletin (TSB) on the proper repair, but you're on your own for the (substantial) cost.

Installing helicoils is a time-honored way to repair stripped threads but isn't a good procedure in this instance: Helicoils tend to fail early, and even if they don't, the stainless-steel insert doesn't conduct as much heat to the head from the plug as bare aluminum, making that plug run hot. Ford has an approved procedure to repair these heads that uses an aluminum insert. Installing this insert is laborious, exacting work and extremely difficult to do successfully when the cylinder heads are on the engine. It's a multistep process that involves drilling the spark-plug hole, cutting a new seat for the base of the insert, tapping threads and then installing the new threaded insert. Then the mechanic has to remove any aluminum shavings from the cylinder. All of this has

to happen with only an inch or so of clearance between the cylinder heads and the body or other underhood obstacles. A good mechanic can usually remove the truck cab from the frame and repair the threads or replace the heads faster and cheaper than trying to do it in situ. It's a little easier on passenger cars but still not a job for a Saturday Mechanic—leave this job for an experienced technician who's done it before.

I do agree with the dealer: I'd put inserts in all eight plug holes now, instead of waiting for them to turn into popguns one at a time. That's why they insisted on changing all the plugs first, because odds are more will strip when being removed, and they'll find it easier to sell you on this huge bill if more plug holes are fouled.

There are alternatives to Ford's procedure, with special tools and inserts that the manufacturers claim can be installed successfully with the engine and bodywork left in place—even if the

plug hole has already been tapped oversize to accommodate that failed helicoil. Repair kits are available from Cal-Van, Time-Sert and Ford's preferred supplier, Lock-N-Stitch. I have no personal experience with any of them.

## Chatterbox

**No, I do not have a talking window! But my 1996 Toyota Avalon driver-side power window chatters/vibrates when raising and lowering. It's driving me up a wall, and I don't know how to fix it without tearing into the door.**

### Any recommendations?

Lube the window tracks and rubber lip seals with silicone spray. No, you don't have to take the door apart: Just spray the tracks when the windows are fully down and spray the seal's inner edges. Run the windows up and down a few times, then clean up the mess.

## Oil Crisis

**My 1990 Range Rover Classic requires synthetic oil, but I accidentally put in regular. Will this cause any problems, and what should I do to replace the oil?**

I can find nothing in the service literature that specifies anything other than mineral oil for your Range Rover. Synthetic would provide more engine protection in temperature extremes, but Range Rover says the mineral oil is fine. Just do your normal oil change at the regular interval, or right away if you feel underprotected, using the specified oil.

## I Can See Clearly Now

**My 2004 Mitsubishi Endeavor has started losing its clear coat in patches. Is there any way I can repair it without getting a new paint job?**

No. All of the clear coat is going to have to be sanded off, because it's not bonding properly to the paint underneath it.

In theory, you could then respray just the clear coat. In reality, the pigment layer will be sanded through to the primer or even to the metal in a lot of places. So the color coat will have to be resprayed as well. Don't expect a quality job to be inexpensive.

## Fantasy Squared

**I have seen a Tesla Roadster downtown a couple of times. When**

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I watched it take off, I noticed that it had the sound of exhaust pipes. I thought that the Tesla Roadster was all electric, and, if it is all electric, why would the car make a noise when moving like it had a combustion engine?

You're right, an EV doesn't make engine noises. In this case, the owner probably installed an aftermarket sound-effects generator, perhaps from European tuner Brabus. It makes all kinds of sounds—conventional engine roars, a *Star Trek*-y whoosh, jet-plane screeches and even a locomotive belch. Who says electric cars aren't really just big toys?

## How Fast Is Too Fast?

**I have a 2005 Toyota Tacoma 4WD with the original factory-optional 18-inch wheels and Michelin P275/55R18 tires. I recently noticed that while driving at highway speeds (65 to 70 mph), the speed that was showing on my Garmin Nuvi GPS was consistently about 3 mph less than the speed showing on my speedometer. Which, if either, is correct?**

The GPS will generally be more accurate. The vehicle speedo is dependent on the outside diameter of the tires being exactly what the engineers designed into its drive calibration. New tires will be larger in outside diameter than worn tires, as will tires hot from being recently driven, because of the increased pressure. Even overinflating a tire will make it larger, which will make the speedo read lower than the vehicle's actual road speed. Worn or under-inflated tires spin faster for a given speed, making the speedo read higher. Maybe someday cars will use the onboard GPS to provide more accurate data, but not yet.

## The Pause That Refreshes

**My battery hold-down bracket somehow came loose, and the battery shifted, knocking one of the caps off. I didn't know about this until I needed a jump. I filled the open cell with tap water—that's all I had—and reinstalled the cap. Over a short period of time, the battery continued to weaken until I had to replace it. Could I have put any of the following substances in the battery to extend its life? What would**

**have happened if I had put one or a combination of these substances in that battery?**

1. Gatorade (powder or liquid)
2. Saltwater
3. Baking soda

**I am very anxious to know before I get stuck again.**

Normally, the only thing you should even consider putting into a lead-acid car battery is distilled or demineralized water. The battery's normal discharge/recharge cycle evaporates  $H_2O$  out of the electrolyte—a mixture of sulfuric acid and water—and thus it might require periodic replacement. Maintenance-free batteries are sealed and can't be topped off, but based on your question, you have the traditional style with accessible caps, which, incidentally, I prefer. In any case, the open cell wasn't just low on water, it was short of electrolyte because it was spilled, so the proper thing to replace it was . . . more electrolyte.

Next time: Use a battery hydrometer, syringe or even an eyedropper to pirate an equal amount of electrolyte from the other five cells and put the liquid in the empty cell. Make sure that when you're done, all six cells have an equal amount. Next, you'll need a hydrometer to measure the acid/water ratio of the electrolyte. With that data in hand, replicate the mixture—most parts stores carry  $H_2SO_4$ —and use it to fill all six cells to the bottom of the filler necks, which is the correct level.

Don't wait to perform this procedure, even if your battery has enough juice to start the car. If the metal grids in the battery are exposed to the air for even a day or two, they'll sulfate and become damaged. Adding any of the substances you mention will quickly destroy your battery, as will adding virtually anything except distilled water or properly diluted electrolyte as appropriate.

**PM**

### Got a car problem?

Ask **Mike** about it. Send your questions to [pmautoclinic@hearst.com](mailto:pmautoclinic@hearst.com) or over Twitter at [twitter.com/PopMechAuto](https://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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## The Xbox Backpack Hack Attack

TWO EDITORS' CRAZED QUEST TO TURN MICROSOFT'S HOME CONSOLE INTO A PORTABLE GAMING SYSTEM.

BY GLENN DERENE  
AND ANTHONY VERDUCCI

Our Xbox 360 backpack, along with its custom-built battery pack, weighs in at 27 pounds.

➔ **Before we discuss the wonder** that is the Xbox Backpack, let's go through the reasons why such an invention isn't at all necessary. First, there are already two respectable portable video-game platforms: Sony's PlayStation Portable (PSP) and Nintendo's DS (with the 3DS coming out soon). These are lightweight, pocket-size, affordable and more than adequate for on-the-fly fun.

Second, the Xbox 360 was never intended to be portable. It is, in fact,

INSIDE

× TECH-SUPPORT TACTICS + XBOX KINECT + ANDROID UPDATES



distinctly nonportable. When you combine the main unit with its big honkin' power supply, the combo weighs 9 pounds. The power requirements for this beast are formidable; ours draws almost 200 watts of power (the newest version draws less)—nearly three times the load of an Apple MacBook laptop. The power supply converts 110-volt AC

current into two separate voltages of DC power, and the plug into the Xbox is totally proprietary. Unsurprisingly, no battery on the market can power it.

Add to that a delicate, spinning optical drive, the lack of an integrated display and a massive heat exhaust that requires active ventilation, and you've pretty much outlined the engineering

challenges we set for ourselves when we stubbornly insisted on building this thing into a backpack.

Why bother? Oh, come on, you know why—because it's there, because it's difficult and because no portable gaming system is as cool as the Xbox 360. Plus, we're pretty sure no one else is walking around with a dual-display, battery-powered Xbox that allows you to play *Halo: Reach* while camping—and we crave that kind of geek credibility.

Yet we also know our limitations.

## ■ PARTS LIST

### The Frankenpack



1

#### Mainboard

To fit the guts of the Xbox inside our backpack, we removed the system's outer plastic casing, then bolted its internal metal cage to the shell of the backpack. To maintain airflow, we drilled intake and exhaust holes in the pack.

2

#### Drives

Like most of the Xbox's working parts, the hard drive is hidden within the confines of the backpack. But to load games, we needed the optical drive to eject out the side. So we mounted the Xbox faceplate and the DVD drive to the outside of the pack.

3

#### Wireless

What's better than a portable, battery-powered Xbox 360? A portable, battery-powered, *completely networked* Xbox 360! We kluged up the connectivity with an Xbox wireless networking adapter and a Virgin Mobile MiFi 3G hotspot.

4

#### Displays

Not one, but two displays! Our 7-inch Viore portable TV was a Walmart special at \$67. It had its own internal battery and was mounted to the back of the pack. For forward-facing action on the go, we also rigged up Myvu Crystal video glasses (\$180).

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We were pretty sure we could build an Xbox 360 into a backpack with X-Acto blades, screwdrivers, electrical tape and—for the stubborn parts—a Dremel angle grinder. Yet we were also pretty sure we were going to need to hit up some outside expertise on the battery pack. So we contacted Xbox peripheral manufacturer Performance Designed Products, and begged for some help (see below for details).

## Start With a Strong Bag

➔ **Choosing our backpack** wasn't easy. We needed something with structure, but a true hard shell was going to be difficult to work with. After a bit of searching, we found the Boblbee

Amphib Pro 30 (\$190), a bright-orange, lightweight, ultra-modern-looking dry-bag/backpack combo constructed of ballistic nylon with foam backing. Strong, yet easy to cut holes into, the Amphib Pro was also just big enough to fit an Xbox—in other words, barely big enough to fit anything else, including our hands. As you can imagine, it's fairly difficult to work in such tight quarters, so all of the constituent components, the wiring and the assembly sequence had to be decided upon and planned out before we hard-mounted anything inside the pack.

We knew we could get the Xbox into the backpack, but what good is an Xbox without a screen? (That's a rhetorical

question—you need a screen.) At first, we took the easy route and bought a battery-powered 7-inch Viore portable TV from Walmart (\$67). This el cheapo set lacks hi-def inputs—sporting only a composite video minijack—but hi-def is a rarity at this screen size. Plus, the Viore has a built-in tuner for on-the-road TV watching as well. More importantly, it was small enough to be installed in one of the few crevices of unused space in the pack, so we cut a screen-size hole in the back of the pack to fit it in.

A screen mounted to the pack is nice to have, but it didn't seem like the optimal solution. After all, you'd need to take off the backpack to play a game. Our quest for a truly mobile game-playing experience led us to the unwieldy piles of neglected gadgets in our lab, where a quick dig revealed an additional option—the Myvu Crystal personal media viewer. Essentially a pair of opaque glasses with tiny, built-in 640 x 480-pixel screens, the Myvu display had always seemed to us like a technology in search of a practical application. Now, combined with our completely impractical creation, it sort of makes sense. (At least, it does until one of us walks into a bus while playing *Gears of War*.)

## When in Doubt, Use Velcro

➔ **As you might expect**, it took many hours of trial and error and a few emergency trips to Home Depot and Micro Center to wire, bolt, Velcro and tape it all together. We had to make some compromises: Our 12-pound battery pack was too big to fit inside, so we strapped it to the exterior, making our high-tech bag resemble a World War II radio backpack. And at 27 pounds total, the backpack is no picnic to carry around. Yet, astoundingly, it works.

We'll end with a note of warning and a surprising bit of encouragement to anyone who dares attempt a mobile Xbox system: First, prepare your extensor muscles—your lower back is not going to thank you for this project. Second, if you are willing to lug this thing around, you really can take a fully networked entertainment system with you. We were able to play games as well as watch movies and even TV outside. It felt like being in a living room made of dirt. At least until the battery died. **PM**

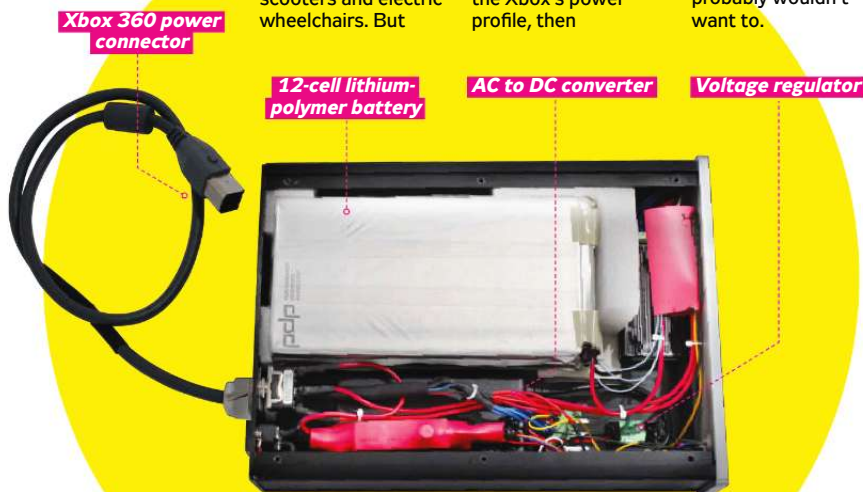
### ■ POWER PACK

## Custom-Designed Juice Box

**T**he new Xbox 360 is a model of efficiency, specced to a maximum power draw of 135 watts. Our build, however, used an older model rated for 175 watts. The only off-the-shelf battery we could think of that could handle that kind of load was a gel-cell battery of the sort used to power scooters and electric wheelchairs. But

even that wouldn't have worked, since the Xbox requires DC power at dual voltages (12-volt and 5-volt). We were in over our heads, engineering-wise, so we called up Performance Designed Products ([pdp.com](http://pdp.com)), which designs accessories for game systems such as the Xbox, PlayStation and Wii, to enlist the expertise of the company's battery experts. They tested the Xbox's power profile, then

designed a 12-cell lithium-polymer battery stack with a step-up circuit and voltage regulator tuned to the Xbox 360's power requirements. It powers our Xbox backpack for 2 to 3 hours per charge. According to PDP product developer Gerry Block, a talented DIYer could put one together, but at a cost of \$3500, he probably wouldn't want to.



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## Digital Clinic

by Seth Porges

Q+A



# Q So You Want to Get a Human on the Line?

I hate, hate, hate waiting on hold for tech support and customer service. Any tips for getting past those incredibly annoying delays?

**A** Maybe it's the Muzak, or the endless hold times, or the countless options. But there are few things as dehumanizing as finding yourself in phone limbo while a company fetches a tech-support or customer-service rep. Fortunately, with a few tricks—and a little assist from technology—you can shorten your wait.

First step is to make sure you're calling the best possible number. The num-

ber published prominently on the website is more likely to lead you into a Kafkaesque labyrinth than toward a human voice. I suggest starting out by going to [GetHuman.com](http://GetHuman.com) to find the best number to call for just about any company. The site will also give you company-specific tips for getting a person on the line. LucyPhone.com takes it even further—not only does the site include a database of company contact numbers, but it actually does the waiting for you. When you select the company you want to call and enter your number on the site, it makes the call, then rings you back when it finally gets somebody on the line, allowing you to jump in at the last minute. There's also a LucyPhone iPhone app for on-the-go calls.

Once you've discovered the best number, the next step is to reach a real person. Repeatedly bashing the "0" button often gets the job done, as does pressing nothing at all (this tricks the system into thinking you have a rotary phone—remember those?—and often causes it to bump you to an operator). If you're dealing with a voice-controlled phone system, you can also repeatedly say "representative" or "operator" or, if you're feeling particularly salty and aren't around any children, yell curse words. If the system thinks you are particularly PO'd, it will send you to an operator rather than let you smolder. So view it as therapy: The angrier you sound, the better service you'll receive.

Another trick: If you are asked to "press 1 for English" or "2 for Spanish," press "2." The wait for Spanish operators is usually far shorter, and they are almost always bilingual, in case somebody accidentally presses the wrong button. Lastly, there may be few things on earth more frustrating than waiting on hold for an hour, only to have your call dropped the minute you finally get somebody on the line. So give the opera-



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tor your phone number and tell them to call you back if you get disconnected. It could save you a lot of agitation.

### Kinect Compatible

**I was at a store and saw one of those slimmer, new black Xbox 360 systems. On the box, it said it was "Kinect Ready." Does that mean my older Xbox 360 won't work with the Kinect gesture-controlled interface?**

Microsoft's Kinect interface—which trades out physical controllers for flailing limbs—may be new, but there's no need to toss out your old Xbox 360 just yet. A quick call to Microsoft confirmed that all existing Xbox 360s—whether they rolled off the assembly line in 2005 or in 2010—can handle the add-on. The newer black consoles, however, still offer some advantages over the older machines—they use less power than their ancestors and take up less shelf space.

### Android Update

**I am interested in the new Android 2.2 operating system. If I have an older Android phone, can I update to the new version of the OS?**

It depends on which phone you have. Android 2.2—or Froyo, as Google has taken to calling it, evoking frozen treats—is a pretty big update. Not only does it deliver the typical interface tweaks and bug fixes, but it gives phones the ability to load Flash websites. This offers a stark contrast to Apple, which refuses to support Flash on the iPhone and iPad. And since Froyo

began trickling out this summer, a few older Android phones have been blessed with the update (typically delivered automatically and over the air). These phones include the Google Nexus One, the Sprint HTC EVO, the Verizon Droid X and the original Verizon Droid. Unfortunately, owners of some older and less-powerful Android phones, such as the T-Mobile G1, may be stuck with older and less powerful versions of the operating system, as well.

### Drag, Drop, Save

**I heard that Gmail now offers the ability to save attachments by dragging and dropping them from my Web browser. I tried this, and it didn't work. What could be going wrong?**

I love Gmail's new drag-and-drop feature, which allows you to save e-mail attachments just by clicking the file, then dragging it from the Web browser into a desktop folder. Problem is, at least for now, it works only in Google's Chrome Web browser. So if the feature doesn't seem to be working, you're probably using Firefox or Safari. This is a noted contrast to a similar feature Google added to Gmail back in April—the ability to add attachments to e-mails by dragging and dropping them into the Web browser—which works across multiple browsers. **PM**

### Got a technology problem?

Ask **Seth** about it.

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



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**Digital Sight for the Blind**  
(CONTINUED FROM PAGE 75)

Barbara sees through the artificial retina, so on my next trip to California I drop by Caltech to visit theoretical physicist Wolfgang Fink (now at the University of Arizona). He seats me in front of a 15-inch MacBook Pro in a windowless basement lab. The image displayed by the laptop's camera is me, sort of. It is a 4 x 4 array of fat, square pixels in a mosaic of black, gray and white; I'm the black blocks on the left-hand side. "Current retinal implants have orders of magnitude less [pixels] than what a camera delivers," he says. "Therefore, one of the first tasks of image processing is to sample the hi-res image to make the low-res image out of it."

Fink changes the view from 16 pixels to 64, roughly the equivalent of Barbara's implant. Now, when I pass my hand in front of the camera, gray blocks shimmer diagonally across the array. "The levels of brightness the camera takes in are translated to levels of visual stimulation—strong phosphenes versus weaker ones," Fink says. Then he loads a 32 x 32-pixel array, or 1024 electrodes, the goal. The image sharpens to graphics akin to an old Atari game. I can pick out the plaid of my shirt, my hair, even the general contours of my face.

Now Fink begins to manipulate the image with an Artificial Vision Support System (AVS<sup>2</sup>): He turns on a contrast enhancement filter, which makes the dark and light pixels starker; when he activates edge detection I can see the outline of my hand, and adding image blur causes it to become more avatar-like. Each layer of processing improves the utility of the otherwise limited arrays. "We'd like to make sure we can give the blind subject as many image-processing filters in real time as possible to choose from to make their visual experience better," Fink says.

He cautions me that what I'm seeing, however, is still through the filter of my own healthy retina, so it's an ideal image. Fink leads me to a National Science Foundation-funded

CONTINUED ON PAGE 130

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## Digital Sight for the Blind

(CONTINUED FROM PAGE 129)

project: a rover about the size of a large Tonka truck with a camera gimbaled at the front center. Loaded with the AVS<sup>2</sup>, the rover, called Cyclops, can navigate around a room using only the number of pixels a researcher gives it, providing a much better approximation of what the blind might see. (Two of Barbara's electrodes, for example, turned out to be disabled.) Plus, researchers can use it 24/7, allowing them to home in on optimal image processing for different environments, sparing test subjects exhausting groundwork.

**DURING ONE OF BARBARA'S** checkups at the hospital, her surgeon showed me a scan of her eye with the Argus II implant. The eye looked like a celestial orb—Mars with dust storms swirling across its surface—and the electrode array resembled the aerial view of a well-lit alien city. Under a microscope in a clean room at Lawrence Livermore National Laboratory in Livermore, Calif., the array appears much more clinical. This is the third generation of the device—the Argus III, in preclinical testing now—and so instead of 60 electrodes, 240 are packed onto the array. Imperceptibly fine traces of gold form a narrow racetrack leading from each electrode to a silicon chip where the electronics package will eventually be mounted.

"You can see it's already pretty tight in that area," says Satinderpall Pannu, a mechanical engineer in Livermore's Center for Micro- and Nanotechnologies. "So you increase the density by a factor of four, and that's a challenge." He's referring—through a face mask, since we're both dressed in sterile garments from head to toe—to the 1024 electrodes that an interdisciplinary Department of Energy team hopes to eventually squeeze onto the device. "One of the interesting scientific questions is: If you increase the density, how do the electric fields overlap with each other?" Pannu says.

A researcher at Oak Ridge National Laboratory is currently mapping those electric fields in order to arrive at an

effective design. Scientists elsewhere are developing more advanced radio-frequency electronics and a biocompatible film that could coat the device, reducing its size. "We all had a unique piece of the puzzle needed to develop these implants," Pannu says. "This was a great vehicle to push all these different technologies along."

For its part, the team at Lawrence Livermore applies microfabrication techniques common to the semiconductor industry, such as photolithography, to manufacture the array. Pannu shows me a 4-inch-diameter silicon wafer with 10 of the thin-film devices, shaped like elegant hockey sticks, layered onto the surface. The same process is used to manufacture inertial sensors, accelerometers and gyroscopes, which now appear in products from automobiles and Wii controllers to critical components in aircraft.

"We have somewhere between 100 and 125 million photoreceptors in our eye," Pannu says. "And so if I was losing vision, I'd want to have roughly that same resolution after I put my device in. So the real question is, how do we go from a thousand electrodes to a million or 100 million?" Though that feat could easily be decades away, the researchers have already begun to think about how to put an integrated circuit directly onto the retina.

The engineering being perfected with the Argus device could also improve other neural implants. For example, microfabrication could make cochlear implants, pacemakers and deep-brain stimulators for treating Parkinson's disease smaller and less invasive. The tiny, lightweight camera could be used in applications ranging from security to endoscopy. And the implant's hermetic packaging could protect environmental sensors, especially ones used in underwater locations such as the Gulf of Mexico.

**AT CHRISTMASTIME, BARBARA IS** able to string the lights on her tree unassisted—and know for herself that they are evenly spaced. A month later, she's become very good at identifying the bus stop and can see the light at the entrance to her apartment building from up the block. By spring, she

can distinguish the white line representing the crosswalk as she approaches the street, a milestone she calls "huge." And a year after she received her artificial retina, she wears it to Disneyland, where the lights fly by her in Space Mountain.

The 30 subjects in the clinical trial appreciate the Argus II for varied reasons, according to Second Sight's vice president of business development, Brian Mech. "Barbara talks about bumping into a lot fewer things when she wears it outside," he says. "For other people, it's being able to see their grandchildren, even if they can't recognize them—being able to see the moon or fireworks. They feel more connected to their environment. They value things they can do with the device, but they value a reduction in isolation even more."

A handful of other teams, in Germany, Australia and elsewhere in America, have begun to develop retinal implants as well, though currently none of the devices is in a U.S. clinical trial. In recent years, scientists have grown new retinal cells from stem cells and shown progress in developing an effective gene therapy. Each approach brings its own challenges. But someday all of them could offer a valid treatment for retinitis pigmentosa as well as for age-related macular degeneration, which gradually destroys photoreceptors in the center of the retina and is the leading cause of blindness in adults over age 55.

The Argus II represents a concrete step in that direction. I meet Barbara one autumn evening for a screening of *The Wizard of Oz* in Central Park. As we take our seats on the bleachers she pulls her glasses out of a black padded case and plugs the cord into the microprocessor, which she slings over her arm. Speakers surround us, but when the movie starts, she turns her head to the left, toward the screen. "How tall would you say that is?" she asks. About 40 feet, I say. "That's what I thought!" To her, the structure looks like a giant block of white pixels that dim and brighten depending on whether Dorothy is skipping through the Haunted Forest or toward the Emerald City. "Oh, this looks so awesome!" she says. **PM**

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## This Is My Job

### ✕ AEROSPACE PHYSIOLOGIST

Name: ELLIS GAYLES  
Location: SAN DIEGO, CALIF.  
Age: 44  
Years on Job: 9

✕ Navy Lt. Cmdr. Ellis Gayles is charged with keeping military flight crews in optimal health while they're in the air—or, in the worst-case scenario, the water. To train aviators to survive a crash into the ocean, he and his staff employ the helo-dunker, a mock helicopter pod. Students climb into the dunker in full flight gear. The pod is lifted above a pool. Then it drops, hits the water, sinks and rolls—and the air-crew members practice escaping a chaotic and deadly environment. "You may swim well, but put on a flight suit, a survival vest, a helmet and steel-toed boots, and it's a whole different ballgame," Gayles says. "You wouldn't want the first time you realized it's hard to move in that to be during a crash." — KALEE THOMPSON

### How to Escape a Downed Chopper

#### 1. OPEN THE HATCHES

It takes heavy training to develop the trigger-fast responses needed to eject aircraft windows and open doors in the seconds before the chopper hits. "It's the presence of mind to think, okay, we trained on this, I know what to do," Gayles says. (Most helicopter windows can be popped out underwater, but it takes much more effort.)

#### 2. BREATHE DEEPLY

Each flight-crew member carries a soda-bottle-size scuba tank in his or her flight vest. The two-pound SEBD, or supplemental-egress breathing device, provides up to 3 minutes of air. And the regulator works no matter what direction it's placed in the mouth.

#### 3. GET A GRIP

Gayles teaches students to keep constant contact with a reference point inside the aircraft, and to pull themselves out, hand over hand. Let go, and they can lose all sense of direction—and any hope of escape. They're also drilled not to kick, which can result in getting caught up in gear or injuring someone else: "Get a steel-toed boot to the chops when you're submerged and you're likely to suck in water," he says.

#### 4. CONQUER THE DARK

Once Gayles's students can escape from the helo-dunker smoothly with their air tanks, they put on blacked-out swim goggles and repeat the sequence. The final dunk simulates the most difficult scenario: no light and no supplemental air. "The training forces you to figure out what you need to be doing to get out of there," Gayles says. "Just talking about it isn't the same."





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