

# POPULAR MECHANICS



HOW YOUR WORLD WORKS

**OLYMPIC  
INNOVATION  
ISSUE!**

## AMERICA'S GREATEST INVENTION

When did the patent system become such an impediment to innovators?  
BY SCOTT EDEN

### FEATURING

The biomechanics genius training Justin Gatlin

Computerized boxing gloves

Sunglasses that make you faster

AND

# RYAN LOCHTE



HOW TO BUILD  
A PICKET FENCE

**TRUCKS!**



Truck tough.



---

ALL-NEW

---

**RIDGELINE**

---

Introducing the **all-new 2017 Ridgeline**, with a dual-action tailgate and a lockable In-Bed Trunk®. Honda innovation, now inside a truck.

Honda smart.



**HONDA**

Banquet

STANDING

TALL

HAS

NOTHING

TO DO WITH

HEIGHT



GREAT BEER  
GREAT RESPONSIBILITY

©2016 COORS BREWING COMPANY, GOLDEN, CO

THE 1936 STUBBY BOTTLE IS BACK

- 4 The Reader Pages
- 8 Calendar
- 10 Popular Mechanics Everywhere

**HOW YOUR WORLD WORKS**

- 13 Pancake printers and the future of the kitchen
- 16 Where next-generation elevators go for a test run
- 18 Cocktails made with fire
- 20 The science behind your haircut
- 24 **Things Come Apart:** Sump pump
- 26 Great Unknowns

**KNOW-HOW**

- 31 A movie star teaches you how to kiteboard
- 34 **Tool Test:** Hedge clippers and multitools
- 38 How to take your TV shows with you, by Baba Boeey
- 40 Shop Notes
- 45 **Getting Started In:** Curing meat
- 48 The saw that saved a reader's life
- 50 Ask Roy

**DRIVING**

- 53 The great tune-up showdown
- 56 Reviews: New rides from Toyota, Chevrolet, and Nissan
- 57 The Argo LX: a land vehicle that swims
- 58 How to take care of your tires
- 60 Buzz Bissinger's motorcycle accident
- 62 My Ride: A Vanagon that won't quit

**THE LIFE**

- 65 **The Hungry Cyclists**  
A bike ride through Malibu with some beer-loving restaurateurs

**PROJECT**

- 101 **The Fence**  
A simple cedar fence to divide the busy world from the comfort of home  
By Ryan D'Agostino

**POPULAR MECHANICS FOR KIDS**

- 108 A cannon that launches ping pong balls!

**STUPID OR AMAZING?**

- 112 Tablets  
By Kevin Dupzyk

**ON THE COVERS:** Justin Gatlin photographed for Popular Mechanics by Peter Bohler. Ryan Lochte photographed for Popular Mechanics by Gregg Delman.



# CONTENTS

JULY/AUGUST • 2016



2016 OLYMPIC  
TECHNOLOGY  
SPECTACULAR

**70  
EVERY CLICK  
IS GOLD**

Last August, Usain Bolt beat **Justin Gatlin** by one-tenth of an eye-blink. Gatlin is ready for his rematch in Rio, and he'll have the U.S.'s secret weapon in biomechanics optimizing each step he takes.  
**BY ADAM PIORE**

**75**

**PLUS: THE GEAR THAT GOT THEM THERE**

Every four years, the world's top athletes compete for gold and glory. Just as impressive? The gear and technology that have helped make every win possible.

**82**

**GREAT AMERICAN  
FACTORY TOURS**

Skip the lines and the mediocre amusement-park food. The greatest place to take the kids this summer is an American factory. Seriously.



**88**

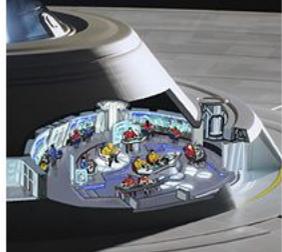
**STAR TREK AT FIFTY**

Since 1966, *Star Trek* has shaped and reflected humanity. On the occasion of *Star Trek Beyond*, an appreciation and a look at the new screens we might be watching on.



**PLUS**

Exclusive sketches of the newest *Star Trek Beyond* spacecraft.



**92**

**THE GREATEST  
AMERICAN  
INVENTION**

Confronted by unprecedented technological change and the threat of idea-hacking "patent trolls," the U.S. Patent and Trademark Office has reformed the system. But now innovators are facing off against the very institution that was created to protect them.  
**BY SCOTT EDEN**

# The Reader Pages



## YOU KNOW WE GAVE THE PLIERS FOUR STARS, RIGHT?

We respect your editorial position, but we were extremely disappointed that you referred to our Ready-Max HubLight feature as a “gimmick” (Tool Test, May). We have spent several million dollars and many years developing the internationally patented HubLight technology and the one term we are most reactive to is “gimmick.” Our HubLight has a 10,000-hour high-intensity LED, a microprocessor programmed to optimize luminosity, and battery life including an auto-off feature to avoid inadvertent usage. The housing is a high-intensity polycarbonate material that is chemical-, water-, and dust-proof. Above all, our patent protects the only way a light can shine through the jaws and directly on the work surface. I don't know how you could describe this as a gimmick.

**Jim Duffy, CEO**  
*ReadyMax, Inc.*



PROJECT  
OF THE  
MONTH

## FOUND LUMBER AND OLD PLANS MAKE A NEW TABLE

Our November 2014 Project, “A Table for Everyone,” was a relatively easy endeavor, at least for the average Popular Mechanics reader, including 37-year-old IT specialist Charlton Briers of Pleasant Garden, North Carolina. A few years ago Briers and his wife bought her grandparents’ homestead, which included a home and three barns built entirely from lumber felled on the property. While exploring the barns one day, Briers found some old rough-cut 2 x 4s and 2 x 6s. He knew exactly what to do with them. Using our plans as his guide, he got to work on the table. He stained the wood and filled the holes with clear lacquer, keeping the blemishes for a worn-in aesthetic. The tabletop weighs about 170 pounds and separates completely from the legs, making it easier to move—a feature that came in handy when Briers finally convinced his wife to let him bring the table into the dining room.

**REMEMBER:** We give \$100 for reader projects that we publish, and \$50 for original reader tips that we run. You can send both to [editor@popularmechanics.com](mailto:editor@popularmechanics.com).

### POPULAR MECHANICS

SINCE 1902

Jake Swearingen • Executive Features Editor Andrew Moseman • DIY Editor Timothy Dahl • Associate Editor Eric Limer • Assistant Editor Jay Bennett • Mobile Editions: Mobile Editions Editor Tom Losinski • Popular Mechanics Interactive: Producer Jeff Zinn • Published by Hearst Communications, Inc. President & Chief Executive Officer Steven R. Swartz • Chairman William R. Hearst III • Executive Vice Chairman Frank A. Bennack, Jr. • Hearst Magazines Division: President David Carey • President, Marketing & Publishing Director Michael Clinton • Editorial Director Ellen Levine • Publishing Consultant Gilbert C. Maurer • Publishing Consultant Mark F. Miller

Publisher, Chief Revenue Officer Cameron Connors • Advertising Director Adam C. Dub • Executive Director, Integrated Marketing Jason Graham • Executive Director, Digital Advertising Sales Deirdre Daly-Markowski • Advertising Sales Offices: NEW YORK: East Coast Automotive Director Cameron Albergo • Integrated Account Managers Sara Schiano, Loren Black • East Coast Digital Sales Managers Brett Fickler, Mia S. Klein • Assistant Vincent Carbone • LOS ANGELES: Integrated California Sales Director Anthony P. Imperato • Integration Associate Michelle Nelson • Assistant Michael Okubo • SAN FRANCISCO: Steve Thompson, William G. Smith, Mediacentric, Inc. • CHICAGO: Integrated Midwest Director Kim Skipper • Integrated Sales Manager Paul Fruin • Assistant Yvonne Villareal • DETROIT: Integrated Sales Director Mark Fikany • Assistant Toni Starrs • DALLAS: Patty Rudolph PR 4.0 Media • Hearst Direct Media: Sales Manager Brad Gettelfinger • Account Manager John Stankewitz • Marketing Solutions: Associate Marketing Director Amanda Luginbill • Marketing Manager Michael Coopersmith • Associate Integrated Marketing Manager Holly Mascaro • Integrated Marketing Coordinator Scott Topel • Digital Marketing Director Kelley Gudahl • Group Digital Marketing Director Anthony Fairall • Digital Marketing Manager Angelique Tyree • Creative Solutions: Executive Creative Director, Group Marketing Jana Nesbitt Gale • Art Directors Elena Martorano, Michael B. Sarpy • Administration: Advertising Services Director Regina Wall • Advertising Services Coordinator Rebecca Taroon • Executive Assistant to the Publisher Sara Blad • Production: Group Production Director Chuck Lodato • Circulation: Consumer Marketing Director William Carter • Hearst Men's Group: Senior Vice President & Publishing Director Jack Essig • Associate Publisher & Group Marketing Director Jill Meenaghan • General Manager Samantha Irwin • Executive Director, Group Strategy & Development Dawn Sheggye



# YOU CAN'T BEAT ZERO HEARTBURN\*



LARRY THE  
CABLE GUY,  
ACTUAL USER



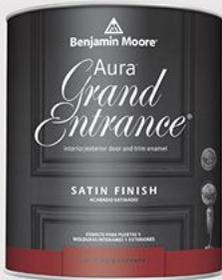
Prilosec OTC® has been the  
**#1** Doctor<sup>†</sup> recommended,  
**#1** Gastroenterologist<sup>^</sup> recommended, and  
**#1** Pharmacist<sup>^^</sup> recommended frequent  
heartburn medicine for **10 straight years.**



**ONE PILL EACH MORNING. 24 HOURS.**  
**ZERO HEARTBURN\***

\*It's possible while taking Prilosec OTC. Use as directed for 14 days to treat frequent heartburn. May take 1-4 days for full effect.  
<sup>†</sup>AlphalImpactRx ProVoice™ Survey, Jan 2005 - Mar 2015. <sup>^^</sup>Pharmacy Times Surveys, Acid Reducer/Heartburn Categories 2006 - 2015.

Whatever your project may be, **Benjamin Moore** has the paint that's right for you.



**Aura®  
Grand Entrance®**

For a luxurious finish on your front door and trim.



**ARBORCOAT®**

For a stain that protects your deck and siding against the harshest conditions.



**Regal®  
Select REVIVE®**

For paint specially designed for vinyl siding in a variety of colors.



©2016 Benjamin Moore & Co. ARBORCOAT, Aura, Benjamin Moore, Grand Entrance, Paint like no other, REGAL, REVIVE, and the triangle "M" symbol are registered trademarks of Benjamin Moore & Co.

# The Reader Pages

**LETTERS**

**TINY HOUSES,  
HUGE AGREEMENT**

I agree with your article on tiny houses (Stupid or Amazing? March). I think they are stupid too. I am originally from Minnesota and when I first saw a tiny house my thought was, *Nice icehouse*. I could never live in one—there isn't enough room for the dog. They're nice for a weekend in the woods, but a fifth-wheel or tow-behind camper trailer would make more sense and is cheaper all around.

**Jeremy Boltjes**  
*Colorado Springs, Colorado*

**OUR LIST OF TOUGH GUYS: NOT LIMITED TO HUMANS, NOT COMPREHENSIVE**

I'm pretty disappointed that a G.I. Joe doll story was included in your list of "Tough Guys" (May). Why not a fireman or World War II vet? Or an emergency-room doctor in Chicago? A doll? It's an inanimate object. It's not tough, it's durable.

**Richard Kelly**  
*Chicago, Illinois*

TWEET  
OF THE MONTH

**GLAD YOU GOT THAT OFF YOUR CHEST, STEVE.**

"Completely obsessed with #PopularMechanics and what our future might look like. There I said it. Sweet relief."  
-@StevePasquale



*Veteran TV actor Steven Pasquale's most recent role was as Detective Mark Fuhrman on The People v. O.J. Simpson: American Crime Story.*

Letters to the editor can be emailed to [editor@popularmechanics.com](mailto:editor@popularmechanics.com). Include your full name and address. Letters may be edited for length and clarity.

**CUSTOMER SERVICE/SUBSCRIPTIONS**

online: [service.popularmechanics.com](http://service.popularmechanics.com); email: [popcustserv@cdfsfulfillment.com](mailto:popcustserv@cdfsfulfillment.com); mail: Popular Mechanics, P.O. Box 6000, Harlan, IA 51593; subscribe: [subscribe.popularmechanics.com](http://subscribe.popularmechanics.com).

## AND NOW, YOUR SUMMERTIME DIY ADIRONDACK CHAIR INSPIRATION

FROM INSTAGRAM USER @THEDUDELYABIDEP



IF ITS COLOR  
STANDS UP TO THE  
TEST OF TIME...

IS IT STILL PAINT?

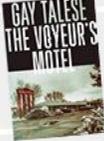
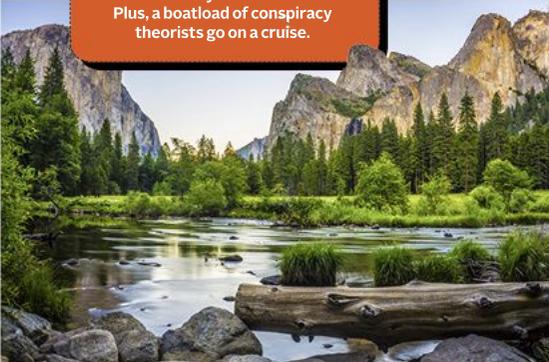
 **Benjamin Moore**  
Paint like no other.

**Aura® Exterior**  
Endures the elements.  
With a lifetime warranty.  
Only at Benjamin Moore retailers.



# Calendar JULY/AUGUST

How to get the most out of your month.

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26		28			JULY 1	
3	4 Most of us will go to a barbecue. The rest will complain about hosting.		6 Celebrate Sylvester Stallone's 70th birthday by taking the stairs.	7		16 Sick of burgers yet? Try some grill alternatives: oysters, sandwiches, pizzas, and just about anything that fits on a skewer.
	11 Baseball's greats are on display in the Home Run Derby and the All-Star Game, today and tomorrow.	12 In <i>The Voyeur's Motel</i> , out today, reporter Gay Talese tells the story of a man who fashioned his hotel to spy on guests, in the creepiest possible DIY project.	13 	14	15 Stream the new supernatural series <i>Stranger Things</i> on Netflix.	
	25	26	20 Forty years ago today, the Viking 1 became the first U.S. spacecraft to land on Mars. In 100 years, it'll be a holiday on the then-colonized planet.	21 	22 <i>Star Trek Beyond</i> hits theaters today. See page 88.	
31	AUGUST 1	2	3 Find people whose patience you haven't exhausted talking about <i>Star Trek Beyond</i> at the Official Star Trek Convention in Las Vegas.	11 	5 Opening ceremonies of the Summer Olympics in Rio. Brush up on all the tech and athletes involved on page 70.	6 Your favorite super villains team up in <i>Suicide Squad</i> , out this weekend.
7 	8	9	11	18 	25 The National Park Service celebrates its 100th year. Go outside.	13 Check out the Perseid meteor shower in your backyard tonight.
14 Enjoy the great American tradition of unloading your stuff with a garage sale.	<div style="border: 2px solid orange; padding: 5px; background-color: #e67e22; color: white;"> <p><b>IN NEXT MONTH'S ISSUE</b> Our annual "How to Make Anything" issue will make you a master of DIY. Plus, a boatload of conspiracy theorists go on a cruise.</p> </div>			20 It's back-to-school time soon. Give the kids something good to say when they're asked what they did this summer by making our ping-pong-ball launcher on page 108.		
21 Closing ceremonies of the Summer Olympics. Only 537 days until the Winter Games.				1	2	3



## A GREAT THERMOMETER: YOUR HAND

To tell if your grill is hot enough to start cooking, hold your palm five inches over the surface for as long as you can stand the heat. If you have to move your hand away after two seconds, you have high heat. Five seconds is medium, and ten seconds is low (or you have very tough hands).



## THREE WAYS TO SELL YOUR JUNK ONLINE

**VarageSale** keeps transactions local by placing you in a location-based seller community. It's like Craigslist, but with volunteers to monitor for spam and scams. **SellSimple** is an all-in-one app that lets users sell within the app but also on sites like eBay, Etsy, and Amazon. **OfferUp** finds buyers or sellers nearby and protects you by incorporating ID scanning and linking Facebook accounts.



## THE MAN BEHIND THE PARKS

Yellowstone may have opened in 1872, but it wasn't until 1916 that the National Park Service was established. An industrialist millionaire named Stephen Mather made it his personal mission to get parks regulated by the federal government. He later became the NPS's first director. Mather even purchased land himself to donate to new parks. Today, a plaque commemorates him in every one of America's 59 national parks.



**MTM SPECIAL OPS**



BLACK PREDATOR |

[SPECIALOPSWATCH.COM](http://SPECIALOPSWATCH.COM)

THE MTM SPECIAL OPS LINE OF TACTICAL TIME PIECES IS EXCLUSIVELY AVAILABLE THROUGH MTM TOLL FREE AT 1 800 284 9487 OUTSIDE OF USA 1 213 741 0808 1225 SOUTH GRAND AVE. LOS ANGELES, CA. 90015

# EVERYWHERE

What We're Up To Beyond These Pages

▽ **FACEBOOK!** ▽

You may have noticed live video streams popping up among the photos of friends' babies on your Facebook feed since April. We're taking full advantage of the new platform with a lineup of live video events to distract you at work. Just follow Popular Mechanics on Facebook and select "Live Subscribe" to tune in. A preview of what you'll see:



**ASK ROY, LIVE**

You read the column (see page 50). Now you can watch it in real time. Long-time senior home editor Roy Berendsohn hosts a weekly Q&A session from the tool closet at Popular Mechanics headquarters.



**TESTS**

Log on and watch as we test the limits of plywood, hit things with a lineman's hammer, and find out what liquid moves best through a Super Soaker. Things will be broken.



**FIELD TRIPS**

Join Popular Mechanics editors while we're out on the job, flying drones, exploring car shows, or playing around with a \$26,000 camera.

▽ **THE ARCHIVES!** ▽

## 114 YEARS OF AMERICAN PRIDE

Since Popular Mechanics' founding in 1902 there have been 19 presidents elected, five states added to the U.S., and 12 new amendments to the Constitution. In honor of the American Olympians in this issue, we scoured the archives for some of our more patriotic covers:



March 1924



January 1952



July 1972



June 1976



September 1983



March 1988

**BONUS!  
OUR FAVORITE  
NEW GADGET**

Amazon Kindle Oasis



The Oasis fixes all the flaws that kept me from loving previous e-readers. It's asymmetrical, which sets most of its 130 grams near your wrist, so your hand never tires. You can turn the page with touch or hard buttons that click reassuringly. An accelerometer automatically adjusts orientation for lefties. And it fits in your back pocket. Brilliant. The caveat: that \$300 base price. Only the most voracious readers need apply.

—Alexander George

▽ **POPULARMECHANICS.COM!** ▽



## EXCLUSIVE: HOW TO FIX FLYING

If you've ever taken a vacation, you're well aware of the annoyances of flying: bad Wi-Fi, cramped seating, inevitable mechanical delays. This July on popularmechanics.com, we're dedicating an entire series to the trouble with flying today. Look for stories on how to fix America's broken air-traffic-control systems and on preventing smaller annoyances, like chapped lips in a dry plane cabin. You can check it out while you're delayed at the terminal at popularmechanics.com/fixing-flying.

**WHERE ELSE YOU CAN FIND US**

**TWITTER:** @PopMech

**VINE:** Popular Mechanics

**SNAPCHAT:** Popmech

**YOUTUBE:** /PopMechShow

**FACEBOOK:** /PopularMechanics

**INSTAGRAM:** @popularmechanics

**GEICO**



The other guy.



Helping people since 1936      24/7 licensed agents      97% customer satisfaction      2nd-largest auto insurer

# The choice is yours, and it's simple.

Why enjoy just one chicken wing when there's a whole plate in front of you?

The same goes for car insurance. Why go with a company that offers just a low price when GEICO could save you hundreds and give you so much more? You could enjoy satisfying professional service, 24/7, from a company that's made it their business to help people since 1936. This winning combination has helped GEICO to become the 2nd-largest private passenger auto insurer in the nation.

Make the smart choice. Get your free quote from GEICO today.

**GEICO**®

geico.com | 1-800-947-AUTO | Local Office

Some discounts, coverages, payment plans and features are not available in all states or all GEICO companies. Customer satisfaction based on an independent study conducted by Alan Newman Research, 2015. GEICO is the second-largest private passenger auto insurer in the United States according to the 2014 A.M. Best market share report, published April 2015. GEICO is a registered service mark of Government Employees Insurance Company, Washington, D.C. 20076; a Berkshire Hathaway Inc. subsidiary. © 2016 GEICO



### **The Esquire Manhattan**

is made with superior Jefferson's bourbon and a combination of the finest sweet and dry vermouth and bitters. Crafted with the editors of Esquire and barrel-aged for 90 days, the result is a damn good cocktail. Serve it up or on the rocks. No labor or equipment needed.

AVAILABLE AT FINE LIQUOR STORES NATIONWIDE

# HOW YOUR WORLD WORKS

HAIRCUTS | ELEVATORS | A S | FIRE

**COOKING**

## The Kitchen of the Future Is Smart But Weird

Magnetic burners?  
Smokeless grilling?  
The PancakeBot?

BY WYLIE DUFRESNE

*Chef and mad scientist Wylie Dufresne helmed wd-50 and Alder in New York City.*

Because I'm a chef, every so often someone asks me about the future of food: "What ingredients will we have in our pantries?" they ask. "What will our stoves and refrigerators do?" I don't know the answers to these questions, so I usually handle them like a politician: I change the subject. But recently, I took five of 2016's most futuristic kitchen toys for a test drive, and I got a glimpse of where we're going in the process. Here's what's next.



**WE WILL GRILL INSIDE.**

**Philips Smoke-Less Infrared Grill** (\$300; [williams-sonoma.com](http://williams-sonoma.com))

▶ Every time I make a steak or burger for dinner, I have to disable my apartment smoke alarm. Philips' new indoor grill is designed to save me from this insanity. On outdoor grills, most of the smoke is caused by fats dripping onto the coals. Oils from fatty or heavily marinated meats can flare and even cause

small fires, charring the food. On this grill, the heat source is on the side—so the oil never hits it. The machine uses a clever angled reflector system to guide heat toward the grate while leaving the grease tray in the bottom cool. This reduces smoke by 80 percent and virtually eliminates splattering.

**VERDICT:** This grill is amazing. Believe me, I tried to make it smoke: I put a skirt steak that was dripping with marinade on it. As promised, the process was smoke-free. The machine also has a dial with three simple settings: off, on, and warm. Any grill lover can appreciate that.



**PANS WILL BE HOT, BUT STOVES WON'T BE.**

**PolyScience/Breville Control Freak Temperature-Controlled Induction Cooking System**

(\$1,800; williams-sonoma.com)

► This year is a big one for induction burners, which are finally moving from commercial kitchens into homes. These use a magnetic field to create heat in a cast-iron or steel pan without actually heating a stovetop. And this one is more precise than I've ever seen: The power ranges from 100 to 1,800 watts, and you can dictate the temperature of both the pot and the liquids inside to within a single degree. If you can't imagine the possibilities here, consider these: You can poach a piece of salmon at precisely 72 degrees Celsius. You can hard-boil eggs without ever getting a rubbery white or a chalky yolk. You can make curd and caramels and candies and not screw any of it up.

**VERDICT:** It's a big investment, but if you're looking to buy an induction burner, you won't find a more versatile unit. It also comes with an ingeniously designed mount for a temperature probe. I wish I had ten of them.

**WE WILL COOK UNDERWATER.**

**Nomiku Wi-Fi Immersion Circulator**

(\$200; available for preorder at nomiku.com)

► If the folks at Nomiku have their way, home cooks will soon start making dinner like many chefs do: in sealed bags in a tempera-

ture-controlled water bath (a technique known as sous vide). After you clip the circulator to the side of a pot filled with water, you can turn the knob as you would a watch bezel to adjust the temperature, or you can control it from a cooking app called Tender (not to be confused with Tinder), which lets you either input your own recipe or choose

from crowdsourced ones. **VERDICT:** It's a solid choice for a first-time user. The recipes I tried were reliable. However, the app didn't always talk to the circulator, and I couldn't start and stop the machine from my phone. While this isn't a huge issue, remote control is a major purported benefit of the Wi-Fi connection.



**PANCAKES WILL LOOK LIKE PEOPLE.**

**PancakeBot**

(\$300; bedbathandbeyond.com)

► Billed as "the world's first pancake printer," the PancakeBot is designed to print any design you can imagine. Of all the gadgets I tested for this article, none came close in terms of sheer excitement and anticipation. My kids planned a whole sleepover around the promise of Disney princess pancakes.

While the physical setup was simple, the tech part was not as user-friendly: The machine doesn't come preloaded with images, so you either need to create your own (a tedious process in a drawing program on the website), or convert other users' creations into a GCode format that the machine can read. By the time I realized I needed an SD card to make all of this happen, my kids had given up and asked for French toast.

**VERDICT:** I love the idea of this machine. The world is a better place when someone puts this much heart into a pancake. The recipe was great, and the pour mechanism was amazing to watch. Just beware: It's still in the early adopter stage.



**WE'LL MAKE**

**ICE CREAM OUT**

**OF EVERYTHING.**



**Cuisinart Fruit Scoop Frozen Dessert Maker**

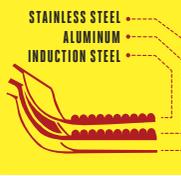
(\$100; amazon.com)

► I used a Cuisinart ice-cream maker in my first chef job 18 years ago and I've been a huge fan ever since. The company's latest version comes with two paddles: a classic ice-cream paddle and a paddle with multiple blades that can turn any fruit into a frozen treat. I followed one of the recipes it came with and transformed half a dozen sliced bananas and a little honey into an excellent creamy dessert in about 15 minutes.

**VERDICT:** Worth every penny.

**► AND THE PANS WILL HAVE BUMPS**

The protrusions on All-Clad's new d3 Armor series pans are created during the bonding process and contain little air bubbles that get less hot than the metal around them. The upshot: Food skates around on top of the bumps and releases more easily. —Jacqueline Detwiler



**We create  
chemistry  
that makes  
locked-in  
flavors love  
bursting out.**



Once its packaging has been opened, food is often quick to lose the freshness and aroma that make it so appealing. It's important that we get the most out of what we have available, as the world wastes about one third of its food. Luckily, chemistry can make a difference.

We have developed a range of packaging products, sealants and light stabilizers to protect food. Apart from offering a longer life span, they seal in freshness. So food is still at its best long after the pack has been opened. When less food goes to waste, it's because at BASF, we create chemistry.

To share our vision visit [wecreatechemistry.com](http://wecreatechemistry.com)

 **BASF**

We create chemistry

**BUILDINGS**

# The State of the Elevator

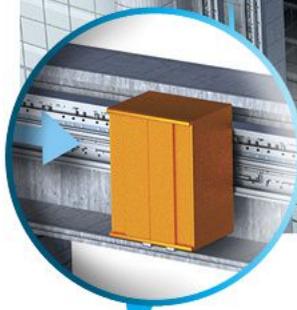
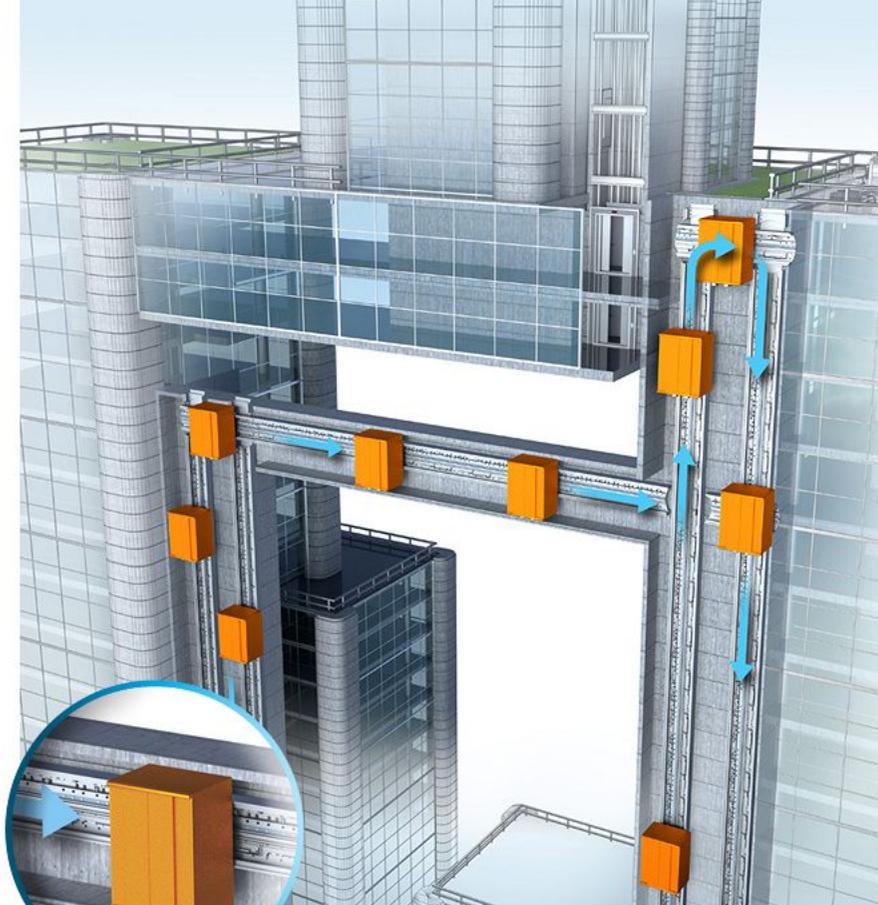
Soon they'll go sideways and slantways and longways.

BY MATTHEW HUTSON

In December, KONE opened a 36-story tower in Kunshan, China, containing a skydeck and 12 elevator shafts, but no offices, apartments, or retail space. The tower, one of eight facilities the company operates around the world, has a different purpose than most buildings: It—and its fully customizable elevators—exists solely to test the coolest new lifting technologies on earth.

One of the concepts being tested in the Kunshan tower is UltraRope, a ribbon of carbon fiber embedded in epoxy and coated with high-friction polyurethane that could enable architects to design skyscrapers that are taller than ever. Traditional steel-roped elevators are limited to heights of about 1,640 feet, requiring passengers in super-tall buildings to change shafts halfway up. Limiting factors include not just the weight of the ropes but also building sway: Beyond a certain height, wind can cause skyscrapers and ropes to move at the same frequency, smacking the ropes against the shaft walls. But UltraRope is lighter and less sensitive to building sway than steel ropes. A few buildings have installed UltraRope elevators already, and in 2018 Jeddah Tower in Saudi Arabia will use it to hoist the world's tallest elevator, at 2,165 feet, and also the world's fastest double-decker elevator (one car stacked atop another).

Super-light carbon fiber is only the beginning. "It's an old dream in the elevator business to get rid of ropes," says Markus Jetter, head of product development for systems and components at KONE competitor ThyssenKrupp. ThyssenKrupp has recently developed a system called MULTI that pushes cars along tracks using electromagnets. One benefit of MULTI is that several cars can move independently in a single shaft. They can move horizontally as well



Exchangers (top) rotate drive and guiding equipment so elevators can make 90-degree turns. UltraRope (above) resists building sway.

as vertically so that a herd of elevators could feasibly circulate in a series of loops.

Jetter's team had to overcome several hurdles before ThyssenKrupp could unveil its 1:3-scale working model of MULTI last November, including designing new traffic-control algorithms and exchangers—devices along the track that swivel to push a car down a different path. They also had to make the cars lighter. But so far, they've been successful: In addition to sending elevator cars to any height and in any direction, MULTI also reduces the number of elevator shafts needed in tall buildings, increasing usable area. This year ThyssenKrupp will complete installation of a full-scale MULTI system in its brand-new 800-foot test tower (the world's tallest), in Rottweil, Germany.

Designing elevator shafts may not sound as glamorous as designing skyscrapers, but futuristic buildings shaped like tripods and flowers require both arts in equal measure. When an architect has a vision, "our job is to support it," says Santeri Suoranta, KONE's head of technology for major projects. This is true even if that vision comes straight out of *Charlie and the Chocolate Factory*.

## LEED FOR SHUT-INS

**IN 2003, AN ODD** house appeared in Urbana, Illinois. The walls were 18 inches thick. It was pieced together with the precision of fine furniture. And it included a device just for exchanging air with the outdoors, called a Heat Recovery Ventilator (HRV).

The house belonged to Katrin Klingenberg, the architect who, in 2007, cofounded Passive House Institute US

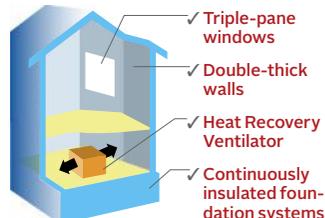
(PHIUS), which certifies domiciles as passive houses, one of the most rigorous and increasingly popular green building standards in the country.

About 50 percent of an average home's energy budget involves space heating, cooling, and air conditioning. Passive houses can cut this by 60 to 75 percent just by tightly sealing the building envelope, using insulation with high R-values, and eliminating

thermal bridges—structural pieces like windows that allow heat transfer even in an otherwise well-insulated house. HRVs allow the building to breathe while still keeping the heat in.

A signal PHIUS project is a 101-unit building in Queens, New York, being built at a cost less than 1 percent higher than the developer's nonpassive projects. It opens in 2017.

—Kevin Dupzyk



# READY... SET... **HOT!**

## Enjoy A **Faster, Endless** Supply Of **Hot Water** With **Rinnai's Tankless** **Water Heating Technology.**

Imagine turning on the shower and getting hot water almost immediately. If you had the smart recirculation technology of a Rinnai Tankless Water Heater, you wouldn't have to imagine. You'd have the integrated solution for a steady stream of daily benefits, including:

- A faster, endless supply of hot water that lets you do more, wait less and live better
- Less water and money down the drain to cut wasted natural resources and utility costs
- Ultra-efficient performance for monthly energy savings in a space-saving design



**The wait is over. The time is now. Experience the breakthrough in tankless water heating recirculation that puts faster hot water a turn of the knob away. Only from Rinnai.**

To learn more about Rinnai's innovative lineup of high-efficiency water heaters, visit us at [rinnai.us/tankless](http://rinnai.us/tankless)

# Rinnai®

SPIRITS

# Fire You Can Drink

Victor Albusu, chef and owner of the Washington, D.C., steakhouse Del Campo, adds fire and smoke to everything. Even his negronis.

BY FRANCINE MAROUKIAN



For Victor Albusu, fire isn't simply a means of cooking. It's a flavor. "My grandfather taught me to cook over glowing embers in pits we dug in the backyard," the Cuban-Peruvian chef says. "And to this day, nothing feels finished unless I smell smoke or taste fire."

At his Washington, D.C., steakhouse, Del Campo, Albusu uses flame to produce meat of striking contrast—silky rare at the bone, charred crispy on the edges. His approach

extends to other foods too. His vegetables are grilled on only one side, using residual heat to render the other side warmly tender, and giving multiple tastes and textures to the same bite of food. His method takes advantage of caramelization, or the oxidation and browning of the natural sugars found on the surface of vegetables. "You catch the heat between medium and high, lay your vegetables down, and then leave them alone," he says. "I don't mess with them until they reach my level of char. For me, that's one step

beyond caramelization, or what I call 'burnt.' Burned gets thrown in the garbage."

And then there are the drinks. Del Campo's cocktail menu is a direct extension of the kitchen philosophy: Crystallized ginger is torched and dropped into a flute of champagne; limes are caramelized into something like hard candy; and even the mint syrup used in the mojito is burnt. In some cocktails, smoke is directly infused into the liquid. Which can be just as fun to watch as it is to drink.

## WHY YOU CAN TASTE SMOKE

Although it looks like the smoke floats out of the glass, some elements are left behind.

A cold glass condenses water from the atmosphere very quickly. So when a cold glass covers a burning mound of canela, the smoke comes in contact with condensed moisture on the sides of the glass. The water-soluble molecules in the smoke—pretty much everything except the tar and carbon particles—dissolve in that moisture, imparting their smell and taste to the eventual cocktail. The film of water on the surface of an ice cube similarly attracts and bonds to the smoke.

### THE DEL CAMPO SMOKED NEGRONI

- |   |   |  |  |   |
|---|---|--|--|---|
| <p><b>1</b></p> <p>Mix 1½ ounces pisco, 1 ounce Aperol, 1 ounce sweet vermouth, 1 dash Peychaud's bitters, and 1 dash Angostura bitters. Chill.</p> | <p><b>2</b></p> <p>On a cedar grilling plank (about \$5 at any kitchen store), crumble canela (Mexican cinnamon quills) in a small tepee-shaped pile.</p> | <p><b>3</b></p> <p>Hold a propane torch (\$15 at any hardware store) about 4 inches above the canela, burning it in a circular motion.</p> | <p><b>4</b></p> <p>Immediately after removing the torch, invert a cold rocks glass over the canela. Let the glass fill with smoke.</p> | <p><b>5</b></p> <p>After 30 seconds, turn the glass right-side up, add a 2-inch ice cube, and pour in the premixed cocktail. Garnish with a piece of orange peel.</p> |
|---|---|--|--|---|

**+** HOW TO IMPROVE ANY DRINK WITH FIRE

Scatter dark brown sugar on a shallow heatproof metal pan, cover with lime slices, and scatter more sugar over the top. Place pan on a hot grill and let the sugar melt and bubble on the edges, caramelizing the lime slices. Let cool, then drop into nearly any drink. Especially a dark 'n' stormy.



PROMOTION

FOR THE MAN WHO UNDERSTANDS THE IMPORTANCE OF FIT...

*the Ultimate* SHIRT & TIE *Collection*

CURATED BY  
*Esquire*

EXCLUSIVELY AT  
MEN'S WEARHOUSE®  
[menswearhouse.com/esquire](http://menswearhouse.com/esquire)



FIG. A ROUND

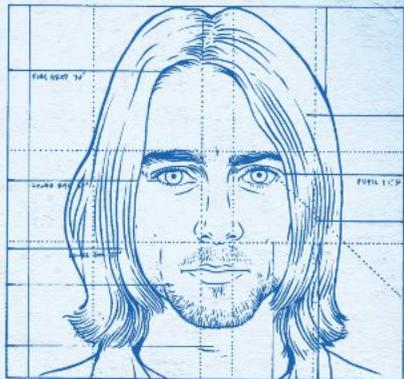


FIG. B OVAL

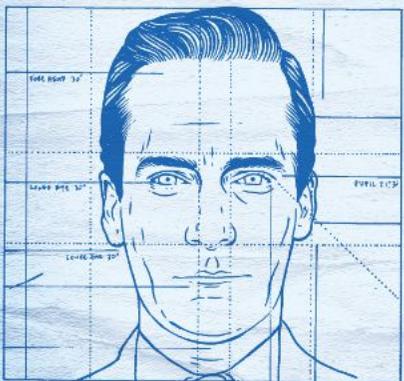


FIG. C SQUARE

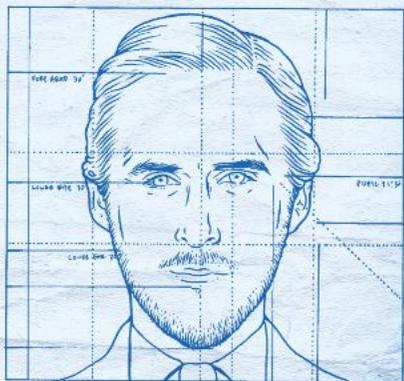


FIG. D TRIANGULAR

GROOMING

# Hair Architecture

Haircuts require engineering. Who knew? BY DIDI GLUCK

There are still places in this country where it's possible to get a great haircut for \$20, but most stylists charge double that, and some even get into the hundreds of dollars. Guys who balk at spending a car payment on a haircut often assume this is a racket, but there is real science behind a great haircut. A solid barber chooses a style for you based on your head shape, then adapts the cut to specifically fit your skull.

"If you use a number 3 guard on clippers, you're cutting every hair to the same length," says Shirley Hagel, a New York City

stylist who cuts the hair of New York Ranger Chris Kreider. "But nobody's head is perfectly smooth. What makes a good haircut is cutting all the hair differently to make it *look* like it's all the same length."

A good barber or stylist will work in narrow sections and follow the contour of your head from base to crown, lifting the hair with a comb while snipping the strands that pop through the teeth. "Cutting with scissors lets me, rather than the guard on the clippers, control how close I get to the head," says Kristan Serafino, who's cut hair for Ryan Reynolds and Matthew McConaughey. This means that if you

have, say, a flat spot, your stylist can cheat and leave a little more length to fill out the shape.

There are other hacks: leaving cowlicks longer than the rest of your hair so they lie flat; thinning out the hair around patches of gray, because gray hair tends to appear shorter; and even blending the areas around bald spots so that the contrast between them is a little less noticeable. The person cutting your hair needs to consider geometry, gravity, color, and texture when creating something that also looks good. It's architecture, made out of something your body grew. Which is only gross if you think about it.

HOW TO FIX YOUR...

Lumpy Head



This really comes into play with a crew cut. Your barber should leave your hair a little longer over any potholes, but too long and the spot can look darker than the rest of your hair. Have him lightly thin out the patch to blend the color as well as the length.

Big Head



Go a bit shorter on the sides than on top—even if you're just going to slick it back. This will create the illusion of a longer face.

Square Head



"The banker" (a square cut) can be flattering, but make sure you get a seamless fade from the longer top to the shorter sides. If the line is harsh, you could end up looking like SpongeBob.

Big Nose



Very long bangs.

A FEW UNEXPECTED NOTES ON SCISSORS



1. Hairstylists call them shears.
2. They cost hundreds to thousands of dollars, and come in a variety of lengths, handle styles, coatings, and edges.
3. A single pair of shears can last for a stylist's entire career.
4. There are professional shear sharpeners who sharpen, tighten, and polish them every few months.
5. Shears are sharp enough to cut wet toilet paper, which is a lot like wet hair.

A SHOWDOWN FOR SKIN SUPREMACY

# GEL THE PROTECTOR RESERVOIR



★ VS ★



THE OLD  
SCHOOL  
**LUBE  
STRIP**

**Schick**  
**HYDRO**<sup>®</sup>  
FREE YOUR SKIN<sup>®</sup>

The new Schick Hydro<sup>®</sup> is designed like no other razor to knock out irritation. Its protective gel reservoir delivers 40% less friction than a lube strip. So leave your face undefeated with Schick Hydro.



# WeatherTech®

American Manufacturing *Done Right!*



## FloorLiner™

Provides “absolute interior protection™”

Laser measured to perfectly fit your vehicle

Has channels to carry fluids and debris to a lower reservoir

Material provides soft touch top, rigid core strength and bottom surface friction



Available in Black, Tan and Grey for Cars, Trucks, SUVs and Minivans

## All-Weather Floor Mat



Underside Nibs and Anti-Skid Ridges



Ribbed Design

Deep sculpted channels designed to trap water, road salt, mud and sand

Will not crack, curl or harden regardless of temperature

Available in Black, Tan and Grey

## Cargo/Trunk Liner

Complete trunk and cargo area protection

Digitally designed for each application

Remains flexible under temperature extremes



Available in Black, Tan and Grey for Cars, SUVs and Minivans



## CargoTech®

Cargo containment system

Couples a durable plastic “fence” with a super-grippy underside to keep cargo stable

Excellent for cargo area organization

Works with WeatherTech® Cargo Liner or existing vehicle carpet or flooring

## Accessories Available for

Acura · Audi · BMW · Buick · Cadillac · Chevrolet · Chrysler · Dodge · Ferrari · Ford · GMC · Honda · Hummer · Hyundai · Infiniti · Isuzu · Jeep · Kia · Land Rover · Lexus · Lincoln · Maserati · Mazda · Mercedes-Benz · Mercury · Mini · Mitsubishi · Nissan · Oldsmobile · Plymouth · Pontiac · Porsche · Saab · Saturn · Scion · Subaru · Suzuki · Toyota · Volkswagen · Volvo · and more!



TechLiner® and Tailgate shown

## TechLiner®

### ARMOR YOUR INVESTMENT

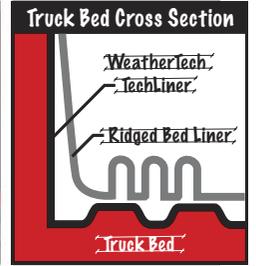
Fits to the exact contours of each application

No messy sprays or drilling needed

100% recyclable, odorless material

Flexible and durable

Chemical and UV resistant



## Roll Up Truck Bed Cover

Low-profile, aerodynamic finish

Easy to operate - opens and closes in seconds

Keeps cargo away from the elements

## No-Drill MudFlaps



Mounts-In-Minutes™

Protect your vehicle's most vulnerable rust area

Installs without tire/wheel removal

No drilling into the vehicle's fragile metal surface

Available for Trucks and SUVs



## BumpStep®

Protect your bumper from minor accidents

Fits standard 2" receiver hitch

Safely stand on the step (up to 300 lbs.)  
for everyday tasks

See the video at [WeatherTech.com](http://WeatherTech.com)!

Order Now: 800-441-6287



American Customers  
[WeatherTech.com](http://WeatherTech.com)



Canadian Customers  
[WeatherTech.ca](http://WeatherTech.ca)



European Customers  
[WeatherTechEurope.com](http://WeatherTechEurope.com)



DISASSEMBLY REPORT

# SUMP PUMP

MODEL: XYLEM GOULDS GSP0311

TIME TO DISASSEMBLE:  
31 MINUTES,  
17 SECONDS

NUMBER OF PARTS:  
**97**

PRODUCED: ZHEJIANG, CHINA

**NOTES:** If you grew up without a basement, you might be under the impression that a sump pump is some kind of fantastical Dr. Seuss contraption. In fact, the rhyme is a coincidence. A “sump”—the word comes from the same Dutch and German that gave us “swamp”—is a low point where water collects. In a home, a sump collects water that would otherwise flood the basement. There are two main varieties: pedestal and submersible. A pedestal sump pump has its motor mounted atop a long shaft to keep it above the water level. But the motor is exposed, so if water reaches it, the machine will fail. A submersible pump like this one is designed to sit entirely in the sump. The motor and impeller are usually encased in cast iron, and because they’re designed to be underwater, can run more or less forever. As Paul Ruzicka, chief mechanical engineer of Xylem, says, “If you threw this pump in a pond, eventually, that pond will be gone.”



## THE FLOAT

When it rains heavily, a home’s drainage system directs water into the sump. The cast-iron body of the pump keeps internal components dry and gives it enough heft to ensure that neither water flow nor pump vibration will move it. If the pump moves, it could restrict the range of motion of the **float (12)**. That would be a problem, because the float’s movements turn the pump on and off, using the same process that signals when a toilet’s tank is full: The float is a plastic capsule of cellular foam that rises with the water level, lifting the **switch lever (13)**. The switch lever feeds into the **mechanical switch housing (1)**. When the rod reaches a factory-set level, it triggers the switch that turns on the motor.

## THE MOTOR

The **motor (6)** is a typical 1/3-hp AC motor. It draws power through a **fully jacketed power cable (4)** routed through a **rubber gland (3)** that keeps water out of the **motor dome (2)**. Two perfectly flat **silicon carbide faces (10)** form another seal between the dome and the impeller cavity. These rotate against each other without letting water in, allowing the motor to turn the **pump shaft (11)**, and the pump shaft to turn the **impeller (8)**, while the motor stays dry.

The dome is filled nearly to the brim with 21 fluid ounces of **mineral oil (5)**—some room is left for thermal expansion—which helps cool and lubricate the bands of the motor. (A removable rubber plug allows oil to

be drained during maintenance.) Any water in the sump also performs a useful cooling function, but with the impeller turning, the water level can drop quickly.

## THE IMPELLER

The impeller spins in the **base (9)** of the pump, which has a slotted design to screen out debris larger than 1/2 inch in diameter, the maximum size solid the pump is capable of moving. The impeller imparts rotational motion to the water in the sump, directing it into the **volute (7)**. The volute funnels water to the outtake port, which connects to a 1 1/2-inch outflow pipe that directs water up, out of the basement and, one hopes, far away.

—Kevin Dupzyk



## CHOOSING A PUMP

If your pump isn’t capable of moving water out of your house faster than rain brings it in, you’re up a creek. Here’s how to make sure your pump is adequate.

**(1)** Measure the diameter of your sump: If the diameter is 18 inches, each one-inch rise in water will equal about one gallon. If it’s 24 inches, each inch is about two gallons. During a heavy rain, measure how much the water rises in one minute. Use this to calculate how many gallons per minute you need to pump.

**(2)** Figure out how far your pump has to move water, which is called total dynamic head. Start with the static head, the vertical distance the water will travel. Then add the friction head—the length of pipe the water will traverse, adjusted to account for fittings and friction. (The appropriate adjustments can be found online.)

**(3)** Check the pump’s performance curve, which will be provided by the manufacturer. The curve shows how many gallons per minute it can pump for a given amount of total dynamic head. If your pairing of measurements falls below the curve, you’re safe.



# GREAT UNKNOWNNS

**BIG QUESTIONS.  
ANSWERS YOU CAN'T FIND  
ON THE INTERNET.**



## What causes that new-car smell? Is it bad for you?

**A** **YOU DON'T WANT** to know. Seriously. Just enjoy your brand-new car as you revel in the sweet, sweet smell of conspicuous consumption. Definitely don't think about the fact that you're inhaling a potpourri of perhaps 200 different chemicals, including formaldehyde, benzene, and various other volatile organic compounds (VOCs). That would just spoil the mood.

The aromas that make up your new car's bouquet are the product of the off-gassing of the plastics, adhesives, and other components that make up the interior—dashboard, upholstery, rich Corinthian leather, etc. Off-gassing occurs because many chemicals that are added to polymers to impart specific qualities (like, say, flexibility) do not bond to the other compounds and are therefore released over time in a process similar to evaporation.

There's no definitive research establishing the risk, if any, posed by new-car smell, though certain of the individual components are known carcinogens. The question is whether drivers suffer harmful levels of exposure—and it's a hard question to answer, especially as most of us encounter the same chemical vapors elsewhere. "One of the things we're concerned about is that some of the important chemicals you're exposed to in a car, you're also exposed to at home and in other environments," says Jeff Gearhart, research director at the Ecology Center in Ann Arbor, Michigan. "Some of these exposures may be cumulative."

Common sense would suggest that you keep your new ride (or freshly painted and carpeted home, for that matter) well venti-

lated, especially on hot days, as off-gassing increases with temperature. Gearhart notes that using the external air-circulation feature on your car's climate-control system can lower the concentration of airborne chemicals by as much as 77 percent. Like most intoxicants, new-car smell is best consumed in moderation. Please enjoy responsibly.



### Which dog breeds could kill a coyote?

The experts will point you toward various brawny hunting and guard-dog breeds, a few of which we'll get to in a moment, but there are alternatives. It seems to us that a Chihuahua, perhaps, or a dachshund, slathered in a nice chimichurri sauce or dipped in sausage gravy and released in the general vicinity of the targeted coyote might pose a very grave choking hazard.

If you're picturing a fang-gnashing, throat-ripping throw-down, however, you may want to import a foreign mercenary to open a can of canine whoop-ass. Various breeds from Europe have long been used to protect livestock from the likes of wolves and bears and are certainly capable of dispatching a mangy ol' coyote. Julie Young, of the National Wildlife Research Center in Logan, Utah, emphasizes that such dogs are intended to keep predators at bay, not necessarily kill them (though that does happen). She mentions the Kangal, from Turkey, the Karakachan, a Bulgarian breed, and the Transmontano mastiff, native to Por-

tugal, as three notably big bowlers that can take care of business. Other breeds that come up in discussion with dog fanciers include the Irish wolfhound, Rhodesian ridgeback, Plott hound, and borzoi. Some folks have even used packs of greyhounds to hunt and kill coyotes.

Then again, you might be best off with another animal entirely—assuming you can keep a straight face. "Some people use miniature ponies," Young says, in all seriousness (we think). These battle-ready beasts, along with donkeys and llamas, apparently are not only great birthday-party entertainment, they also despise canine-type animals. They routinely flatten foxes with their front hooves and will gladly stomp a coyote. And let's not forget that if none of the above appeal, there's always the trusty roadrunner—*meep meep!*



### Which U.S. arena has the best acoustics for rock shows?

This is an entirely subjective question, but the answer is any arena in which Nickelback is not playing.

In truth, none of the typical multipurpose arenas shared by circuses, hockey teams, monster-truck shows, and basketball squads is ideal from an acoustic standpoint. They tend to be boomy, reflective environments with cave-like architecture and expanses of hard surface area that can turn even the most delicate strains of death metal to aural mush. Though some more modern arenas—and even some old standbys—have made significant strides by allowing for the temporary installation of absorptive materials such as curtains, the sound quality you experience (or don't) at any given concert is largely a function of the skill of a band's sound crew along with the sophistication of the equipment it employs.

Speaker placement, for instance, is especially critical and may be determined with "prediction software," which analyzes data gathered with lasers to dictate the ideal setup. "A big piece of modern sound-system strategy is control of the sound into very, very highly directional beams," says Bob McCarthy, director of system optimization for Meyer Sound, a maker of concert sound gear. "Believe it or not, in an arena it can be a game of 1 or 2 degrees—that's how precise these systems are." Concertgoers themselves also help—people reflect less sound than do empty seats—so packed houses generally sound better than sparsely attended shows. And they're certainly more fun.

**Do you have unusual questions about how things work and why stuff happens? This is the place to ask them. Don't be afraid. Nobody will laugh at you here. Email [greatunknownns@popularmechanics.com](mailto:greatunknownns@popularmechanics.com). Questions will be selected based on quality or at our whim.**

# THIS IS THE FORD F-150

## AND EVERY OTHER TRUCK IS HISTORY

THE ADVANTAGES OF ALUMINUM ARE HUGE

- Up to 700 lbs. lighter
- Most towing power\*
- Best payload capacity\*\*
- Highest gas mileage†
- 5-star safety rating††

THE FORD F-150  
/// FORD.COM



\*Class is Full-Size Pickups under 8,500 lbs. GVWR based on Ford segmentation. When properly equipped with available 3.5L EcoBoost® V6, 4x2. \*\*Class is Full-Size Pickups under 8,500 lbs. GVWR based on Ford segmentation. When properly equipped with available 5.0L V8, 4x2. †EPA-estimated rating of 19 city/26 hwy/22 combined mpg, available 2.7L EcoBoost V6, 4x2. Actual mileage will vary. Class is Full-Size Pickups under 8,500 lbs. GVWR based on Ford segmentation.

†† Government 5-Star Safety Ratings are part of the National Highway Traffic Safety Administration's New Car Assessment Program at [www.safercar.gov](http://www.safercar.gov).

Try to avoid water higher than the bottom of the hubs and proceed slowly. Refer to your owner's manual for detailed information regarding driving through water.

**Proven Leaders.**

**Team Players.**

**Future Colleagues.**

 **RESUME ENGINE**



**The right team can take a business to the next level.**

The experience veterans gain in the military makes them ideal employees in the civilian workforce. Resume Engine translates military experience, training, and honors into relatable job qualifications and allows recruiters to search for veteran candidates at no cost. Veterans can use this free tool to create and share a strong resume with employers nationwide.

Start searching for your next team member today.

**[ResumeEngine.org](https://ResumeEngine.org)**

**HIRING OUR HEROES.**  
U.S. CHAMBER OF COMMERCE FOUNDATION

 **TOYOTA**  
Let's Go Places

# KNOW-HOW

HEDGE CLIPPERS | STREAMING TV | CURED MEAT



←  
With your host,  
Maika Monroe,  
star of  
*Independence Day:  
Resurgence*.

## How to Kiteboard

The premise is pretty simple: Attach yourself to an enormous kite, strap your feet to a board, and let the wind do the rest. The execution, though—that's where it gets a bit tricky. With enough practice and plenty of waterproof sunscreen, you can synthesize three extreme water sports—surfing, wakeboarding, and windsurfing—into your new favorite summer hobby.

BY CAMERON JOHNSON

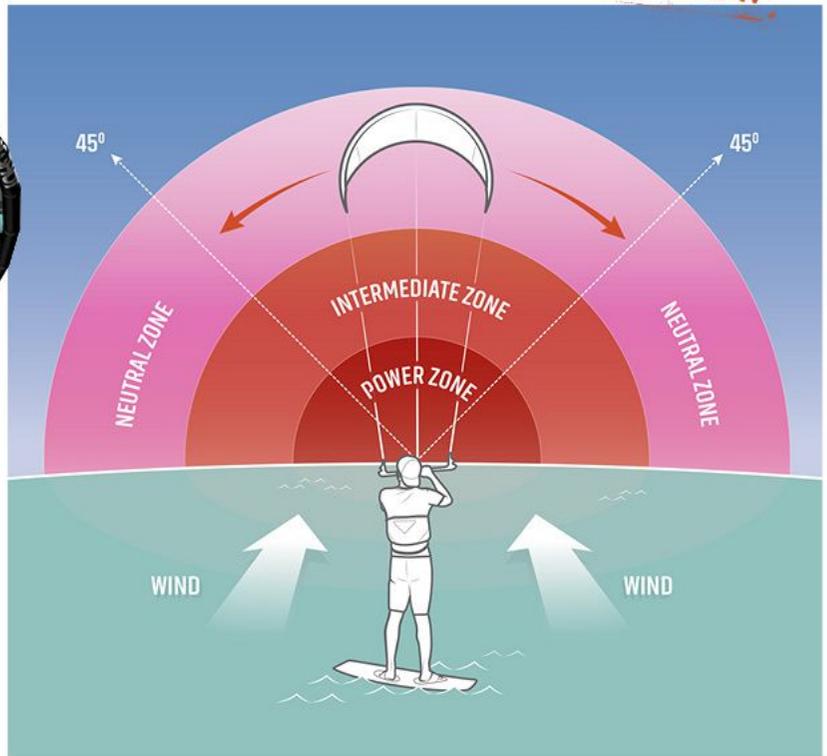


KITEBOARD  
HARNESS

**THE BASICS**

**FIRST, GET AN** instructor. You can't teach yourself to kiteboard without also taking a trip to the ER. First up is a trainer kite, a smaller kite used only on the beach, to get a feel for how you'll be pulled in the harness. From there, full-size kites range in size from five to 18 square meters. The size you need is determined by your weight, the wind speed (the faster the wind, the smaller the kite) and your experience, so expect to start with something right in the middle. Every kite has inflatable support beams that help the kite spread to catch wind and also keep it (and you) from being pulled under when it hits the water.

In terms of staying attached to the kite, there are two types of harnesses: A seat harness is more like a climbing harness, securing your legs and waist. Most pros (and Maika), however, opt for a waist harness, which increases mobility for tricks and twists. You'll be fine with either. From there you use the bar to control speed and the board to change direction. And don't forget your life vest.



**THE WIND WINDOW**

**IMAGINE THERE IS** a half-dome directly downwind in front of and above you. The location of your kite in this dome dictates how strongly you'll be pulled along by the wind. Straight up above you and out to your sides is the neutral zone, where your kite will stay aloft but not pull you. Directly out in front of you is the power zone, where your kite will pull the hardest. In between the two is the aptly named intermediate zone, where you will be pulled hard, but not too hard.

**CONTROL**



**IF YOU FEEL** like you're going too fast and need to slow down, push the bar up and away from you. The kite will rise straight up out of the power zone and into the neutral zone where it won't pick up as much wind. This is known as depowering. When you're ready, pull the bar back toward you.



**IF YOU START** to lose control and feel like you're in danger, harnesses have a quick release called a chicken loop located right in front of you between the harness and the bar. Pull the tab on the release to disengage the lines, and the kite will fall harmlessly into the water.



**ABOUT OUR EXPERT**

Maika Monroe is a kiteboarder and actress. The kiteboarding came first. She started at 13, when her father, also a kiteboarder, gave in to years of begging and agreed to teach her. Four years later, she turned pro. She moved to the Dominican Republic to focus on training and soon became one of the top American female kiteboarders. But after sending out audition tapes, Monroe had to cut short her career as a pro athlete when she was cast in 2012's *At Any Price*, with Dennis Quaid and Zac Efron. That led to a role in the critically acclaimed horror flick, *It Follows*, and this summer the 23-year-old California native costars with Liam Hemsworth and Jeff Goldblum in *Independence Day: Resurgence* (out June 24), the alien apocalypse follow-up to 1996's alien apocalypse original.

I CAN WIN  
ANY CAR GAME  
IN MANUAL OR  
AUTOMATIC.

NOT JUST A PRETTY HAIRSTYLE.

SPIKED-UP LOOK  
STYLING PUTTY.



EXTREME HOLD.  
LONG-LASTING.

**AXE**  
FIND YOUR MAGIC.

# TOOL TEST

THE PROVING GROUND FOR EVERYTHING YOU NEED



## Hedge Trimmers

Putting hedges in your yard involves two promises: Your hedges promise to do what you need—block your view of the street or your neighbor's view of your living room—and you promise to keep your hedges neat and trim and looking good. We tested three of the best new trimmers on 300 square feet of dormant yet entirely out-of-control rose of Sharon bushes (and one poodle, but only pretend). Most were  $\frac{1}{4}$  to  $\frac{1}{2}$  inch thick, with a few as thick as an inch across.



**Gilmour 938**

★★★★☆

**OVERALL LENGTH:** 22½ in.

**CUTTING EDGE:** 8 in.

**WEIGHT:** 2.2 lb

**LIKES:** The rubber-coated aluminum handles have a comfortable oval cross section, and the arch of the handle makes it easier to come in over branches without snagging your hands. We also appreciated the rubber bumpers just below the blades to reduce closing impact, and the small notch in the right blade, which was very helpful on thicker branches.

**DISLIKES:** The hanging hole in the right blade isn't big enough to actually be useful.

\$25



**Fiskars HS551**

★★★★☆

**OVERALL LENGTH:** 23½ in.

**CUTTING EDGE:** 8¾ in.

**WEIGHT:** 2.4 lb

**LIKES:** Fiskars use gears to increase mechanical advantage. You can feel the difference when you sink into a thick branch.

**DISLIKES:** There's no branch notch, so thicker limbs took a lot of sawing. More disappointing, the first pair we tested somehow turned the steel edge of the blade, keeping the two blades from fully closing. Fiskars quickly replaced the faulty trimmers, and the new pair had no problems.

\$42



**Corona HS 4244**



★★★★☆

**OVERALL LENGTH:** 21 in.

**CUTTING EDGE:** 8 in.

**WEIGHT:** 2.2 lb

**LIKES:** Special gel grips made a huge difference on our hands, especially after 20 minutes of cutting. But even better is the shock guard, which allows the blades to extend slightly past overlapping when closed. It feels like you're squeezing a marshmallow. The top blade's serrated cutting edge and one-inch branch notch made these our go-to shears on the toughest branches.

**DISLIKES:** None.

\$41

# ENGINEERED FOR THE JOB

**DURAHIDE™**  
GENUINE LEATHER

UNITED WE WORK™

RUGGED BY DESIGN AND ENHANCED BY DURAHIDE™ GENUINE LEATHER. DURAHIDE LEATHER WORK GLOVES PROVIDE EXTREME DURABILITY SO YOU CAN TAKE ON YOUR ENDLESS TO-DO LIST. DURAHIDE LEATHER IS POROUS AND WILL SETTLE INTO ITS OWN DISTINCT FORM WITH A LITTLE BIT OF SWEAT AND SOME HARD WORK.



**FASTFIT®**  
ELASTIC  
CUFF

**THE  
ORIGINAL®**  
SEAMLESS  
PALM

**M-PACT®**  
IMPACT  
PROTECTION

**THE TOOL THAT FITS LIKE A GLOVE®**

US: 800.222.4296 | [WWW.MECHANIX.COM](http://WWW.MECHANIX.COM)

#mechanix   



# TOOL TEST

THE PROVING GROUND FOR EVERYTHING YOU NEED

KNOW-HOW

## Multitools

Because a toolbox would be uncomfortable in your pocket.



### SOG PowerPlay

★★★★☆

**FOLDED SIZE:** 4 1/8 by 1 1/2 in.

**TOOLS:** 18

**LIKES:** A lot of tool for the money. The only Chinese-made option we tested, the SOG displays good fit and finish and a powerful, geared plier head. A magnetic seat grips any of the tool's 12 screwdriver bits. Knife-centric users will appreciate the two different blades, straight and serrated.

**DISLIKES:** All of the tools and blades lock securely, but the button latch that unlocks them pokes directly into your palm. It can be uncomfortable to hold.

\$64



### Leatherman Signal

★★★★★

**FOLDED SIZE:** 4 1/2 by 1 1/2 in.

**TOOLS:** 19

**LIKES:** Impeccable industrial design and workmanship. All blades and tools fold out with a crisp snap that contributes as much to the pleasure of ownership as to the tool's safety and utility. Bonus points for the diamond-grit file you can use to sharpen the serrated knife blade, and the ferrocerium-rod sparker surface, in case you're out of matches and want to light a fire.

**DISLIKES:** None.

\$100



### Gerber Multi-Plier 600

★★★★☆

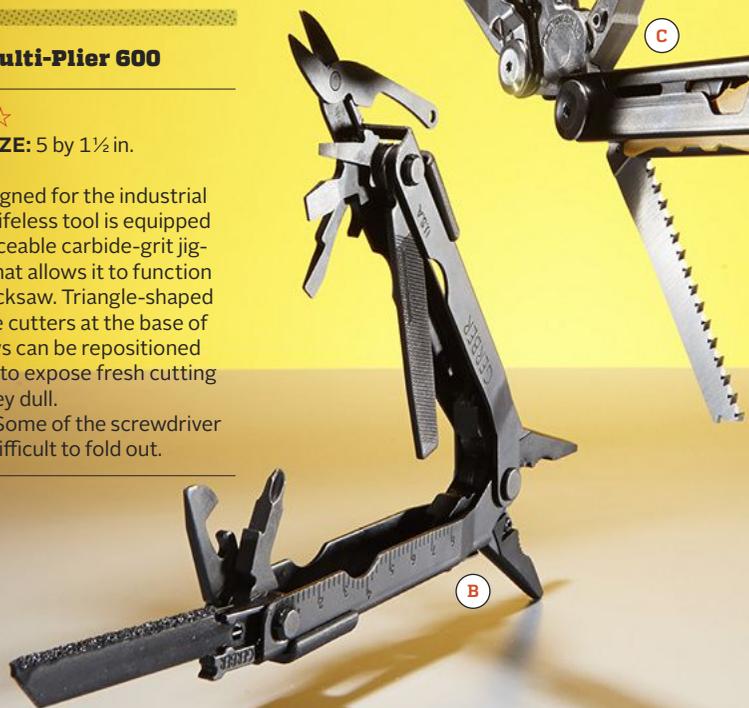
**FOLDED SIZE:** 5 by 1 1/2 in.

**TOOLS:** 14

**LIKES:** Designed for the industrial user, this knifeless tool is equipped with a replaceable carbide-grit jigsaw blade that allows it to function as a mini hacksaw. Triangle-shaped carbide wire cutters at the base of the plier jaws can be repositioned three times to expose fresh cutting edges as they dull.

**DISLIKES:** Some of the screwdriver blades are difficult to fold out.

\$83



# 8 CIGARS ONLY \$10\*

**\$52 VALUE**



## First-Class Premium Cigar Sampler

When it comes to cigars, no one even comes close to Cigars International and we're ready to prove it to ya with an outrageous intro offer: 8 premium handmade cigars for just \$10. Go ahead, price shop this one and prepare to be stunned. When you're ready, we're here waiting with the world's largest selection of premium handmade cigars at the planet's lowest prices, delivered fast and fresh. That's our guarantee.

*Limited time offer. One per customer please.*

[www.CigarsIntl.com/SA6030](http://www.CigarsIntl.com/SA6030)

You must enter complete web address for special offer

1-888-244-2790 mention code SA6030

Includes 1 each of: Torano • HC • 5 Vegas • Cuba Libre • Jesus Fuego  
La Perla Habana • Alec Bradley • Rocky Patel



## UPGRADE NOW!

ADD A TRAVEL HUMIDOR

only \$5 MORE

PERFECT FOR:

- **Golf:** worry about golf, not damaged cigars.
- **Fishing:** airtight and it floats – perfect for fishing!
- **Hunting:** keep your cigars protected even in nature's toughest conditions.



\* Plus \$3/h. PA residents add 6% tax – taxes on orders shipped outside of PA are the responsibility of the purchaser. Offer expires 8-15-16. Offer available to first-time purchasers. From time to time substitutions may occur. Cigars International does not sell products to anyone under the age of 21. For more information please see [www.cigarsinternational.com/ageverify](http://www.cigarsinternational.com/ageverify).



✓ Easy to Use Website



✗ Waiting in Line



✓ Huge Selection



✓ Parts for Your Car



✓ Fast Shipping

**MotorWeek**

**DETROIT muscle XTREME OFF ROAD**

AS SEEN ON TV

**POWERNATION**

✓ As Seen On TV

ALL THE PARTS YOUR CAR WILL EVER NEED.

[www.RockAuto.com](http://www.RockAuto.com)



# TECHNOLOGY

WITH BABA BOOEY

KNOW-HOW



## TV On the Go

With so many streaming options, you can watch anything anytime. But not anywhere.

BY GARY DELL'ABATE



Years ago, when you flew you had to watch whatever crappy movie the plane was showing. Now we just bring our entertainment with us. Look around, and everybody is power-watching a show or movie on a tablet or laptop.

Problem is, most video services are streaming only, which is an issue for anyone who travels. We think that Wi-Fi is going to be everywhere soon, but it's not. Trains, planes, hotels, and cars

say they have Wi-Fi, and tablets and phones have data, but I don't trust any of it. Even when the Wi-Fi works, airlines make it clear: You can email, but forget about trying to stream movies, even if you pay extra for the faster connection. What B.S.

Until streaming is fully integrated and strong Wi-Fi is everywhere, if I want to be sure I can watch something, I download. A friend brought this up the other day. Even though he could

watch *Peaky Blinders* on Netflix, he bought episodes off iTunes. Why did he buy what he was already paying for? "I can't stream Netflix on a plane," he said. It's ridiculous that you have to pay for something twice just because you don't have Wi-Fi.

It's an annoying oversight, but there are solutions. For example, I kept meaning to see the Amy Winehouse documentary, *Amy*. It's a perfect plane movie. Before my last trip, I found it on Amazon Prime Video. I hit "Download" and had it on my iPad, ready to watch without a data connection. Prime Video is the only major streaming service that does this and it's gotten me to look at Amazon's content in a way that I never did before. One day a week I take the train to work, so I started watching *The Man in the High Castle*, one of Amazon's series. I'm only on my fourth episode, I watch it here and there, but it lives on my iPad, always ready. Now we just need Netflix and Hulu to follow Amazon's lead.

I also rely on DVDs, especially for work, where I get screeners of new movies or shows. Yes, DVDs. I have a library of stuff I've ripped, as in I converted the video from the disc to a digital file. There's a million ways to do it, but HandBrake is the most reliable software I've found for every video format. I put those movies onto an external hard drive, then sync that drive to my iTunes library. It sounds completely outdated, but it's the only way to always have what I want to watch. If I'm going to L.A., I sit down the night before I fly, connect my iPad mini, and plan my next day's entertainment.

 Gary Dell'Abate has been the executive producer of *The Howard Stern Show* since 1984. He can be heard on Sirius XM.



### GARY'S HEADPHONES

I just started using these Bowers & Wilkins P5 wireless Bluetooth headphones (\$400). They're really high end, with detailed sound and strong bass. Even though they're not noise-canceling, I'm crazy about them. I always get an aisle seat on planes, which means that whenever someone in my row has to get up, I unplug the cord, gather everything, put the tray table up, then step aside to let them out. Now when someone has to get up, I pick everything up and keep the headphones on. All I have to do is stand.

## HOW TO FIX YOUR HOME WI-FI

Recently, a few designers and product heads from places like Apple, Microsoft, and Nest created **Eero**, a router system that uses multiple units to repeat your Wi-Fi signal up stairs and around walls like a satellite relay. At \$500 for a three-pack, they're expensive. You could buy two \$100 routers to produce a similar effect, but you would need to actively drop the weaker network and rejoin the stronger one every time you walk your iPad between rooms. Eero routers, besides being pretty enough to almost blend in with a countertop, automatically connect you to the strongest signal. We had two of them running in less than a minute, with immediate results: An aging iMac in a brick-walled home office loaded web pages like it was on a 56K modem. With the Eeros, the iMac got a strong enough signal to play Hulu clips instantly. Even better, the iPad got the same benefit without adjusting the connection, or drilling holes for more cables. —Alexander George



PROMOTION

# POPULAR MECHANICS WORKSHOP

A COLLECTION OF PRODUCTS & OFFERS FROM OUR PARTNERS



## YARDBIRD SOUTHERN TABLE & BAR

We proudly present Yardbird, a house of worship to farm-fresh ingredients, classic Southern cooking, culture and hospitality. We're serving up the most inventive takes on regional Southern fare seven days a week with a foot-stompin', soul-healin' brunch on the weekends.

Call (702) 297-6541 or visit [www.RunChickenRun.com](http://www.RunChickenRun.com) for more information.



# Safety you can see

Philips upgrade headlights show you what's ahead sooner. More time to react increases driver safety. With a clear view of the road ahead, that's safety you can see.

innovation + you



Vision, VisionPlus, CrystalVision ultra and X-tremeVision upgrade headlights

**PHILIPS**

# drive HD™ Dual Camera Dash Cam

Simultaneously record front and rear facing video for ultimate protection and peace of mind. Full featured, easy to use, and records beautiful HD footage.

**FULL HD 1080P** Full HD Video – 1080P Front / 720P Rear

**2x** Simultaneous Front & Rear Recording

**Loop Recording**

**G-Sensor Accident Protection**



CDR 895D

**Cobra**

[www.cobra.com](http://www.cobra.com)

800-852-6258 Dept: PMECH



Protect. Re-live. Share.

# SHOP NOTES

EASY WAYS TO DO HARD THINGS

KNOW-HOW

## Pen Spring Prevents Fraying Cords

Phone chargers and headphones are notorious for fraying near the ends, which are constantly wrapped up and yanked around. Protect them with the spring from a spent retractable pen. After removing it from the pen, slightly stretch out the tightly coiled ends of the spring. Then wind it onto the cable, taking care not to puncture the cable (or your finger).

## Use a C-Clamp as a Hammer Holster

If you're hammering from a ladder, fix a C-clamp on a vertical member and you can use it to hang the hammer.



## A Knot to Know: The Midshipman's Hitch

When you're out camping this summer, you may need to guy your tent or hang a bear bag. You'll need a sturdy knot to fix the rope to a stake or rock, one that can be easily tightened and won't slip. That kind of knot is a hitch. Scouts learn the taut-line hitch. The midshipman's hitch is a variation with superior slip resistance.



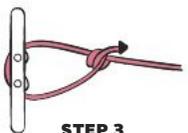
### STEP 1

Pull the rope around the anchor, then wrap the free end around the line that goes to the load (tent or bear bag), creating a loop.



### STEP 2

Wrap the end of the rope around the load line again, pulling through the loop and then toward the load.



### STEP 3

Tighten the two coils you've created around the load line.



### STEP 4

Wrap the free end of the rope around the load line one last time, this time outside the loop. Pull tight.



### STEP 5

To tighten a guy (or hang a bear bag higher), use one hand to pull the load end to get slack and the other to slide the knot up or down the rope. It moves easily but under a load will not slip.



## Use a Winter Sled in Peak Summer

A **PLASTIC SLED** is great fun for the kids for three months of the year, and dead weight in the garage for the rest of it. Unless you're reader Dean Toth of Brookfield, Wisconsin, who suggests a sled as a handy tool for moving yard debris or heavy equipment even without snow on the ground. A sled will slide easily over grass, sand, or gravel, and the plastic is highly durable. In fact, his favorite use is for a standard summer chore—getting camping gear from the car to the campsite.

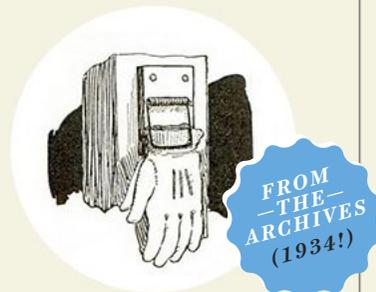


## BELT HANGS BARBECUE GEAR

*If you've got a tree next to the patio (or sturdy balusters on your deck railing), wrap an old belt around it, as tightly as possible (tighter than you'd prefer on your own trunk). Put S-hooks over the top of the belt. Now you can hang a barbecue brush, tongs, or even a skillet for easy access.*

## Remove a Stripped Screw With a Power Drill

If you strip a screw when it's already partway out of the surface, clamp onto it with the chuck of a power drill and slowly back it out. Set the speed low and the torque high to prevent slippage.



## Mousetrap Keeps Gloves Handy

Nail a spare, triggered wooden mousetrap to a stud in the garage, and you've got a perfect place to store work gloves—the spring-loaded hammer holds them in place.

PROMOTION

POPULAR MECHANICS  
**WORK/SHOP**  
 A COLLECTION OF PRODUCTS & OFFERS FROM OUR PARTNERS



**SOMETIMES IT DOES TAKE  
 A ROCKET SCIENTIST**

The only sunglass technology certified by the Space Foundation for UV and blue-light eye protection. Eagle Eyes® Navigator™ Black Sunglasses \$49 + S&P PLUS receive the Navigator™ Gold absolutely FREE! — 2 pairs for the price of one!

Call (800) 333-2045 with offer code EEN445-03 or visit [www.stauer.com](http://www.stauer.com) for more information.



**FREE  
 Stud  
 Earrings  
 With Ring  
 Purchase**

**ADD SOME WOW TO YOUR VOWS**

These exotic beauties possess a radiant rainbow of color arranged in a sterling silver setting finished in lustrous gold...a beautiful tribute to your lasting love. Five-Star Opal Anniversary Ring — \$99 + S&P

Call (800) 333-2045 with offer code OAR127-01 or visit [www.stauer.com](http://www.stauer.com) for more information.

Quieter.\* Smarter.  
**Beats Honda.**



**iQ2000**  
 PORTABLE INVERTER GENERATOR

**FACTORY  
 DIRECT  
 PRICING** **\$799<sup>00</sup>**

**FREE Shipping & Handling†**  
 a \$59 VALUE

**Call or Go Online Today!**  
[www.PowerAnywhere.com/popular](http://www.PowerAnywhere.com/popular)  
**800-914-5715**

**Ask About Special Financing!**

**GENERAC®**

\*Based on independent lab tests using ISO 9614 to measure sound power levels vs. Honda EU2000i. †Customer pays return shipping.

# THE POPULAR MECHANICS BOTTLE OPENER *BY BEN AROH*

Stained and sealed bourbon barrel staves catch your bottle caps before they can hit the ground!

Handmade by craftsman Ben Aroh in an exclusive partnership with Popular Mechanics.

GET YOURS WHILE THEY LAST  
AT [AROH-CO.COM](http://AROH-CO.COM)!



**LIMITED  
EDITION!**

Getting  
Started  
In...

# CURING MEAT

The most counterintuitive way of preparing meat can also be the most delicious.

BY KEVIN DUPZYK AND CAMERON JOHNSON



Curing your own meat involves seasoning, table salt, curing salt, and a whole lot of patience. The time between buying a cut of meat from the butcher to actually serving it at the table can be months. Or even years. That's when the meat breaks down, unlocking flavor you could never cook into it. If you're concerned about the wisdom of holding on to a slab of pork for two months before eating it, that's good. You should be.

But science will keep you safe. The salt and cure mix draw moisture out of the meat, and without moisture, bacteria and pathogens cannot germinate, and the meat doesn't spoil.

You just have to do it right.

*With thanks to Elias Castro of Olympia Provisions in Portland, Oregon, and Justin Severino of Cure and Morcilla in Pittsburgh.*

KNOW-HOW

KNOW-HOW

1

# Gather Your Supplies



**MEAT**

If you have a recipe, it will tell you what cut of meat to use. Most of the time that cut will be pork shoulder, also called pork butt or Boston butt. Relatively inexpensive and with around a 30 percent fat composition, pork butt is perfect for sausage. For meats that require a different proportion of fat, you can also buy a leaner cut and a separate slab of fatback, then grind them together.



**CURING SALT**

A mixture of table salt and sodium nitrite. It adds flavor and color and prevents meat from going bad. There are two options: Insta Cure No. 1 or Insta Cure No. 2. (See below.)



**SAUSAGE GRINDER**

Any meat that's going to become sausage has to be ground before it'll go in casing. For most hobbyists, a hand-cranked grinder will work just fine. The LEM Products No. 10 clamps to your counter and costs under \$100. Or if you already have a stand mixer you can buy a grinder attachment for even less.



**CASINGS**

Sections of the inner lining of animal intestines hold sausages together. (Synthetic options are more durable, but they have a substantial effect on taste. Skip them.) Pick based on the size of your final product. The standard is 32- to 35-mm hog casings. You'll also find 19- to 21-mm sheep casings, and 40- to 43-mm cow casings, which tend to be too big and complicated for beginners.

HOW IT WORKS

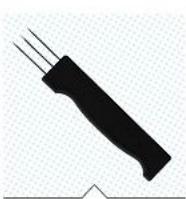
**INSTA CURE**

Nitrite (NO<sub>2</sub>) draws the water out of meat, preventing bacteria such as *Clostridium botulinum* (which causes botulism) and other pathogens from germinating. Insta Cure No. 1 is a mixture of salt and sodium nitrite (NaNO<sub>2</sub>) and should be used for short-duration cures that sit for a couple of days to a couple of weeks, like capicola or mortadella. After that the nitrite becomes inert, and the curing process halts. For longer-curing meats such as chorizo or prosciutto, Insta Cure No. 2 adds sodium nitrate (NaNO<sub>3</sub>). After the initial nitrite stops working, the nitrate molecules (NO<sub>3</sub>) give up oxygen atoms and turn into additional nitrite to finish the job.



**SAUSAGE STUFFER**

A large container with a plunger operated by hand crank. Turn the crank to extrude the meat into the casing. Some grinders come with a sausage-stuffing attachment, but a stand-alone stuffer will be more efficient and hygienic.



**SAUSAGE PRICKER**

Use these sharp tines to puncture any air bubbles you see in your links.

**TIP!** Don't freeze natural casings—it ruins their integrity. Keep them in their brine, or, if you've rinsed some and then realized you don't need them all, cover them in salt and refrigerate in a sealed container, where they will last for a full year.

2

# Make Some Sausage

Before you cure anything, you should learn to make sausage. It's delicious and doesn't involve any waiting. Plus, many of the best cured meats, such as kielbasa and salami, start off as sausages.



**1.** Cut meat and fat into 1½ inch chunks and feed into the grinder with a handful of crushed ice. Add the spice mix from your recipe and mix thoroughly. You're ready to stuff.



**2.** Rinse the brine off the casings and soak them in warm water for at least an hour. Wet the table and the horn of the stuffer to deter tearing.



**3.** Tie off the casing and thread it onto the horn until only a few inches are free. If there are air pockets, lightly prick the tube with your sausage pricker.



**4.** Put your mixture in the stuffer's hopper. Work the hopper with one hand while using the other to control the rate at which meat fills the casing.



**5.** When all your meat is packed, cut and tie off the casing.



**6.** One hand's length from the end, pinch and twist a few times to form a link. Repeat, twisting in the opposite direction. Continue until the entire sausage is in links.

## SAFETY

Without proper sanitization, preparation, and storage, illnesses like botulism can flourish—at which point the number of people interested in trying your home-cured salami will drastically diminish. A few tips:

- ➔ Always keep raw meat below 44 degrees Fahrenheit unless you're about to cook it or start fermenting.
- ➔ Put all equipment (grinder blades, cutting board, bowl, etc.) in the freezer half an hour before you start. When grinding, process a small amount of meat at a time, and grind into a bowl nestled in a larger bowl filled with ice.
- ➔ Sterilize your workstation, equipment, hands, and anything else that may come in contact with meat.
- ➔ Use the right amount of cure mix—table salt and curing salt. The amount is based on a percentage of the weight of the meat you're using.
  - Steamed sausage (e.g., bratwurst): 1.5 percent table salt, no curing salt
  - Cooked meat that is consumed cold (e.g., ham): 2.7 percent table salt, 0.2 percent curing salt
  - Dry cured meat: 2.5 to 4 percent table salt (depending on size), 0.5 percent curing salt
  - Salami: 2.6 percent table salt, 0.2 percent curing salt
- ➔ During the first stage, keep your meat refrigerated at 33 to 35 degrees.

Techniques requiring more time and precision to get right are riskier to get wrong.



The Starter Recipe  
**FLAT PANCETTA**

This recipe, from the *Olympia Provisions* cookbook, gives you the option of cooking the meat like bacon after curing or, if you have a dry box, letting it dry, slicing it thin, and really impressing your friends.



## Cure the Meat

Whether it's sausage or a slab of pork belly, there are three common methods of curing meat: drying, fermenting, and smoking.

### SMOKING

The easiest of the curing methods, smoking can be done on a standard kettle grill. Here's how:

- Presoak your choice of wood chips in water for an hour.
- Set charcoal on one side of the grill. When the flame has burned off, add the wood chips.
- Put the meat on the side opposite the coals, close the lid, and open the vents above the meat side of the grill.
- Smoke the meat to an internal temperature of 110 degrees, then put it in an oven set to 300 degrees, slowly bringing the internal temperature of the meat to 155 degrees.

### DRYING

Dry boxes provide a temperature- and humidity-controlled environment for your meat. You can buy one for around \$1,500, or you make your own out of an empty refrigerator, an automatic thermostat, a fan, a humidifier, and a dehumidifier. The dry box keeps the meat at 58 degrees and 83 percent humidity. Your recipe will tell you how long to dry the meat, but as a general rule, meat is ready to eat when it weighs less than half of its initial raw weight.



If you see unwanted mold on your salami, wipe it away with vinegar. Its high acidity will lower the pH level, killing the mold and preventing its spread. Vinegar is also a great natural way to keep your dry box sanitized during the curing process. Wipe down the walls of your dry box with a vinegar-soaked cloth twice per week.

### FERMENTING

Tangy sausages like salami are made by adding acid-producing bacteria (available at meat hobbyist sites such as butcher-packer.com). The meat ferments in a climate-controlled chamber—like that dry box you just built, but set to 73 degrees and a humidity level of 95 percent. You'll need MicroFine pH paper (also available at butcher-packer.com) to periodically test the pH of the meat and determine if enough lactic acid is present to make it safe.

### INGREDIENTS

- 1 **tblsp** ..... crushed black pepper
- 1½ **tsp** ..... crushed juniper berries
- ½ **tsp** ..... freshly grated nutmeg
- 2 **tsp** ..... chopped garlic
- 2 ..... bay leaves
- 5 ..... sprigs thyme
- 3 **tblsp** ..... fine sea salt
- 1½ **tblsp** ..... brown sugar
- 1½ **tsp** ..... Insta Cure No. 2
- 4 **lb** ..... pork belly, skin-on

### STEPS

- 1 Combine spices, salt, sugar, and Insta Cure No. 2. Sprinkle a generous coating of this mix on the bottom of an airtight container. Lay the pork belly on top, then cover with the rest of the mix. Seal the container and refrigerate for one week.
- 2 Take the container out of the fridge, flip over the pork belly, then reseal and refrigerate for an additional week.
- 3 Open the container, remove the meat, and swish around the liquids and salt. Put the meat back in, then everything goes in the fridge, uncovered, for four more days.
- 4 You're done—if you want to be. You can cook it now: Rinse the meat off, slice it thin, and fry it up. Perfect as a pizza topping. Or continue to step 5.
- 5 Thoroughly rinse the pancetta, then hang it in a dry box for 35 days. Then slice it up and serve.

# The Day My Saw Saved Me

One Friday, after a pleasant workweek doing remodeling and repairs at a boatyard, I drove my truck, a 2005 Nissan Frontier King Cab, to meet up with friends, light a bonfire, have a few beers, and make plans for the weekend. We were standing around the fire talking when the sky began to blacken—quickly. The temperature dropped 15 or 20 degrees within a few minutes, and thunder rolled in the distance. Next thing we knew, the storm was on top of us, and we ran toward our vehicles. The wind was raging and three-quarter-inch hail began to fall, so I jumped in my truck, which was semi-protected by trees on both sides. One of those trees was a big cottonwood 50 feet high. From inside the cab I watched rain pour down the windshield.

Suddenly, I heard a crack like a pistol shot, followed by a loud thump. The truck rocked violently. The windshield was still intact, but there was a sharp broken branch pointing directly at it, six inches away. What little light remained in the sky was blocked by the thick tangle of branches and big, wet green leaves, and the truck was dark inside. My power windows had been acting up, so the one on the driver's side was down a little, and hail was bouncing in.

I always have a heavy-duty Werner extension ladder racked above the cab and bed of the truck. Only a carpenter would think this way, but the first thing that crossed my mind was whether that ladder was okay. Then I had to think about how to get out. I tried to shove the driver-side door open. No dice. And because the tree had fallen from the passenger side, the brush was even heavier and thicker there. I rolled the driver-side window the rest of the way down, but the branches were too thick for me to climb through. That's when I remembered the Stanley SharpTooth 15-inch saw that I always keep in the backseat.

I grabbed it. The SharpTooth went right



**What Makes the Stanley SharpTooth the Essential Saw**



- Thick and strong
- Fewer teeth per inch means fewer strokes
- Cuts in both directions, reducing fatigue
- Composite-coated to limit friction

through the first small branch—and then the others, one after another, as the cab filled with the bitter yet pleasant smell of cut wet hardwood. When I got to the four-inch-diameter branch that bent over the cab, it twisted and jammed the saw as I cut. My arm was so tired it felt like it was going to fall off. Just then my friend Kelly came running up. I unjammed the saw by taking the weight off the branch that had bound around it. Kelly made what progress she could, then I took another turn. Reaching out of the cab to saw at odd angles really wears

out your muscles, but fortunately I have construction tendons. They kick in when the muscles go, kind of like a backup system.

After a few rounds, the branch finally fell free, and there was just enough room to open the door and climb out.

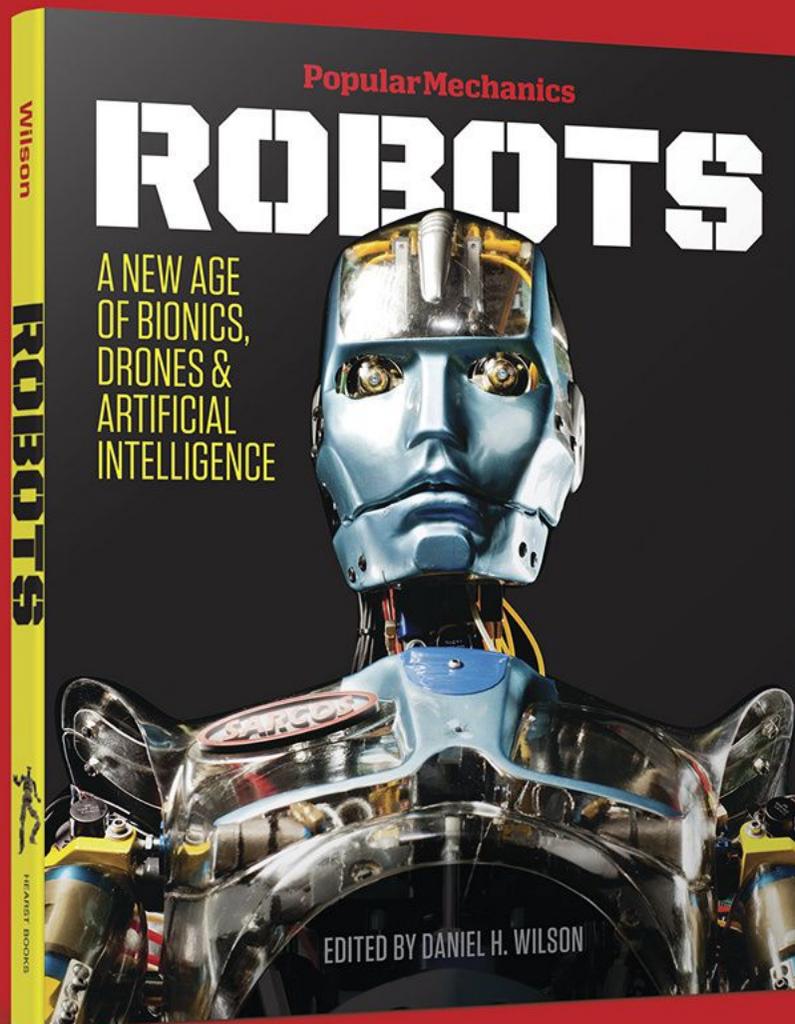
The rain had let up, and my friends gathered around the truck to help cut away the limb. The entire top of the tree had blown off. The ladder took most of the impact, likely saving my life by preventing the tree from coming through the windshield. There were dents on the roof, the hood, and the top of the door, and even marks on the fender—\$2,300 of damage in all—but the truck was drivable, and I was alive.

—Submitted by reader Tom Birnbaum



Have a tool story of your own? Share it with us at [editor@popularmechanics.com](mailto:editor@popularmechanics.com).

# THE ROBOT REVOLUTION IS HERE.



**B**

rave new world . . . or source of fear? Ever since robots first appeared in science fiction, they've inspired fascination, dread, and wonder. *Popular Mechanics* tells the true story, examining the way we live with these sophisticated machines today—in our cities, skies, military, medicine, and in space.

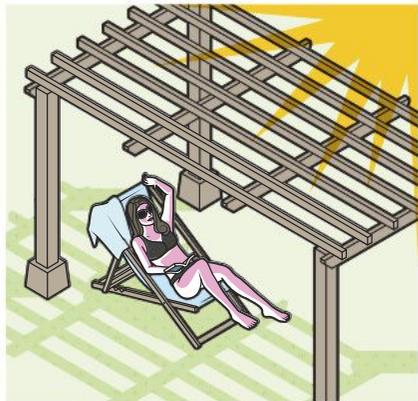
Available wherever books are sold. **HEARST BOOKS**

# ASK ROY

POPULAR MECHANICS' SENIOR HOME EDITOR SOLVES YOUR MOST PRESSING PROBLEMS.  
BY ROY BERENDSOHN



KNOW-HOW



**Q** If we want to increase the shade over our pergola, is lattice our best option?

LUELLA B., ATLANTA

**A** Lattice works, but it does have some drawbacks. First, it will catch seeds, pods, and leaves. Second, it's bulky and difficult to remove and store should you want more sun and less shade during cooler times of the year. If you are going to use it, go with a vinyl product and secure it with latches, even if each latch is nothing more than a block of wood with a single screw through the center. That way, you can easily take the lattice down for cleaning or removal. In northern climates, it also makes it easier to avoid snow and ice damage during the winter.

For me, though, a precut piece of sun fabric is a better alternative. You can buy it with varying degrees of sun-blocking performance. The higher its shade percentage number, the more sun it blocks. And because it's lightweight, you can put it up in the spring or summer and take it down in the fall, hose it clean, let it air out, and roll it up for winter storage. It's attached using a variety of clips, hooks, or a bungee ball—an elastic loop with its ends joined by a plastic ball. You feed the loop through the grommet in the edge of the fabric, around the attachment point on the pergola, and back to the ball. Just pass the ball through the loop to secure the bungee.

You can purchase shade fabric where nursery and growing supplies are sold and from online stores that specialize in shade and patio supplies.



**Q** We have a long ranch house and it takes forever to get warm water to the farthest bathroom. Is there anything we can do?

DENNIS R., LINCOLN, NEBRASKA

**A** You need a hot-water recirculation system. Instead of water moving in only one direction, from the water heater to the bathroom, it also moves cooled water from the bathroom to the water heater, making room for new hot water to take its place. A recirculation valve is installed under the bathroom sink and a circulator with a timer is installed at the water heater. The timer kicks the circulator on, and it pushes hot water up to the fixture. The recirculation valve under the sink opens and the warm water flows into the cold-water line and, eventually, back to the water heater. Of course, this occasionally results in some lukewarm water in the cold-water line, but it's better than freezing your hands.

The most robust versions of this system that I've seen are the ones made by Taco. The company's Hot-Link setup even has an easy-to-clean, removable O-ring-sealed cover on the crossover valve under the sink. You could also install a tankless hot-water system with a dedicated recirculation line. Rinnai makes a small wall-mounted instantaneous gas water heater that supplies hot water on demand. The water can be recirculated one of three ways: periodically throughout the day, timed to align with events such as morning showers, or whenever the hot water falls below a given temperature.



**Q** I made some cuts in plywood with a plywood-cutting blade in my circular saw, but the cuts aren't as smooth as I'd like. What did I do wrong?

ANDREW G., EUGENE, OREGON

**A** A circular saw is versatile and effective, and there's no reason you can't make flawless cuts with it. But you do have to be using it properly. There are five essentials to making a smooth cut:

- 1 If a test cut reveals that you're not getting a smooth edge with a plywood blade, check out some of the new specialized blades. Freud's 60-tooth Hi-ATB blade (\$55) delivers pro-quality results with a narrow cutting channel. You can also get its full-width standard ATB blade for \$20.
- 2 Don't push the saw too aggressively into the work.
- 3 Put the so-called good side facedown—this is the side that you want to remain visible when the project is built. Since a circular-saw blade spins upward, the side that the blade enters will have a smoother cut edge than the side it exits. For table saws, the opposite is true. The good side faces up.
- 4 Guide the saw using a straightedge clamped or screwed in place, or use an after-market accessory like the Kreg Rip-Cut.
- 5 Press a layer of masking tape on the cut line to reduce splintering as the blade exits the wood.

Call 212-649-2828 and leave a message with your home or yard question. You could be featured on a new Popular Mechanics podcast. Questions can also be emailed to [askroy@popularmechanics.com](mailto:askroy@popularmechanics.com).

# BE DIRECT CUT OUT THE MIDDLEMAN

## Great pricing on **custom-welded** saw blades.

### Q201® Premium Band Saw Blades – 72"x½" (6'0"x½")

72" length for Shopsmith or similar models,  
hard edge, Hard Back Carbon

**only \$12.57ea**

### Q201® Band Saw Blades – 93½"x½" (7'9½"x½")

Hard Back Carbon, fits most 14" Delta Jet, etc.

**only \$15.11ea**

### Q201® Band Saw Blades – 105"x½" (8'9"x½")

Hard Back Carbon, fits most  
14" band saws with risers

**only \$16.38ea**

### Q201® Band Saw Blades – 80"x½" (6'8"x½")

Hard edge, flex back, Hard Back  
Carbon, for Sears Craftsman  
12-inch models

**only \$13.84ea**

### Q201® Custom Band Saw Blades

- Manufactured with precision ground tooth
- Computer controlled hardening
- Custom welded to any length
- Shipped in 24 hours

Ideal for the woodworking industry, our custom welded blades feature spring-tempered backs and precisely hardened teeth allowing for very accurate cuts.



## We also carry a **complete line of saws, blades, and fluids** for any and all projects.

- Sawblade.com is the largest online supplier of saws, blades and fluids in the industry
- You'll always find the best prices here on a full line of metal and wood blades for radial and band sawing operations from the most popular manufacturers
- Great pricing on a wide range of Evolution radial saws and Trajan band saws
- Delivered straight to your home or shop with same-day shipping
- Satisfaction guaranteed with hassle-free returns

800.754.6920

**SAWBLADE•COM**  
RUN LEAN



# GRIP THE MOMENT

Sasha DiGiulian @sashadigiulian  
Professional Rock Climber



**FALKEN**  
TIRES

ALL-NEW  
WILDPEAK M/T

Trusted by the pros to take on the harshest conditions, the tough WILDPEAK M/T is built to get you there and back whether you're on the pavement, mud, snow or rocks. The M/T features Falken's proprietary three-ply DURASPEC™ Sidewall Technology, developed to sustain the most punishing off-road conditions. For the mild thrill seeker to the extreme adventurer, the WILDPEAK M/T powers through it all.

# DRIVING

WITH EZRA DYER



## The Great American Tuner Shoot-out

TWO OUTRAGEOUS MUSCLE CARS, THE WIDEST DRAG STRIP IN THE COUNTRY, AND A NASCAR DRIVER.

**B**ack in the days of horsepower excess, by which we mean a couple years ago, fearsome Mustangs and Camaros prowled the streets packing outrageous supercharged V-8s. The Camaro ZL1 made 580 horsepower and had a differential that GM engineers nicknamed Gravedigger, because it looked like it belonged in a monster truck. Ford's Shelby GT500 Mustang was even more extreme, routing 662 horsepower through a solid rear axle. We'll remember 2014 as a great year for gratuitous burnouts.

Then the Mustang and Camaro got redesigned, losing their megaton-blast V-8s in the process. Ford embraced a new philosophy with the Shelby GT350, opting for high-revving road-course finesse over drag-strip supremacy. GM has a new ZL1 in the works, but you can't buy it yet. In other words, this is the opportune moment for aftermarket tuners to step in and fill the horsepower void.

Roush ("rowsh") Performance and Hennessey Performance Engineering are manufacturers in their own right. Roush was founded in 1995 and specializes in Fords. John Hennessey started his company in 1991 and while he will tune anything but a piano, his deep expertise

is in GM products. The engine in his record-breaking 270-mph Venom GT is based on a highly modified GM block. When you know how to extract 1,451 horsepower from a 7.0-liter V-8, amping up a 2016 Camaro is pretty straightforward.

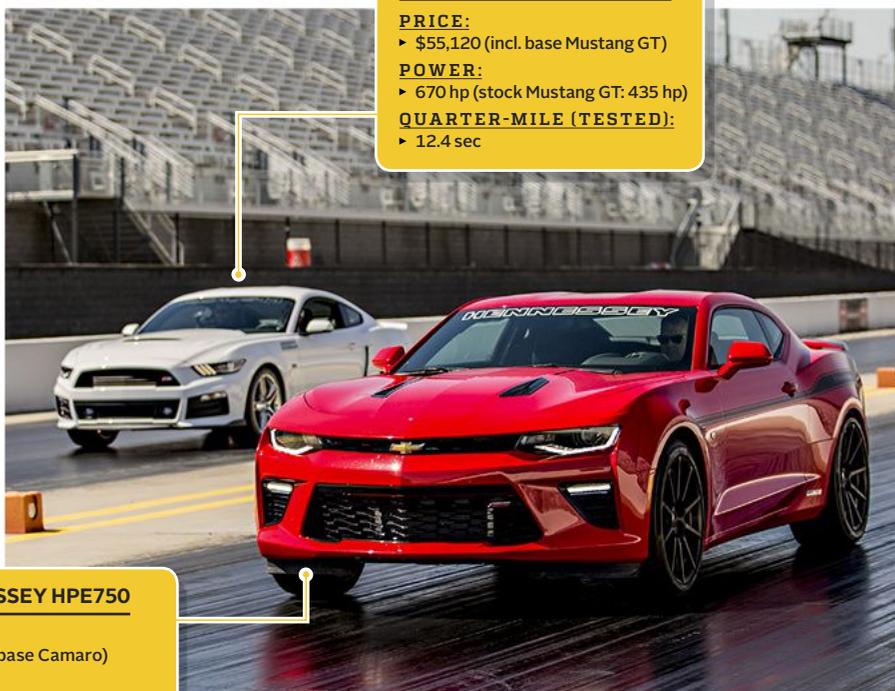
Thanks to these two companies, you can buy a turnkey 670-hp Mustang or a 750-hp Camaro for the price of a sensible German sedan. So we brought the Roush Stage 3 Mustang and Hennessey HPE750 Camaro to ZMax Dragway in North Carolina to experience what the latest factory Mustang and Camaro could be. To drive these beasts, we recruited Nascar driver Darrell "Bubba" Wallace Jr. and John Hennessey, who, besides having his name on the Camaro, is the kind of guy who owns his own drag strip.

The word *tuner* might conjure notions of a finicky, fragile machine, the kind of vehicle you steer with one hand while holding a laptop in the other, trying to find a boost map that doesn't send the connecting rods through the hood in a geyser of Valvoline. But despite their exotic-super-

car-level horsepower, both cars come with three-year, 36,000-mile warranties and are intended to serve as happy daily drivers should you wish to commute in a coupe with as much power as six or seven Nissan Versas. Hennessey didn't have time to ship the Camaro from his Texas headquarters, so he had one of his employees drive it 1,000 miles to Charlotte. That's confidence in your product.

These cars are on similar missions but they're not direct competitors. Hennessey's Camaro has a longer list of modifications and is more expensive. Roush's Mustang is more of a road-course car, with its three-way adjustable coil-over suspension. What they have in common is a wide performance advantage over their stock selves. Instead of challenging BMWs, these two can take on Lamborghinis, Ferraris, and Porsche 911 Turbos.

The Camaro snorts and grunts at idle, occasionally requiring a jab of the accelerator pedal to bring the revs above stall-out range. When



**2016 ROUSH STAGE 3 670R**

- PRICE:**  
 ▶ \$55,120 (incl. base Mustang GT)  
**POWER:**  
 ▶ 670 hp (stock Mustang GT: 435 hp)  
**QUARTER-MILE (TESTED):**  
 ▶ 12.4 sec

**2016 HENNESSEY HPE750**

- PRICE:**  
 ▶ \$70,785 (incl. base Camaro)  
**POWER:**  
 ▶ 751 hp (stock Camaro SS: 455 hp)  
**QUARTER-MILE (TESTED):**  
 ▶ 11.8 sec

someone lit a string of M-80s inside a tornado. When Hennessey guns the 6.2-liter V-8, your clothes tremble from the shock waves of furious internal combustion. As it launches down the strip, it looks like an invisible elephant is sitting on the trunk, the rear end squatting under massive weight transfer.

As it is, traction is the limiting factor. You need to get the Camaro into third gear before you can go full throttle without lighting up the tires. Still, Hennessey records a run during which he hits 131 mph in the quarter-mile. That trap speed, measured in the final 60 feet of the strip, is in Ferrari 488 GTB territory.

The Roush isn't on that pace, but it's still a rocket off the line. Like the Hennessey, boost comes from a 2.3-liter TVS supercharger, the same one you'll find in the Dodge Hellcat. The 5.0's forged internals are stock, but Roush installs beefier half-shafts, lest the supercharged V-8 turn the stock parts into metal Twizzlers. Wallace engages Ford's ingenious "line lock" feature, which clamps the front brakes, holding the car in place for

the active exhaust opens the muffler-bypass valve, it's like

a righteous burnout. Tires primed, the Mustang breaks into the 12-second range and hits 120 mph in the quarter. It's an impressive performance, more so when Wallace reveals that this is his first time on a drag strip. Despite the power upgrades, we find that the cars' inherent personalities are still present. On the track, the Camaro is definitely loud and bombastic, but on the street, the exhaust quiets down, the magnetic suspension softens up, and the prospect of a 1,000-mile road trip sounds reasonable. The Mustang retains its frictionless power delivery, but now it revs so quickly that you need to eyeball the tachometer to keep from constantly hitting the rev limiter. The Roush has about the same power as the old Shelby GT500, but this car is so much more multitalented and controllable than that overpowered apple cart. This is what a 2016 GT500 would be like, if it existed.

Sadly, it doesn't. Even Chevy's ZL1 will be at least 100 horsepower short of Hennessey's creation. But if you want Hellcat-level power from a factory Mustang or Camaro, it's there to be had. The factories just aren't Ford's or GM's.



**THE TRACTION PROBLEM SOLVED?**

► We're heading to lunch and discussing how much horsepower is too much. John Hennessey says, "Someone asked me how you control 1,000 horsepower. I said, 'With your right foot.'" Fair enough, but both the Camaro and Mustang can easily light up their rear tires on the street, and launches were tricky even on a perfectly prepped drag strip. Ford, though, might have a solution in the works. "The new GT350 has splined front hubs," he says. "So it's set up to accept driveshafts for the front wheels." That means the next GT350 might have wheelspin-eliminating all-wheel drive. Interesting move, Ford. Sometime in the next few years, launching a 670-hp Mustang won't be hard at all.

PROMOTION

POPULAR MECHANICS  
**WORKSHOP**

A COLLECTION OF PRODUCTS & OFFERS FROM OUR PARTNERS

**AMAZING NEW TINY & AFFORDABLE HEARING AID**



Fits like no hearing aid before it: nothing behind your ear and nothing in your ear canal. Patented shape uses the natural curves of the ear to fit comfortably, securely without unsightly tubing. Doctor-designed and FDA-registered at 80% less than custom hearing aids. RISK-FREE TRIAL, 100% money back guarantee, FREE batteries for a full year.

Call (800) 873-0698 with promo code CL55 or visit [www.MDHearingAid.com](http://www.MDHearingAid.com) for more information.



Limited to the first 1900 responders to this ad only!

## It's Enough to Make You Blue in the Face

Time to take a stand against overpriced watches with the Stauer Urban Blue. AND, get a **FREE pair of Flyboy Optics® Sunglasses** as our gift to you!

You need a new watch...the one you are wearing was made when Nixon was in office, but extravagantly-priced watches that add zeros just because of a high falootin' name are an insult to your logic. Why shell out big money so some foreign company can sponsor another yacht race? It's time to put an end to such madness. It's absolutely possible to have the highest quality, precision classic time-piece without the high and mighty price tag. Case in point: The Stauer *Urban Blue*.

**Packed with high-end watch performance and style, minus the high-end price tag.** It's everything a high-end watch should be: Sturdy stainless steel and genuine leather construction. Precision timing that's accurate to four seconds a day—that's more precise than a 27-jewel automatic watch priced at over \$6,000. And, good looking— with simple, clean lines and a striking metallic blue face.

*"Blue watches are one of the growing style trends seen in the watch world in the past few years"* —WATCHTIME®, Sept. 2015

**Your great escape from the overpriced watch craze.** At Stauer, we go directly to the source (cutting out the middleman), and engineer our own watch designs. So, while we're busy revolutionizing the watch industry to bring you more real value, you can take your own stand against overpriced watches with the *Urban Blue*. **We'll even throw in a pair of Flyboy Optics® Sunglasses (a \$99 value)** to show how much value you can still get for your dollar.

**Your satisfaction is 100% guaranteed.** Wear the *Urban Blue* for 60 days. If you're not convinced that you achieved excellence for less, send it back for a refund of the sale price. You can even keep the \$99 sunglasses, no hard feelings.

**Stauer Urban Blue Watch** ~~\$199†~~

Offer Code Price **\$49** + S&P **Save \$150**

**1-800-333-2045**

**Your Insider Offer Code: UBW148-01**

You must use this insider offer code to get our special price.

† Special price only for customers using the offer code versus the price on [Stauer.com](http://Stauer.com) without your offer code.

CLIENTS LOVE THE STAUER WATCH...



*"The quality of their watches is equal to many that can go for ten times the price or more."*

— Jeff from McKinney, TX



Rating of A+



**Stauer®** 14101 Southcross Drive W., Dept. UBW148-01  
Burnsville, Minnesota 55337 [www.stauer.com](http://www.stauer.com)

- Precision movement • Stainless steel caseback and crown • Cotswold™ mineral crystal
- Date window • Water resistant to 3 ATM • Genuine leather band fits wrists 6 3/4"–8 3/4"

@ThePMWorkshop

**REVIEWS**  
WITH EZRA DYER

Base price: \$35,835

Auditory accomplishment: The exhaust brake. Big-truck sounds, less wear on actual brakes.

2



Base price: \$56,225

First impressions from the landscaping guy: "Thing's the size of a monster truck."

3



1

Base price: \$24,200

Badass feature: Clutch Start Cancel, so manual models can start in gear with the clutch engaged. Handy when off-roading.



1

**2016 TOYOTA TACOMA**

➔ Toyota designers didn't change much when they made the new Tacoma. Well, why would they? Toyota was moving 150,000 of them a year using a ten-year-old design. So, yeah, the redesigned truck is pretty similar. If you've got an enchanted cash-dispensing ATM, you don't convert it to a Mountain Dew vending machine just because you're bored.

The biggest change is in the engine bay, where a smaller 3.5-liter V-6 makes 278 horsepower, 42 more than Ol' Chuggy, as the prior V-6 was affectionately known. Both the new V-6 and the 2.7-liter four-cylinder are available with manual transmissions, and a V-6 with the tow package can pull 6,800 pounds. If there's a downside to the new V-6, it's that the 265 lb-ft of torque peaks at 4,600 rpm, which is pretty high for a beast of burden. Translation: You're gonna be redlining it if you want to make haste.

The redesigned interior looks a lot more modern, like a tougher Camry, and there are certain details that speak to the Tacoma's occasional role as plaything. There's the built-in GoPro mount by the rearview mirror, and crawl control, a sort of off-road cruise control (and yet another button meant to replace driving skills). But overall, the new Tacoma is a solid compact pickup. Which is fortunate, because Toyota will probably still be selling it in 2026.

2

**2016 CHEVROLET COLORADO CREW CAB DIESEL**

➔ The woman at the drive-through coffee hut leans out the window. "They make this thing with a diesel?" she asks. "I was gonna get a Tacoma, but I might have to look at this." She then calls back over her shoulder to her co-barista, "Hey! They make that little Colorado with a diesel! And it's quiet!" Only then do we turn to the topic of caffeine.

I don't know what her frame of reference is for "quiet"—perhaps a UPS truck delivering cymbals—but the Colorado is indeed an interesting proposition. Worldwide, the word *pickup* conjures something small and diesel-powered. Here in the United States, however, the Colorado is in a class of one, two if you count its GMC twin. Its 2.8-liter four-cylinder gives up some horsepower compared with the base four-cylinder, but its 369 lb-ft of torque is downright V-8-like. The diesel Colorado tows a very legit 7,700 pounds, well into the realm of full-size trucks, and yet I managed to get around 32 mpg over a two-hour highway drive. That's a unique combination of thriftiness and muscle.

It's a palatable arrangement as long as you're not in a hurry. When I ran the Colorado down a quarter-mile drag strip, it hit just 77 mph. And yet this is still a fun truck. That four-cylinder diesel clatter makes you feel like a Costa Rican pineapple farmer every time you turn the key.

3

**2016 NISSAN TITAN XD SL 4X4**

➔ Truck buyers pay attention to numbers, hence the ever-escalating industry war for bragging rights over horsepower, payload, and size of ski boat you could tow up Mount Chimborazo. And numbers are not on the side of the new diesel Titan.

Nissan's concept is sound: Build a truck that's more capable than a standard pickup, but with a smoother ride than a Ford or Chevy heavy-duty. That explains the 5.0-liter Cummins V-8, which sits between the Ram 1500's 3.0-liter diesel and the heavy-duty 6.7-liter. But the problem—and this might sound ridiculous for a vehicle with 555 lb-ft of torque—is that the Titan XD needs more power.

The Titan's max tow rating (12,314 pounds) is only 114 pounds more than that of the cheaper, smaller Ford F-150. Its horsepower total (310) is equal to a Chevy Duramax diesel—from 2005. And its 7,400-pound weight is the same as a hulking 2016 Silverado 2500 diesel. When you combine the horsepower of an 11-year-old heavy-duty truck with the weight of a modern heavy-duty truck, you get the tow rating of a non-heavy-duty truck.

The fix is pretty simple: This rig needs to commit to its heavy-duty aspirations and find more power. Like the new nondiesel 5.6-liter Titan, which has 390 horses and a seven-speed transmission. Diesel has cachet, but in this case, gas makes more sense.

FIVE-WORD REVIEWS



**INFINITI QX50**  
Now longer, taller. Japanese Allroad.



**VW PASSAT 1.8T SE**  
Now safer, restyled. German Camry.



**VOLVO XC90 T8**  
Now plug-in. Swedish Range Rover.



## The ATV That Swims

WHY YOU'LL ALWAYS REMEMBER THE FIRST TIME YOU DRIVE INTO A POND.

**Y**ou've been told that the Argo LX floats, so you stay on course toward the water, fighting the instinct to grab the brakes. You eye the bilge-pump switch, just in case, then twist the motorcycle-style throttle and splash in. The jostle of the trail is replaced by the serene glide of buoyancy. The treads on the eight tires become paddles, churning like oars on a Viking galley. Congratulations: Your ATV is now a boat.

Argo's been building amphibians in Canada since 1967, catering primarily to commercial customers like power companies that need to access remote pipelines or municipalities that've experienced a natural disaster.

### OTHER NOTABLE AMPHIBIANS



**THE AMPHICAR**



**THE HUMDINGA**



**FROGS**

New Jersey ordered some after Hurricane Sandy. But there's also a brand of recreational outdoorsman—duck hunters and swamp-based survivalists, for instance—who prize a vehicle that can traverse otherwise impassable terrain. For them, Argo created the LX, which is spruced up with a few comforts unavailable on the commercial models. It's not exactly a Bentley of the bayou, but you do get a four-speaker stereo, a USB jack, and snazzier upholstery. The red anodized brush guard and 3,500-pound winch up front look pretty sweet, too.

Mechanically, Argo keeps it simple. There are no Transformer-like articulations to transition betwixt land and sea. There's no suspension except the cushion provided by the

ultra-low-pressure tires. There's no steerable axle: Directional changes are effected by the trusty skid-steer method—speeding up or braking either side's wheels, like a tank. It even has optional crawler treads, which can distribute its 1,400 pounds so evenly that you can drive over ground that's too soft to walk on.

In the water, the Argo's front end sits lower than the rear bumper—er, stern. That's by design. First, running nose-down puts each row of tires at a slightly different height in the water, which helps minimize cavitation (meaning, the third axle isn't spinning away uselessly in the frothy churn of the first and second sets of wheels). Second, the Argo can accept a 10-hp tiller-steer outboard motor on the back for faster movement through the drink. If you're sitting in the back and steering, the center of gravity moves closer to the middle of the vessel. Finally, the tail-high posture means that the rear end is already halfway out of the water when you need to execute a quick landward climb. If you're driving on ice and break through, that's how you get out—in reverse.

In boat mode, the Argo has a top speed of about 4 mph, which means you need to be mindful of currents and plan your exit before splashing in. On land, the 30-hp V-twin propels the 8x8 to 25 mph, which feels plenty fast for a skid-steer. You should also be careful with how hard you turn the handlebars. Ask for max turning at max speed and the LX will toss you like an irate bronco. But keep it moderate and you find that eight-wheel drive will deliver you anywhere you care to go.

It's a unique beast, the Argo. At \$27,295, it's priced against the most expensive recreational off-roaders. But what other machine can ferry 900 pounds across the Mississippi while cranking tunes and charging your phone? Your choice is this or a Kawasaki Mule towing an airboat.

Practicality aside, plunging into a body of water in a land vehicle is just ridiculous fun. It feels wrong. You're Keith Moon sending the Rolls-Royce into the swimming pool, except, in this case, there are actually two gratifying moments: first when you drive into the deep, and then when you climb out the other side, back on solid ground, morphing from boat to ATV like it's the most natural thing.



## The Tire Guide

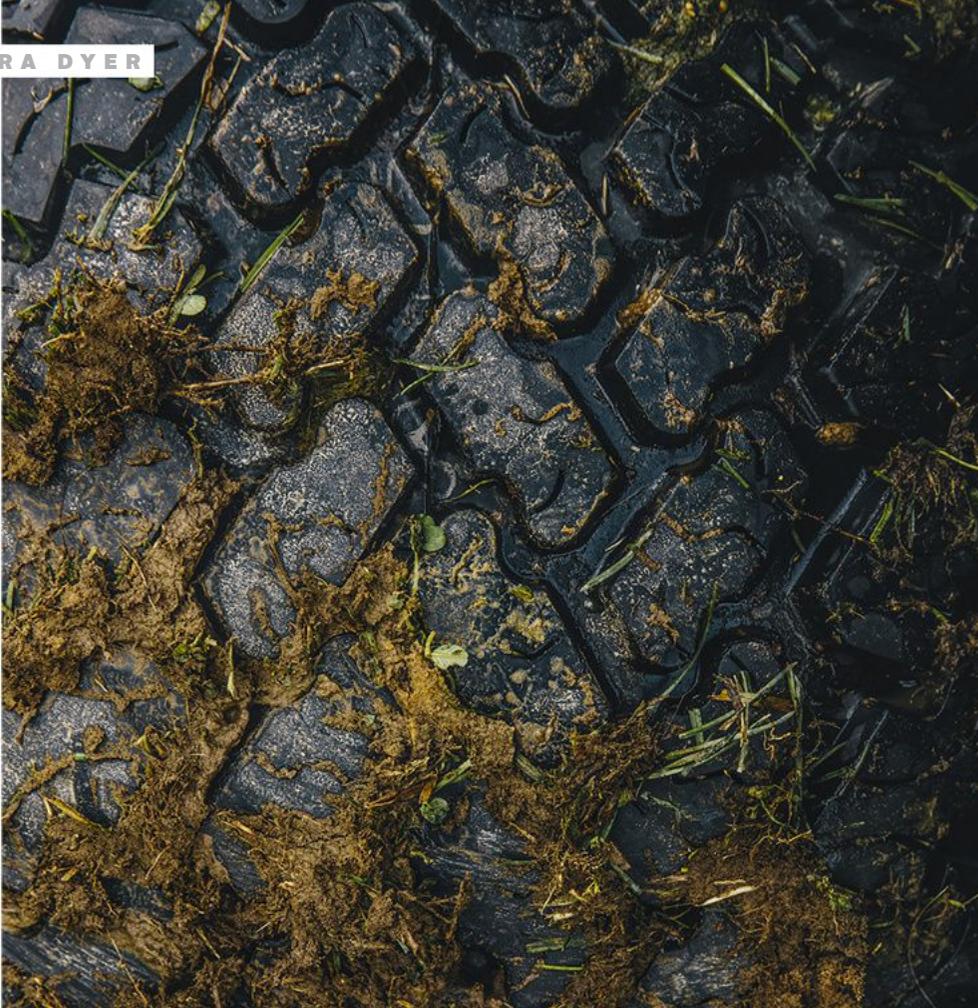
FIVE WAYS TO GET THE MOST FROM YOUR TIRES. NO MATTER WHAT YOU PUT THEM THROUGH.

### Get Winter Tires. Now.

● My winter tire true-believer story: a Boston blizzard in my rear-wheel-drive '98 BMW M3 fitted with Vredestein snow tires. Six inches of snow on the Mass Pike, cars stranded everywhere. It took three hours to drive ten miles, but I never came close to getting stuck. Winter rubber is formulated to stay pliant in temperatures that turn all-season tires into rocks. The treads, counterintuitive as it may sound, trap snow and use it to stick to the snow on the road for more grip. Expect to pay about \$100 per tire and \$100 per rim. If that price stings, consider that your non-winter tires will now last twice

#### ➔ Bonus Winter Tire Tip!

For your winter wheels, buy takeoffs—stock rims that owners sell when they get custom rims. Aftermarket manufacturers change styles so often that supply runs out, which means a headache when it comes time to replace them.



as long, not to mention the accidents avoided with a shorter stopping distance. Buy in summer, be ready in November.

### Buy Leftovers

● Last year, I bought a set of 2011 Pirelli Scorpions. They were new but discounted, because they were four years old. I asked the Tire Rack rep. “They have the same warranty as a tire that was manufactured last month,” he said, “but they might have less ultimate grip.” Ultimate grip is more of a priority on the track than on the street, so I got them.

### Rotate Yourself

● Most modern front- and all-wheel-drive cars have square tire setups in which all wheels are the same size and the tread isn't directional. Check the first of those three numbers on the tire's sidewalls to see if all are the same width. If so, use jack stands and move the tires at home, or ask to have it done while the car's on a lift at a service station. You'll even out the wear and they'll last longer. Works with mattresses, too.

### Check PSI

● Pay attention to the damn air pressure. Best-case result of neg-

ligence: lower miles per gallon. Worst case: Your soft tire heats up and blows out, like those Firestones on Ford Explorers. I have a compact Kobalt air compressor that plugs into the 12-volt outlet and automatically shuts off when it reaches the programmed pressure. Pick a number between the max and minimum psi figures written on the tire's sidewall. Tires heat up (and raise the psi) when you drive.

### Ignore Treadwear

● Ostensibly, this rating system shows how long a tire should last. Ignore it. Manufacturers invented the spec.

RANT



DEALER  
STICKERS

A friend just bought a 2016 Corvette Z06. Black on black, polished wheels, seven-speed manual—his dream car. He found it at a dealer five states away, agreed on a price, and drove out with a flatbed to pick it up. Deal done. When he arrived, the car was slightly different from the photos: It had a dealer decal on the bumper. “What is that?” he asked, gesturing to the cheesy plastered-on graffiti. “We thought you'd like it!” said the salesman. “Why would I want to drive around with someone else's name on my car?” he replied.

That's the issue, car dealers. We, the buyers, go through quite enough. We negotiate the price, we dance with the finance guy trying to sell us floor-mat insurance, we politely listen to pitches for service deals, accessories, and warranties. We go through all that to get the car that we want. And then you slap your sticker on it. I'm sorry, I don't remember selling the naming rights to this Chevy Traverse. Get that vinyl nonsense off my car.

If the dealer won't do it for you, do it yourself. I used Turtle Wax Label and Sticker Remover on my own car. When the last shred of that dealer logo comes off, that's the moment the car is truly yours.

# Affordable Hearing Aid Technology Only \$299!\*

(\*Each when you buy a pair)

Learn about our great digital technology at an affordable price.



- A) Microphone
- B) Volume Control Wheel
- C) Program Button
- D) Long Lasting Battery
- E) Digital Signal Processor
- F) Receiver (Speaker)
- G) Sound Tube

More Technical Information At:  
[www.AdvancedHearing.com/PM67](http://www.AdvancedHearing.com/PM67)

## The Revolutionary HCX!

- ▶ Digital sound processing chip provides crystal clear sound and makes speech easier to understand without feedback
- ▶ Multiple memory programs adapt to most listening situations
- ▶ Nearly invisible thin tube design
- ▶ Long lasting size 13 batteries and a low battery warning
- ▶ 10 bands of layered noise reduction helps to emphasize voices while balancing out background noise
- ▶ 100% Money Back Guarantee

## 5 Star Reviews! ★★★★★

**They Are Fantastic!** "I just received my HCX hearing aids and they are fantastic. Advanced Affordable is far superior and far more affordable!"  
 - Chuck D.

**Wonderful Company!** "I will definitely recommend your company to my patients." - Dr. Arun P.

## Hear Better With 2 Hearing Aids!

Your brain is designed to use both ears working together to fully understand what you hear. In fact, studies show that you may be able to hear up to 3 times better in noisy situations when using two hearing aids.

## Digital Hearing Aid Technology... For Only \$299!\*

All hearing aids work the same way. The **microphone** picks up the sound and sends an electrical signal to the digital signal processor. The **digital signal processor** is the "brains" of the hearing aid. It takes the sound it receives and adjusts the sound to amplify important speech sounds as well as filtering out unwanted noise. (To ensure the best in quality, our digital processor is designed and manufactured right here in the **United States.**) Once the processor has amplified the sound, it is passed to the **receiver** (also known as the speaker) which emits a corrected and amplified sound through the **sound tube** into your ear.



Most importantly, your new HCX hearing aids work at a **fraction of the cost** of name-brand hearing aids. In addition to the technical components of the hearing aid, you also have a **volume control** that can be modified with a light touch of the finger. Your new hearing aids come with **3 different audio programs** that help you listen in different sound environments. You will love the Open-fit design, that is so light you probably won't even feel that you are wearing your hearing aids – you'll just be hearing clearly!

You can spend thousands for a high-end hearing aid or you can spend just **\$329** for a hearing aid that just plain works (**only \$299 each when you buy a pair**). We are so sure you will love our product, that we offer a **100% Money Back Guarantee - Risk Free** if you are not satisfied for any reason. It's time to get great digital technology at an affordable price!

**BUY A PAIR AND SAVE \$60!**

**1-877-263-4771**

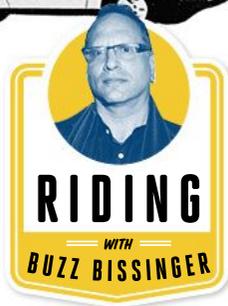
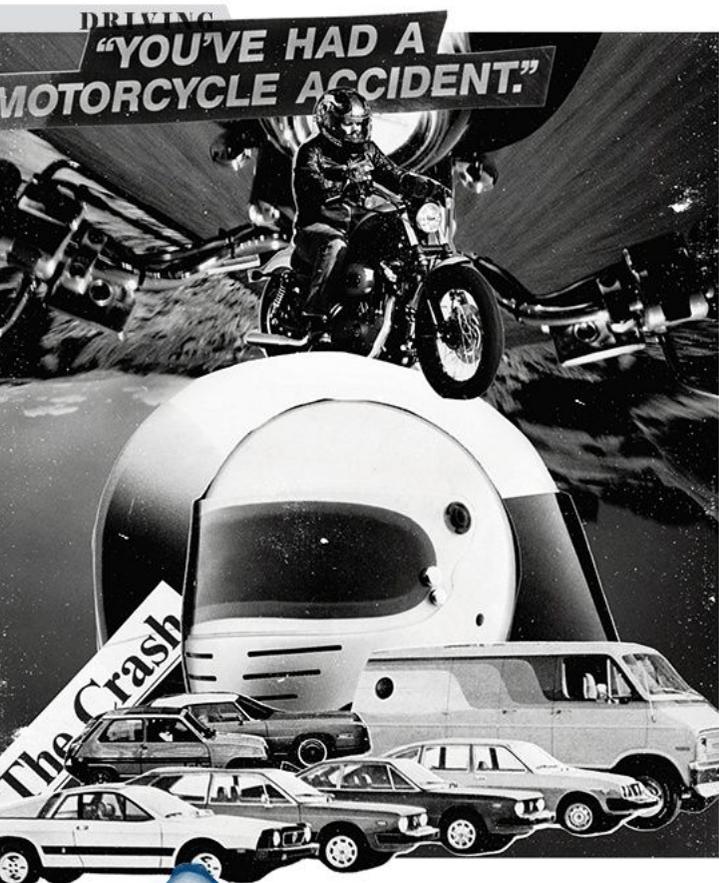
\*Free 1 Year Supply Of Batteries With Hearing Aid Order. Use Coupon Code: **PM67**  
 (Coupon Code & Price Valid For A Limited Time Only)



The HCX



Visit and Save: [www.AdvancedHearing.com/PM67](http://www.AdvancedHearing.com/PM67)



## My Very Bad Day

EVERY MOTORCYCLE RIDER WIPES OUT EVENTUALLY. BUT WHEN IT HAPPENS ON A BRAND-NEW BIKE, IT HURTS EVEN MORE.

Anytime I mention to someone that I ride a motorcycle, the first thing they do is tell me a story about a crash—some ghoulish tale filled with lip-smacking gore. Their implication is that riding a bike is about as safe as taking two sticks of dynamite with a glass of water to cure a hangover. And they're not entirely wrong.

According to the National Highway Traffic Safety Administration, 92,000 riders were injured in crashes in 2014 (the latest year for which data is available). And 4,586 riders were killed. Wearing a helmet helps, but it is no guarantee: 61 percent of those killed were wearing one. Bikers are about 26 times more likely to die in a crash compared with people in cars.

Of course, this danger is what attracts us to riding. It makes us different, daring. We ride with the wind while the rest of the world trudges behind in the morass of its own monotony. Yet make no mistake: If you ride a motorcycle, you will crash sooner or later. For me, it happened just a few months after I got my license—and on the very same summer day that I bought a shiny new Harley-Davidson Sportster 1200.

By the time the paperwork was done, it was close to five p.m. The dealership was in suburban Portland, Oregon. I had a two-and-a-half-hour ride home to southwestern Washington. I was giddy but I

was also tired. I should have had the bike shipped and gotten a lift.

I left the dealership into the snarl of Saturday shopping traffic—a chaos I had never ridden in before. I got nervous. Then I got lost. For a half-hour, I went the wrong direction. I veered onto an uphill highway ramp. The bike began to sputter. I was clearly in the wrong gear. I downshifted but released the clutch lever too quickly. The bike violently lurched and fell to the left. I went with it.

There is no worse sound than helmet hitting pavement. I can still hear it. I didn't lose consciousness, and by some miracle there were no cars behind me. I managed to get the bike upright and push it off the road. The left front directional had cracked off and the gear shifter was bent to hell. I felt foolish, mortified at the thought of having to call the dealer and say, "Oh, hey, it took me all of 30 minutes to total my brand-new Harley. How 'bout a tow?" But somehow the bike still worked. I took a minute to calm myself then turned around and headed the right way.

Soon it started getting dark. I had never ridden in the dark. There was also a soup of fog as the elevation increased into the coastal mountain range. It was hard to see. And on that stretch of road there were no gas stations.

The Sportster 1200 has a 2.1-gallon peanut tank. It gets 45 miles to the gallon, which would have been enough to get me to the Oregon town of Seaside and a gas station—had I not gotten lost earlier. I ran out of gas with 20 miles to go and wound up having to get towed anyway. I got home seven hours after leaving the dealership.

Still, I was lucky. Lucky not to have been hurt. Lucky not to have hurt anyone else. And lucky to have done something so stupid so early in my riding career. We are bikers. By the very act of riding we are supposed to be fearless. But with that attitude it is easy to confuse

**There is no worse sound than helmet hitting pavement.**

hubris with confidence, to think you are the king of the road when really you are a pawn.

That's what crashing teaches you. That and how you can't stay scared. I got back on the bike the next day, humbled and ashamed. And a much better rider.

Buzz Bissinger is a Pulitzer Prize-winning journalist and the author of *Friday Night Lights*.

### HOW TO CRASH CORRECTLY



1

#### LET GO

Resist the urge to save the bike or correct its course. If you hold on, you risk catching a limb between the machine and the asphalt.



2

#### GET FLAT

The goal is to slide, not roll. Hands up, feet first, back flat. This is why you bought that pricey leather jacket.



3

#### STOP FULLY

Shock (or embarrassment) can make you try standing too soon, leading to more tumbling (and embarrassment).



4

#### GET OFF THE ROAD

Limp, crawl, whatever. Sure, you might exacerbate an injury by moving, but if you stay in traffic, you're liable to be run over.

A scenic mountain road with a silver Airstream trailer and two motorcycles. The trailer is on the right, and two motorcycles are on the left. The background shows a vast mountain range under a blue sky. The text "WE GO WHERE YOU GO." is overlaid on the image.

**WE GO WHERE YOU GO.**

Going the distance to help you save. Now that's Progressive.

**PROGRESSIVE**<sup>®</sup>

1-800-PROGRESSIVE | [PROGRESSIVE.COM](https://www.progressive.com)

Progressive Casualty Ins. Co. & affiliates.



# 1984 Volkswagen Vanagon

## OWNERS:

Alice Cho and  
Christian Amundson

## LOCATION:

San Francisco,  
California

## YEARS OWNED:

Eight

**ALICE CHO:** When we moved from New York to San Francisco, our mechanic told us that we *should* make it. So we set off. Things came up, but every time we would go onto TheSamba, a VW forum site.

**CHRISTIAN AMUNDSON:** We'd do quick patches based on the advice we got, but by the time we got to Kansas, we were losing oil fast. We kept topping it off until we crossed into Wyoming—

**AC:** It was hemorrhaging oil.

**CA:** A waterfall of oil. We settled for a Volvo mechanic in Laramie and slept in the van outside the shop. He told us not to wander around since he had a guard dog. He wanted us to fly home and leave the van with him to rebuild the engine. We'd bent the push-rod and it came through the

casing, but we told him to just do a Band-Aid fix. We could go to California on three cylinders and rebuild there.

**AC:** We left Laramie on Friday at 5 p.m. I had work in San Francisco on Monday.

**CA:** We had to go through Donner Pass, one of the highest crossings in the Sierras. Twenty miles per hour uphill, hazard lights flashing. No speaking. Just teeth bared, tense, tense, tense.

**AC:** It was July and so hot. I had this electric fan plugged into the cigarette lighter, and a spray bottle of water. I would spritz Chris to keep him from roasting.

**CA:** Somehow, we climbed up without overheating. We got to the top and said, "Oh my God, we made it!" We stopped, hugged, then coasted down to

San Francisco. She made it to work, and we found a mechanic. He looked at us and said we had one cylinder operating at 80 percent, and one at 25. We didn't know it was that bad.

**AC:** Maybe when we're rich and have a family, when there's more on the line if you break down, we might get something more reliable.

**CA:** But it's fun solving these problems. They make good stories. We've had four people in there and spent nights in the pop-top. We fold out the tables and have a dinner party in this little living room. Those are things that you can only do in that van. It's special.

**AC:** And it was our first big purchase together.

**CA:** We got it before we were married. Now we're married and it's been our thing. I'm sure we put more than \$12,000 into it. We could've spent that on something more reliable, but it wouldn't have been as special.



# TOO SHINY?



It Just May Be Possible.



Reflect Your Passion™

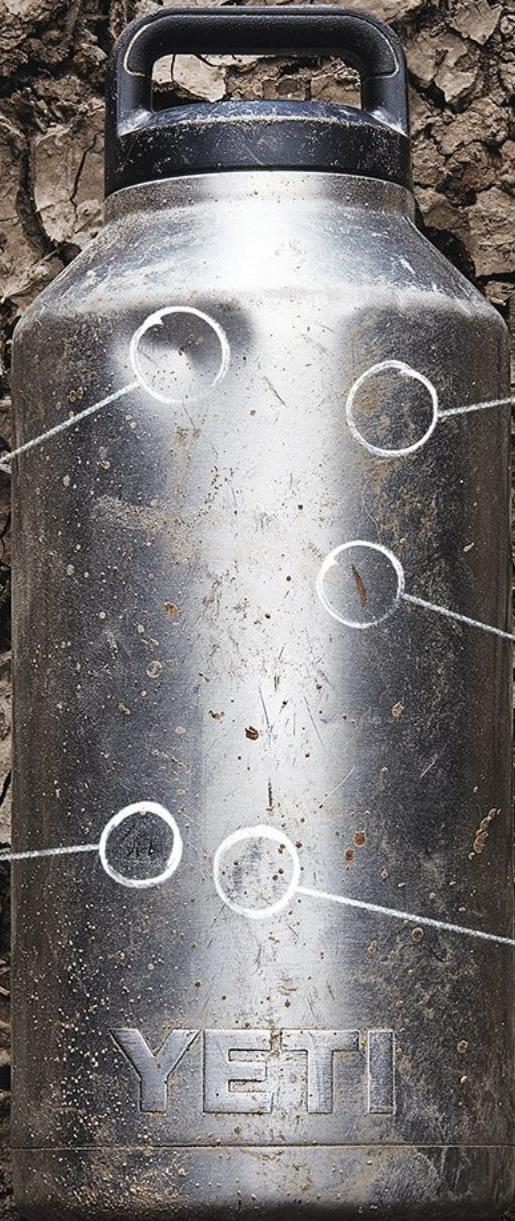
## ULTIMATE LIQUID & PASTE WAX

Can your car be "too shiny"? Meguiar's® Ultimate Wax's advanced synthetic polymer formula delivers incredible water beading protection, amplified reflections and so much gloss, it just might be too shiny...

(NOTE: No cacti were harmed during the filming of this advertisement)

For free personal car care advice go to [meguiars.com](http://meguiars.com) or call 800-347-5700





BY DEFINITION,  
WILD COWS AREN'T CAUGHT  
IN GREEN PASTURES.

MESSED WITH  
THE BULL.  
GOT THE HORNS.

HORSE DECIDED TO  
COME UNBROKEN.

STAMPEDE.  
NOT METAPHORICAL.

RODE OFF  
INTO THE SUNSET.  
AND A SAGUARO.

USED AND ABUSED BY:

*Travis Emerson* WILD COW CATCHER

LEAVE THIRST IN THE DUST WITH A YETI RAMBLER™ BOTTLE. BUILT WITH 18/8 STAINLESS STEEL, A TRIPLEHAUL™ CAP, AND VACUUM INSULATION, THIS OVER-ENGINEERED BEAST IS TOUGHER TO BREAK THAN A WILD MUSTANG.



The

# LIFE

## THE HUNGRY CYCLISTS

You've got to find a way to burn off steam in the hectic restaurant business. Luckily, bicycling works up an appetite.

Photographs by  
**CHRISTOPHER WRAY-MCCANN**



### THE KIT

On Cory Lane: Rapha jersey (\$170), Rapha bib shorts (\$235), Airnet helmet (\$150), Engine 11 hat (his own), Specialized Tarmac Expert bike (\$3,700) from Cynergy Cycles Santa Monica.



### THE HOME BASE

The Santa Monica house where Lane and Pappanicholas have set up an office/crash pad where they can keep their cycling gear is conveniently equidistant from their new restaurant in Culver City and the curving rides in the mountains of Malibu.

On Lane: Rapha trousers (\$170).



**T**

**THE DAY STARTS EARLY.** There's a lot to do, and Los Angeles traffic can be unforgiving, so Cory Lane and Christian Pappanicholas like to get up and going by seven if they want to fit a ride in. The two are partners in The Cannibal, a beer-centric bar and restaurant in New York City (another location is wrapping up construction in Culver City, California)

that has the soul of a butcher shop. They are also cyclists, and, as happens in a well-filled life, the line between the two roles can get blurry. Pappanicholas named The Cannibal after the nickname of legendary Belgian cyclist Eddy Merckx. The restaurant sponsors an amateur cycling team. And when Pappanicholas and Lane go riding, it's often with fellow chefs, cooks, and hospitality entrepreneurs, like Jeff Mahin, who helms ten restaurants and trains with a coach. Mahin's just coming back from an injury, actually. A kitchen knife fell and stuck him right in the foot, which got infected.

Pain—not knife-through-the-foot-pain, but the kind that comes from a twelve-hour shift—and the adrenaline of a chaotic kitchen can be addictive. For the restaurateurs, the burning slog up a mountainside or the precarious lean into a hairpin bend is as comparable a fix as they can find. It doesn't hurt that cycling is a lot healthier than the alternatives.

Sucking down iced coffee from a plastic take-out container, the guys gear up. They trek out to the mountains of Malibu, pausing to avoid barreling cars, take in views of the Pacific, or chat with fellow riders on the curving, sun-dappled roads.

After their heads are cleared by the morning ride, it's off to the new restaurant to negotiate with contractors, assess the lighting, and make sure the final details of the construction are up to code. Pappanicholas and Lane will have a beer and go over the plan for the next few days: who's going back to New York, what needs to be done in L.A., and when they'll get out for another ride. Because when you love something this much, you don't find the time, you make it.

—Matt Goulet



#### GEAR CHECK

Say you're going on a three-day, three-hundred-mile journey, like the owners of The Cannibal do as part of Chefs Cycle, a fundraising ride to fight childhood hunger in the U.S. Gear is important. Specialized's Tarmac Expert bike is constructed from a carbon frame, making it incredibly lightweight but still sturdy enough for a long slog.

#### THE UNIFORM

The guys of The Cannibal are so into the sport, the business sponsors an amateur cycling team, Rockstar Racing. The pink on the Castelli uniforms helps them stand out in crowded fields during races.





↓  
**THE RIDE**

La Tuna Canyon Road, off the Pacific Coast Highway, winds through the mountains of Malibu, with views of the Pacific and downtown L.A.





## THE UNWIND

Platform in Culver City is a new complex built on the site of two old car dealerships. Now it's home to retail, coffee shops, and the L.A. outpost of Pappanicholas and Lane's Cannibal Beer & Butcher. The two men have sweated the details for nearly three years on everything in the thirty-seven-hundred-square-foot space, including the fully exposed walk-in beer cooler, open kitchen, wood-framed ceiling, custom-built beer-regulating system, and meat-cutting room.

Above, on Lane: Apolis shirt (\$168). On Pappanicholas: Rapha shirt (\$140), Monterey hat (\$125). Opposite page, top, on Lane: Levi's Commuter jacket (\$178), Kit and Ace T-shirt (\$108), Apolis chinos (\$138), Filson watch (\$800). On Pappanicholas: Levi's trucker jacket (\$148), Rapha T-shirt (\$80), Mountain Hardwear pants (\$90). Bottom right, on Mahin: Black Sheep bib (\$160), Black Sheep uniform (\$290), Poc sunglasses (\$230).

EVERY  
CLICK  
IS \_





2016 OLYMPIC

TECHNOLOGY

SPECTACULAR!

**When Justin Gatlin faces Usain Bolt**

**in a rematch to become the fastest man in the world at this summer's Olympic games,**

**he'll have the science and engineering of**

**the United States' secret weapon in biomechanics**

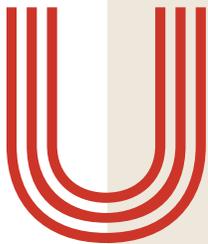
**optimizing each step he takes.**

**BY ADAM PIORE**

**PHOTOGRAPHS BY PETER BOHLER**

**PAGE 71**





Usain Bolt made the sign of the cross, pointed to the heavens, and kissed his skinny fingertips. Two lanes over stood Justin Gatlin, his thick shoulders filling out his bright-red team USA tank top, diamond studs in his ears. He was as somber and focused as Bolt was loose. The runners set their feet in their respective blocks and placed their fingers on the track, waiting for the gun.

Like Bolt, Gatlin had tasted Olympic glory before, having won gold at the 2004 games. But that was a lifetime ago—before a ruinous 2006 doping ban, before authorities annulled his world record and exiled him from the sport for four years, and before the 2008 Summer Olympics when Bolt burst onto the scene, running the 100-meter dash in an unthinkable 9.69 seconds, leaving the entire field behind him and erasing any thought of Gatlin.

It had been a long road back. Gatlin settled for the bronze in the 2012 London games as Bolt broke his own world record with a blistering 9.63. But the distance was closing. As Bolt and Gatlin crouched over that starting line at the 100-meter finals of the 2015 World Championships in Beijing, one announcer called the matchup a “world heavyweight title boxing match.” In the semifinals, Gatlin pulled off a performance so flawless many thought the 100-meter final was his to lose.

At the pop of the starting gun, Gatlin exploded off the blocks. Bolt had a slight edge in the straightaway. There were nine men in the race, but the two rivals surged ahead, hurtling toward the finish line, heads extended. They finished so close that when it was over you needed high-speed photography to have any chance of understanding what happened: Bolt won the race by ten milliseconds. One-tenth of an eyeblink. Four inches.

This August, at the Rio Olympics, will be the first time the two men race again. In the rarefied air world-class sprinters breathe, it takes about forty-six strides to get from the starting blocks to the finish line of the hundred meters. If Gatlin can knock just two ten-thousandths of a second off each stride—and Bolt hasn’t improved his pace—he’ll take the gold.

Those two ten-thousandths of a second are why Ralph



[Above: Four high-speed cameras record Gatlin's starts. Right: Mann and Gatlin study the footage \[click by click.\]\(#\)](#)

Mann, USA Track & Field biomechanist for sprints and hurdles, has set up a computer monitor and a laptop on a flimsy folding table next to the track in Orlando where Gatlin and his coach are practicing on a hazy spring Tuesday. From Mann’s table wires snake outward across the red rubberized track and connect to four high-speed Casio cameras capable of recording three hundred frames a second, fast enough to capture the individual beats of a hummingbird’s wings. The cameras are arrayed around Gatlin as he digs his heels in against a pair of force-sensing starting blocks. He places his fingers on the ground to set his stance and waits for his cue.

“Ready!” his coach yells. “Set... Go!”

At thirty-four, Gatlin is an old man in the sport. Yet he’s never been better. He launches himself off the blocks, his upper body virtually parallel to the ground, his arms a blur, his feet tapping the track like fingers drumming a tabletop. At the three-meter mark, Gatlin pulls up and ambles over to Mann’s table. Mann rewinds the video and superimposes a stick figure composed of lines in different fluorescent hues directly over Gatlin’s tattooed, muscular frame on the screens.

The positions of the stick figure represent Gatlin’s “ideal” body positions, a perfection of angles and form optimized at each point in time and space for efficiency of motion. If Gatlin can match each click of the figure’s movement, if sprinter and stick figure can run in lockstep on that screen, Gatlin won’t just put Bolt away, he’ll shatter world records.

Mann taps a button and Gatlin's start unfolds in slow motion. At this pace, the horizontal tilt of Gatlin's trunk is a marvel—low and level to the ground, he'd surely face-plant were it not for the power and impossible frequency with which he propels his feet into the track. After months of work, there's not much daylight left on Mann's screen between the stick figure avatar and the real thing. Offset clicks are rare.

"This is what you do better than anybody else," Mann says, pointing to Gatlin's outstretched form, his torso even lower than the target line. "Right there. You should travel with me a little while to see how tough it is to do that."

Suddenly, a single fluorescent line representing the ideal position of Gatlin's left leg inches ahead of his actual body on the screen. His back leg has stalled ever so slightly.

"That's one click behind the model," Mann says, freezing the video at the end. "One! That's beautiful. Holy Jesus. That's half a tenth of a second faster than anybody else on the planet. That's how good that start is."

Mann pauses just long enough to allow Gatlin to absorb the reality.

"You got one more start in you?"

If anyone can find a way to shave off the two ten-thousandths of a second that separates Gatlin from Bolt, Mann is the one to do it. For more than three decades, Mann has used technology to make people faster. He is a biomechanist. He built the statistics-based computer program he calls his "performance model" by filming hundreds of world-class sprinters competing at track and field events around the globe. Then he extracted a dizzying array of variables from each performance—everything from the lengths of each runner's feet, ankles, and forearms to the angles and precise location these body parts occupy in relationship to one another and the track at any given second of a race.

"Ralph gives me times that I need to hit for a certain part

of the race. He says, 'This time right here will put you at 9.7 to 9.6 pace,'" Gatlin says, "and he's always been correct. Each time when he comes before the season and I hit a certain time that he said 'This is where you'll be at,' that's where I'm at. So I put my trust in him."

Mann's obsession with the biomechanics of speed predates his interest in science. At sixty-seven, Mann is long and lean and moves with the grace and confidence of a natural athlete. He runs, bikes, lifts, and skis. Were it not for his snow-colored hair, he could pass for a much younger man.

The son of a former semipro baseball player who worked the docks of Long Beach, Mann was groomed early on for glory on the baseball diamond, and earned a scholarship from the University of Southern California. He turned it down for a track scholarship to Brigham Young University, where he specialized in intermediate hurdling.

"Damn near broke my dad's heart," Mann says.

Back then, Mann recalls, the knowledge of sprint mechanics was practically nonexistent.

"The understanding of what it took to be fast was totally unknown," he says. "We had no idea. You just ran."

Mann broke a U.S. hurdling record and claimed NCAA glory for the BYU track team. At the 1972 Munich Olympics, Mann roomed with Bruce Jenner and a crazy shot-putter named Brian Oldfield, who was known for psyching out opponents by smoking cigarettes between throws, and who later posed for *Playgirl*. In the 400-meter hurdles, Mann took home a silver medal, defeated by an inconsistent Ugandan who ran the race of his life.

After the games, Mann went on to pursue a doctorate in biomechanics at Washington State University, where he began building a mathematical depiction of speed, initially picking apart the biomechanics of the long jump. The model would serve as the basis for both his dissertation and the athletic consulting firm he opened after he realized, about eight years into an academic career, that standing on the edge of a track was more fun than standing at the front of a lecture hall.

His involvement with USA Track & Field dates back to the early 1980s, a time, Mann recalls, when "we were just getting killed by the East Germans and the Russians." Systemic doping was certainly part of the reason. But it was only one part of a larger effort.

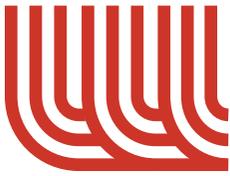
"They had a great biomechanics program," Mann says. "They set it up and they produced incredible athletes, and basically we did nothing. We sort of came out and said, 'Okay, run faster. Lift your legs, pump your arms,' and that wasn't working."

Mann volunteered to analyze sprinters and hurdlers and spent the next ten years refining his models, working off and on with the organization and leading track and field coaches. Then, six years ago, USA Track & Field hired Mann and his firm to provide regular analysis to all of the top U.S. sprinters and their coaches as part of a new sports science initiative.

That was 2010—a year, as it happened, when there were few people who had more reason to listen to Mann than Justin Gatlin. That year the elite sprinter finished his doping ban. When Gatlin came back from what Mann calls his "drug vacation," Mann recalls, "he was awful."

But it didn't stay that way for long. Gatlin set out to recapture Olympic gold—this time using science to help him.





When he was a kid growing up in Brooklyn, Justin Gatlin hurdled the fire hydrants lining the streets outside his home near Sheepshead Bay. By the time he was in high school, his family

had relocated to Pensacola, Florida, where Gatlin's acrobatics won him a full ride to the University of Tennessee as a 110-meter hurdler. Gatlin's coaches at Tennessee switched him to sprinting, and he flourished. In just two years, Gatlin won six consecutive NCAA titles, and in 2002, he turned pro. At twenty-two, in the 2004 Athens Olympics, Gatlin sprinted to a gold medal in the 100 meters, clocking a blazing 9.85 seconds. He was the fastest man in the world.

"It was surreal," he recalls. "It's just a whole different kind of feeling, coming across the line. A hundred thousand people in the stands watching you, crowd roaring, going crazy. It's the one moment where everyone in the world stops."

Two years later, Gatlin reached another high, when he equaled the world record of 9.77 in Qatar. Then it all came crashing down. That July, Gatlin revealed he had tested positive for performance-enhancing drugs. Testosterone. In the pantheon of doping excuses, he holds a world record for absurdity: He accused a vengeful massage therapist of sabotaging his career by surreptitiously applying an illegal cream. Not that anyone was really listening. Gatlin's coach at the time, Trevor Graham, soon had eight of his athletes ensnared in doping scandals. He would later receive a lifetime ban from the sport.

Gatlin's world record was erased. He served out his ban as Bolt ascended, and, at Gatlin's first race back in 2010, he was shaky off the blocks—"like a car that is starting really fast and fishtailing," according to his then coach. His time, 10.17, was a world away from Bolt. It seemed as if he was finished. But Mann had already begun evaluating the sprinter and had diagnosed his weaknesses. Gatlin was leading with his trunk, leaning too far forward. There were problems with the way he positioned his legs. His nervous system wasn't yet primed to produce explosive power. And there was an even bigger problem. Gatlin was fat.

"Weighing 210 pounds wasn't going to get the job done," Gatlin recalls Mann telling him.

In 2012, Gatlin signed with a new coach, Dennis Mitchell, a retired three-time former Olympian, and things began to turn around. His coach introduced a new structure and consistency into Gatlin's training regime, managing his diet and designing a new circuit-based weight-room routine. Gatlin dropped to 175 pounds. His body fat percentage fell from twenty-five to just six.

On the track, the coach set about fundamentally redesigning Gatlin's gait based on insights that came out of Mann's models.

Speed is simple, Mann likes to say. There are primarily two components: the number of strides a runner takes each second and the length of those strides. Each comes at the expense of the other, and a coach has to decide which to

emphasize. That's where Mann's performance model comes in. Its algorithms are calibrated to produce the maximally efficient ratio, based on body type and a whole host of other variables, including race length, the length of different limbs in relation to one another, and overall height and weight.

One of the clearest insights to emerge from Mann's models is one of the most important for Gatlin if he is to triumph over Bolt in Rio: It is far more effective to strike the ground with your foot out in front of your body—and focus on immediately getting that foot back up in the air—than it is to push off with a foot that is behind it. Both the angle of impact and the position of the different muscles in relation to the ground with the foot out front, Mann argues, generate as much as 20 percent more force. That extra force is essential for achieving the ideal tradeoff between foot touches and stride length. If you want to maximize foot touches, you have to get off the ground quickly, and the only way to get off the ground quickly, while maximizing force, is by hitting the track with your foot in front of you, Mann says.

Mitchell had embraced this reasoning by the time he started working with Gatlin, and he quickly recognized they had a problem.

"He was a very powerful runner, so his stride was very elongated and powerful," Mitchell says. "We took at least two years to try to shorten that up. He was a push-off guy, and I changed him to a strike guy. We changed his technique up totally."

Mann's models suggested that Gatlin's start needed major modification. Rather than catapult forward off the blocks with long strides, Mann's models suggest that it is as much as 30 percent more efficient to take smaller steps that

sacrifice raw power for quantity. The model shows that it maximizes opportunities to push off the ground, which are essential for initial acceleration. But Gatlin's tendency was to explode out of the blocks with long strides, wasting valuable time in the air.

"Justin was a good, powerful runner, he had run fast," Mitchell recalls. But he added that Justin's start was still technically flawed.

Mitchell designed a program aimed at creating new muscle memory in Gatlin. He'd practice his start and his strides

tethered to bungee cords or sleds weighted down with fifty pounds. The resistance slowed the motion of the start, allowing Gatlin to exert the same explosive force while making it possible for Mitchell to tweak Gatlin's biomechanics and for Gatlin to connect the new concepts of the mind to the feelings in his body.

Over the last two years, Gatlin has gone from a below-average starter to the best Mann has ever seen. But he still has work to do. Mann's models show that Gatlin has a tendency to let his hips come forward ever so slightly, subtly shifting the angle at which his feet strike the ground. The tendency costs him just the tiniest slice of time—but it could make all the difference against Bolt.

Gatlin, Mitchell, and Mann all know the solution is practice. At the track in Orlando, rising from his chair at Mann's track-side table, Gatlin resolves to regain that one "click" that put him behind his virtual avatar on his start. Doing so will require Gatlin to consciously yank his left leg forward with more power after coming off the blocks.

Gatlin takes his position on the track, Mitchell behind him. Mann is ready to film.

"Ready," Mitchell yells. "Set...Go!"

This time, when Mann cues the footage, the time tells the story. Gatlin is two hundredths of a second faster than his previous trial, dropping below a 0.7-second start for the first time ever—breaking the record for the fastest start Mann has ever clocked.

"Every click is gold," Mann says. Then Gatlin walks back to the starting line, sets his feet in the blocks, and goes again.



## GATLIN HAS GONE FROM A BELOW-AVERAGE STARTER TO THE BEST MANN HAS EVER SEEN. BUT HE STILL HAS WORK TO DO.

# THE GEAR

## THAT GOT THEM THERE

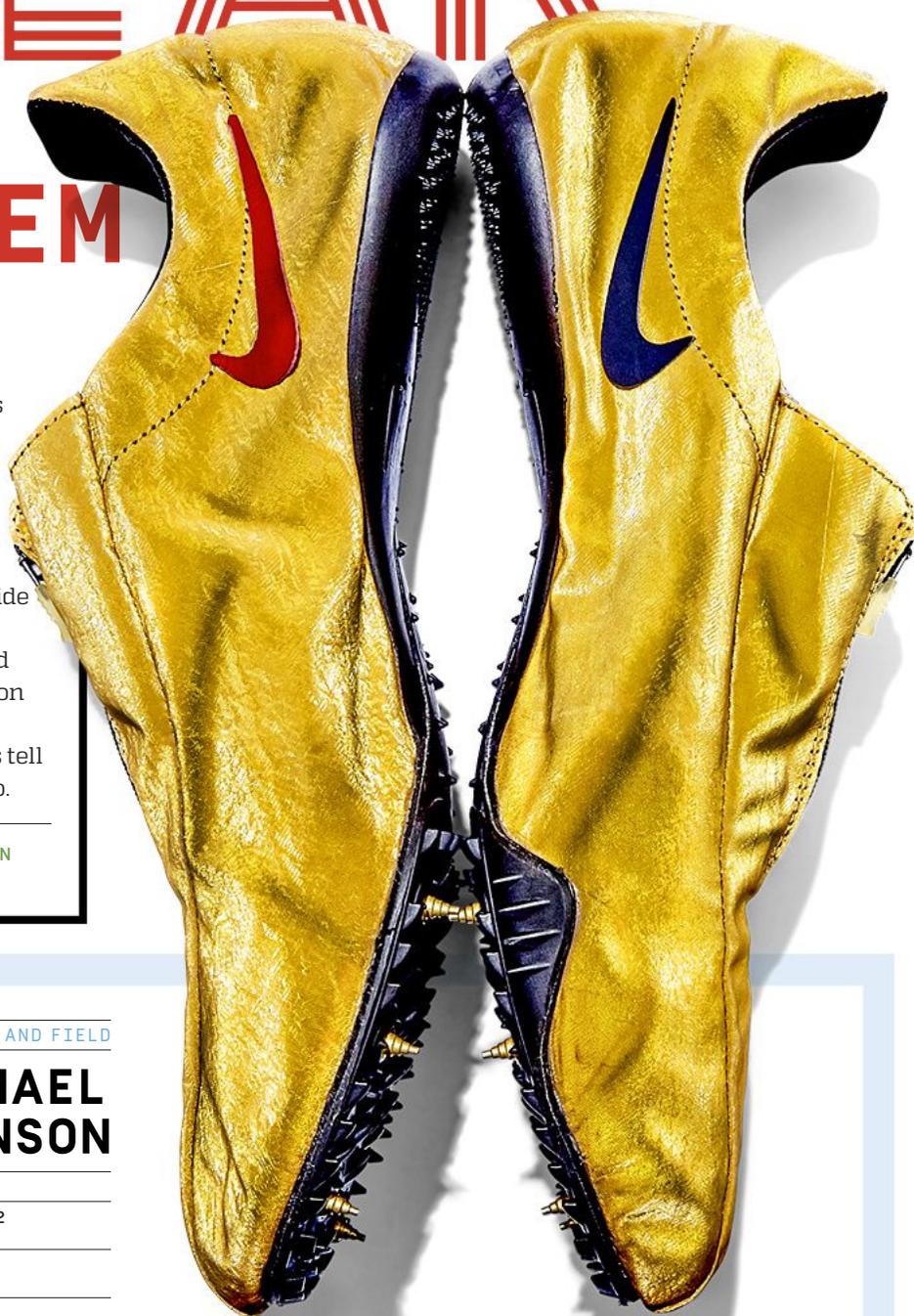
2016 OLYMPIC

TECHNOLOGY

SPECTACULAR!

In Olympic competition, hundredths of seconds and tenths of inches decide the difference between glory and going home an also-ran. Our greatest Olympic heroes have always counted on their equipment, in training and competition, to provide every possible (legal) advantage. In their own words, the most renowned U.S. Olympians of the past geek out on the gear that helped them get to the podium, and this summer's athletes tell us what they'll be counting on in Rio.

INTERVIEWED BY MATT GOULET, CAMERON JOHNSON, AND LARA SOROKANICH



### TRACK AND FIELD

## MICHAEL JOHNSON

### MEDALS

Barcelona 1992



Atlanta 1996



Sydney 2000



"In '96, I was six years into my professional career and Nike was making new spike plates for sprinters, which I didn't like that much. I was still wearing a spike plate that had been developed back in 1984. So I started working directly with the designers at Nike and their sports scientists to create a **sprint spike** that was specific to my feet and events. A big part of my success as a 200-meter sprinter was my ability to run the curve very efficiently. You need to have dorsal flexion when you place each foot to get power on the curve. You want to be able to feel each foot placement and the interaction between the foot and the track. With the gold shoes, we took out some areas of the spike plate that didn't really provide functionality to make them lighter. We took those areas out strategically, placing slots in the plate instead to achieve that flexibility. It would be speculation to say that the three-ounce difference made an x amount of difference in my time. Who knows? I'll be honest, a lot of it is psychological."

2016 OLYMPIC

TECHNOLOGY

SPECTACULAR!



ROWING

## MARY WHIPPLE

MEDALS

Athens 2004 | Beijing 2008 | London 2012

"There's a misconception that coxswains are just passengers in our boats. We're actually the reality check, somewhere between a teammate and a coach. My job is to figure out how we can be rowing better and make calls accordingly. So we rely on a piece of equipment called a **CoxBox**, which is a computer that tells us our stroke rate and is connected to speakers in the boat to amplify my voice. The ability to communicate with someone back in the stern is awesome, and my rowers' ability to hear me keeps things from getting chaotic. When we're in a race, the coxswain is looking down at the CoxBox, steering, and telling the rowers commands like 'Okay, in two strokes we're going to take it down two beats.' Then I'll look at my computer and tell them when we're on rhythm. If we've done it right, the feel of the boat will be better and we'll be going faster."



GYMNASTICS

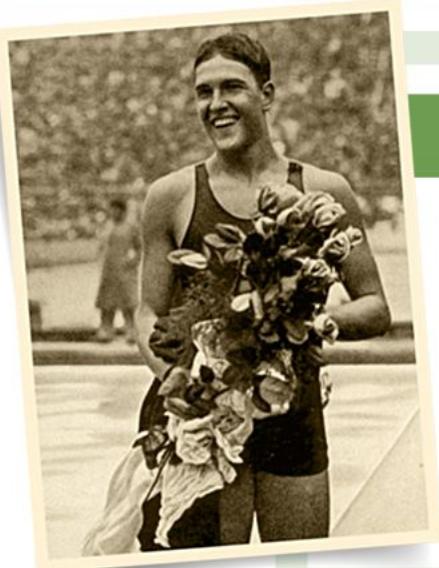
## BRANDON WYNN

"FOR ME, HEADING into Rio, monitoring my body composition is really important. I like to train heavier, then lose a little bit of weight for competition. Under Armour has a tracking kit called **HealthBox**—an app, band, heart-rate monitor, and scale—that I use to monitor my calories and body-fat percentage. If I'm going to burn 3,000 calories on a daily basis, I want to be eating at least 3,000 calories. When you track

your day-in and day-out activities, you can see each of those calories. Before, manipulating all those factors had always been kind of a guessing game. Now I can be 3 or 4 percent more accurate, and it actually makes a difference. Gymnasts are really lean athletes. If you're sub-6 percent body fat and you want to lose three pounds, that's a very tedious task. And if you lose three pounds of body mass versus three pounds of muscle mass, that can make a big difference in your performance. When I get on the rings and I'm three pounds lighter, I can absolutely tell."

### An Appeal from Michael Johnson: BAN THE RACING NUMBER

"That the racing number is still pinned on athletes disappoints me. I don't think safety pins are used for anything else in the world anymore other than pinning numbers on track and field athletes. Apparel companies go through all this research and development to make materials that are aerodynamic. At the end of the day the athlete has to go out there and attach this paper number by safety pin, which creates all sorts of drag. Get rid of it."



## MOST VALUABLE OLYMPIAN

As a 16-year-old kid from Chicago, Adolph Kiefer became the first person ever to swim the 100-yard backstroke in less than a minute. At 18, he won gold swimming the 100-meter backstroke at the Berlin Olympics in 1936. (He got to meet Hitler and still regrets not shoving

him into the pool.) But more impressive is what the legendary swimmer did for the U.S. and his sport after the games. In 1942, he enlisted in the Navy. After noticing how many deaths were caused by drowning, he created a training program that taught two million recruits

how to swim. (Ask your grandpa about the Victory Backstroke.) After the war, he founded an eponymous swim-equipment company at which he developed the staples of modern swimming: the nylon bathing suit, the kickboard, and swim-lane dividers, which reduce water turbulence. Kiefer's turning 98 now, and he's one of our greatest Olympians. He still goes for a swim most days.

## MIKAELA MAYER

RIO  
BOUND

“Under Armour completely designed a **boxing boot** for us. It looks very different from other boots and is made with a material that uses ClutchFit technology—the entire boot molds perfectly to your foot. It’s almost like I’m slipping into a really thick sock. They also added mesh to the boot to create breathable air pockets so our feet don’t overheat. When it’s time to train in the ring, we also use little **sensors** from a company called Hykso in our hand wraps. They calculate the number of punches we throw, how many of each kind of punch we throw, and how many seconds we take between each combination. After each fight, we go through all the stats. The most important thing that I’ve picked up is that I used to punch every four to six seconds. Now I’m punching every three to four seconds. That’s something I never would have thought about. You don’t just *feel* like you’re improving. Statistically, you are improving.”



Under Armour’s proprietary ClutchFit fabric technology employs Poisson’s ratio (a material that is stretched in one direction will contract in the opposite direction) to give an athlete the ability to move and still feel support.



USA  
BOXING



GYMNASTICS

# SHANNON MILLER

MEDALS

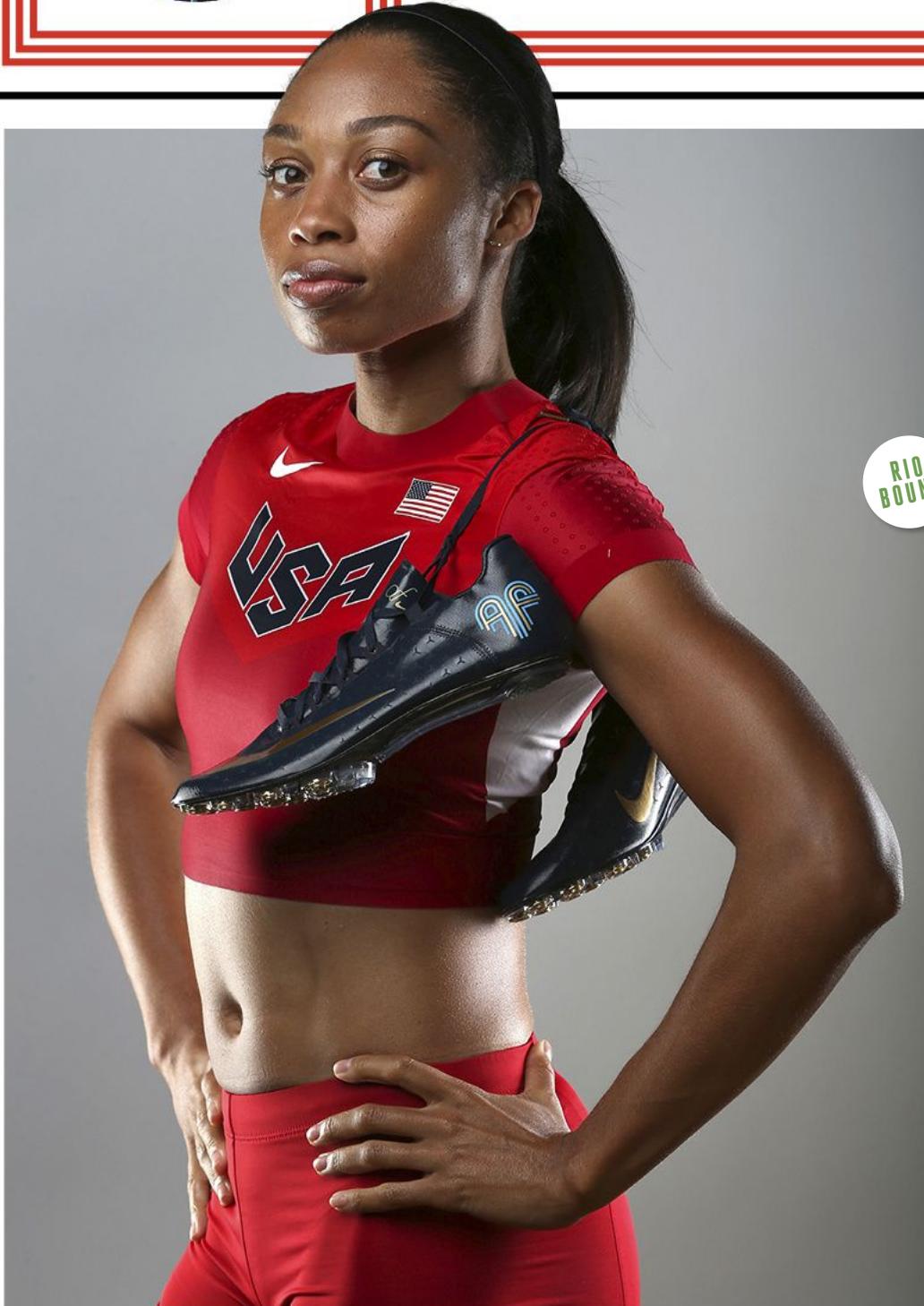
Barcelona 1992



Atlanta 1996



"We were always told: Keep your grips and your chalk in your gym bags. Those were two things you didn't want to be without. My **leather handgrips** were specially made for me by a man in Nebraska. You had to break them into an exact shape, so they would mold to your hand and surround the bar. For the chalk, you'd take a spray bottle and mix water and chalk to make a paste that would help you to stick to the bar. When I was at my first National Championship, I reached for a spray bottle and mixed it up with the men's team's, which had sugar water in it. They use it for the parallel bars, but it made my grips so slick that I actually ended up flying off the uneven bars."



TRACK AND FIELD

# ALLYSON FELIX

MEDALS

Athens 2004



Beijing 2008



London 2012



"**FOR A LITTLE** over two years I've been working with Nike to develop my own spikes. I've always had a personalized touch with them, but this is the first time that they've built a shoe specifically for me. I'm kind of unique in terms of what I like. Most sprinters like a very rigid shoe, but I like one that feels like an extension of my foot. So these are very minimal. They used Nike's new **Flyknit technology** for the upper. The plate with the spikes is 3D printed—that's completely new technology."

## MARTY NOTHSTEIN

### MEDALS

Atlanta 1996

Sydney 2000

**"I CAME ALONG** in an era when the technology was really starting to take off in the world of cycling with the usage of **carbon fiber and titanium**. That's still prevalent today—the bikes haven't changed a whole lot since '96 and 2000. While I was racing, **wind tunnels** were kind of new. That led to the solid rear wheel, which has huge aerodynamic advantages. I laugh when I look back at some photos of me in '96. I'd have a one-piece skin suit, which everybody wore, but you'd have your collar flapping in your face. You don't see that anymore. For me, I had to have all my uniforms custom-made. My quads were 35 inches around. Like most cyclists, I wasn't near normal."



2016 OLYMPIC

TECHNOLOGY

SPECTACULAR!

## DARA TORRES

### MEDALS

Los Angeles 1984

Seoul 1988

Barcelona 1992

Sydney 2000

Beijing 2008

**"BACK IN THE** old days, we had what were called **paper suits**. They were a really thin material, and the less suit you wore the better. People would get massages before their races, and they'd have oil on their skin to make them slick. At that point, that was faster than whatever material you were wearing. Between '92 and 2000, a lot changed. We went from small suits to very long, sleeveless suits, with pants down to your feet. And the material was faster than just your own skin. By 2004 the suits were really slick, and they were a pain in the butt to get on. It took ten minutes to put the damn suit on, and your hands would hurt. By 2009, they were almost like flotation devices. I remember, someone put a brick in the leg of one and tied up both sides. The brick floated. So they banned those suits, and now they're back up at the knee. I went right from 'less suit the better' in '84 to 'more suit the better' in '08."

## THE (BETTER) BOAT MAKERS

There are only about three companies making the kind of boats that qualify for the demands of Olympic rowing teams: two old-guard European brands, and one North American company that got its start in a garage. Hudson Boat Works, simply known as Hudson today, started in 1981 as a family operation in London, Ontario. Since then, the company has become the leading innovator in one of the Olympics' stodgiest sports when it comes to equipment. After the current world record in the men's eight competition was set in a

Hudson boat at the 2004 Athens games, the company threw out its production models and reinvented its racing shells. In 2008, with a former auto engineer leading design, Hudson introduced a proprietary weave of structural carbon for its racing shells with a stiffness, weight, and durability ideal for Olympic-level rowing. With 12 Olympic medals logged, it's the great disruptor rowing needs.



Turn the page to see this year's suit, with Ryan Lochte.

2016 OLYMPIC  
TECHNOLOGY  
SPECTACULAR!

SWIMMING

# RYAN LOCHE

## MEDALS

Beijing 2008 | London 2012  
●●●● | ●●●●●

"I've been wearing Speedo since I was eight, when I first started swimming. I've watched the development of the Speedo suits and remember back to the Aquablast suit, which felt like a parachute when you were putting it on. Today, you put on the **LZR Racer X**, it's like part of your skin. The old full-body suits took me at least 30 minutes to get on, and sometimes they'd rip. Now the technology has gotten to where the fabric has better stretch. And the compression of the LZR Racer X kind of holds you together. You can feel it going through the water. I've always had a little superstition thing, where I have to have a new suit every race. It's like when you buy a pair of brand-new shoes—the smell, the feel, it's amazing. I feel the exact same way when I put on a fresh suit."

RIO  
BOUND

Speedo used ultrasonic welding to bond the seams along the suit, creating a line that flows along the leg muscles, providing greater support and activation. For the women's LZR Racer X, the shoulder straps were laser cut.





### THE SHADES YOU'LL SEE EVERYWHERE

It took two years for Nike Vision to build the Vaporwing Elite sunglasses. The new shades were specifically engineered for speed. Partnering with Zeiss Optics, the company crafted a single shield-style lens from polyamide that is incorporated into the frame of the glasses. The result is a supremely lightweight piece of equipment with incredible clarity and a wide-open field of vision.



### TABLE TENNIS

## ARIEL HSING

*In the London 2012 games, at 16, Hsing nearly upset the No. 2 seed, Chinese star Li Xiaoxia, becoming the American hope for table tennis.*

"I used a specific pair of **table-tennis shoes** from Butterfly. You want to be comfortable. But the thing that separates table-tennis shoes from other competition shoes, like for running or for track, is that table-tennis shoes have to be very, very low to the ground. You do a lot of side-to-side movements at the table, and if the shoes are too high, then it's really easy to roll your ankle."



### MARATHON

## MEB KEFLEZIGHI

### MEDALS

Athens 2004

"**I TRAIN TWICE** a day. Instead of doing another run in the evening, I'll go on the elliptical because it helps take out some lactic acid and gives me a recovery workout with no impact. I can go for two hours. That's an assurance. I also started wearing **Oxysox** compression socks in 2004, after the Athens Olympics. I was one of the first runners to wear them in a race, and people thought I was crazy. I think they're good for recovery purposes and help my circulation. I will train in them, and I'll have them on before a flight. I use them quite a bit except for when I'm sleeping. You're looking for any advantage that is natural."



RIO BOUND



### FENCING

## PETER WESTBROOK

### MEDALS

Los Angeles 1984

*Westbrook is the only American male since 1904 to medal in the individual sabre event.*

"I don't know how we fenced without electrical equipment to track scoring. I mean, I did it most of my career, but when I fenced with electrical equipment I could actually win national titles and make world championship finals. You're just putting another thin jacket with **electric sensors** over your whites. Not a problem. You can get it as tight or as loose as you want. As an American in those days, without electric equipment, judges screwed us. I got screwed so many times. You were at the mercy of how the international judges felt and their honor system. The electrical equipment revolutionized fencing. Now there is nothing they can say. The light is on. You'll get the touch."

RIO BOUND



### SWIMMING

## MISSY FRANKLIN

### MEDALS

London 2012



"**I'M PRETTY PICKY** about my **nose clips**. Speedo makes a good pair for my backstroke that I started wearing in 2011. It's a very weird feeling, not being able to breathe through your nose, and I'm particular about how it pinches my nostrils together. I wear the same one for practice and competition. It's adjustable. If I'm going to be wearing the nose plug for a long practice, I can kind of loosen it up. Whereas in a race I want to make sure that sucker doesn't come off, so I normally put it really tight."

**THE POPULAR MECHANICS**

**REGISTER OF**

**GREAT  
AMERICAN**

**FACTORY TOURS**

➡ There's probably no escaping taking the kids to an amusement park this summer—sweltering in long lines and paying for overpriced junk food. But when that torment is over, take them to a different kind of theme park, one you'll both enjoy: an American factory. You'll see how baseball gloves are made. Or how they print the posters for your favorite concert. Or how a guy at Harley-Davidson takes every bike up to 77 mph on what looks a lot like an automotive treadmill. Sometimes you'll even get candy. And unlike at Six Flags, admission is often free.

JULY

PAGE

82

AUGUST

Hatch Show Print uses nine antique and vintage presses. The oldest dates to 1900.



## HATCH SHOW PRINT

NASHVILLE, TENNESSEE

75 minutes; \$15 (adults), \$10 (ages 6 to 12)

Nashville's recent "it city" status has our skyline so dotted with cranes that longtime residents have started calling it Little Dubai. I worry that the town where my ten-year-old daughter, Margot, was born is becoming unrecognizable to her. So I decided a tour of the Hatch Show Print letterpress was in order.

"What's a letterpress?" Margot asked.

"They make music posters," I said. She got excited.

"Think they have any of Taylor Swift?" she asked.

"Maybe," I said, explaining that they've been in business since 1879, and have worked with just about every musician you can think of—from Elvis Presley to Elvis Costello.

"Who's Elvis Costello?" Margot asked.

The production process hasn't changed much in over a century. Some of the letter blocks—exactly 0.918 inches high, a stan-

dard established in 1886 by the United States Type Founders' Association—are the original end-cut maple versions. This isn't Photoshop. There is no erasing. If even the smallest amount of grit builds up beneath an individual block, it must be sanded by hand so that it prints evenly. The rollers have to be reinked every four prints—each one slightly more faded than the last. These subtle inconsistencies are what make Hatch Show Print posters so special: No two look exactly alike.

The craftsmanship wowed my daughter—just like it had wowed me on my first visit, not long after I moved to Nashville two decades ago. But her favorite part was the end, when we got to browse through an inventory of photo plates and posters dating back to the shop's very first print run. I marveled at the photo plate for Led Zeppelin's first Nashville appearance in 1970. Then I glanced over and spotted Margot. She had the very same grin on her face. She was looking at a poster from Taylor Swift's "Speak Now" tour.

—Adam Ross

## THE U.S. MINT

PHILADELPHIA, PENNSYLVANIA  
(ALSO DENVER, COLORADO)

45 minutes; free

From a 40-foot observation deck you'll see coins—tens of millions each day—sliced from metal coils that weigh 6,000 pounds and stretch five football fields. Inspectors use magnifying glasses to check the quality. Just one flaw in one coin and the entire batch is destroyed and recycled.

## JOHN DEERE

WATERLOO, IOWA (ALSO EAST MOLINE,  
ILLINOIS, AND ANKENY, IOWA)

90 minutes; free

Tours take place on a tram pulled by—what else?—a John Deere tractor. Huge robotic arms spray each vehicle in signature green and yellow. But the logo is still applied by hand.

## AIRSTREAM

JACKSON CENTER, OHIO

One to two hours; free

Each of the iconic travel trailers has thousands of rivets holding together huge sheets of aircraft-grade aluminum. And every one of those rivets is drilled in by hand. Once finished, the campers go into the rain-test booth, where they're pounded by hurricane-strength rain for 20-minute cycles.

## BOURBON BARREL FOODS

LOUISVILLE, KENTUCKY

25 minutes; free

The nation's only soy sauce microbrewer—yes, soy sauce microbrewer—uses repurposed bourbon barrels and limestone-filtered Kentucky spring water to create a uniquely smoky-sweet condiment. FDA restrictions keep you from the factory floor, but you can still watch through glass as workers cook soybeans, roast grain, and press mash with six tons of force.



## WOOLRICH

WOOLRICH, PENNSYLVANIA

One hour; free

Woolrich has been churning out fabric since 1830, including blankets for Civil War soldiers. And for the factory's 60-odd employees, working with raw wool—a single blanket takes roughly four pounds—is its own kind of battle. A variety of heirloom machines dye, comb, spin, wind, warp, weave, wash, and roll the material before it can be turned into something you'd cozy up with on the couch.



In a single day, Coors can fill more than a million cans with beer. And a keg in just seven seconds.

## COORS BREWING COMPANY

GOLDEN, COLORADO  
30 minutes; free

What kind of dad takes his five-year-old son on a brewery tour? A cool one, I thought, boarding the shuttle bus to the Coors plant in Golden, Colorado—the largest single-site brewery in the world, capable of turning out 13 million barrels of beer annually. To me, it was just another father-son outing—a chance to see something new and learn something interesting. Like the zoo, but with the freshest free beer imaginable. Little did I suspect my boy would end up scarred for life.

In and of itself, the self-guided tour is utterly wholesome, an experience as pure as the vaunted Rocky Mountain spring water that prompted Adolph Coors to set up shop in Golden back in 1873. Exhibits explain ingredients, malting, mashing, etc., while affording a look at impressive mechanized assembly lines that channel endless rivers of freshly filled cans and packed cardboard cases in perfect perpetual motion. It wasn't easy to detach my son's nose from the observation window, but over the clack of the machinery, Daddy discerned the siren song of the samples that await responsible drinkers of legal age at the end of the tour.

As I sipped a cold glass of Coors and my son a soda, we surveyed our surroundings: an ersatz pub, decorated with old adver-



Golden Flake produces 100 million pounds of snacks per year.

tisements—including one featuring E.T. (left), that lovable extraterrestrial, imploring imbibers to “phone home” for a ride should they overindulge. This seemingly harmless poster, unfortunately, made by far the largest impression of the day on my son. What is that thing? Is it coming to get me? What part of me do you think it would eat first? Years later, the poor lad is still uncommonly concerned with the perceived dangers posed by aliens, even smiling ones in bartenders' aprons.

Then again, if that keeps him out of the taverns for a few extra years, maybe it's not all bad.

—Kendall Hamilton

## GOLDEN FLAKE

BIRMINGHAM, ALABAMA  
45 minutes; free

When my wife and I moved from New York City to Birmingham, Alabama, five years ago, I'd braced myself for culture shock. I knew as much about college football and black-eyed peas as I do thermonuclear fusion. But while I'm still rusty on the vagaries of the wishbone formation, we definitely came out ahead. We've got a yard now, and a dog, and some savings. And we live ten minutes from a snack-food factory.

Since 1923, Golden Flake, “The South's Original Potato Chip,” has been supplying



It takes about three weeks to build a Fender guitar—including three days for the body paint to dry.

chips and puffs and curls and popcorn and pork skins from Florida up through Virginia, in flavors as unlikely as Tangy Pickle BBQ and just plain Hot. It is tiny next to the Utzes and Pringles of the world, and touring its 700-employee Birmingham facility can feel like visiting a friend's home-brewing shed, if instead of beer he churned out Chili Lime Pork Cracklin Super Strips.

"This is our cheese puff, corn puff, and popcorn department," said both our guide and, I hope, whoever greets me in the afterlife. There are 14-foot drums of vegetable oil and giant rotating seasoning cylinders and kind-looking ladies slicing potatoes in half (by hand, for quality control). The highlight comes at the halfway point: a basket brimming with potato chips plucked fresh off the conveyor belt, intercepted between fryer and bagging station, and offered to you for sampling. It is the perfect bite of a perfect chip. Thin but still crunchy, with just-too-much salt. Whatever's in your pantry seems like wafer-shaped Styrofoam in comparison.

It's just one of several snack breaks on the tour. If your taste buds still want more—and they will—you get a few complimentary bags to take home. Lucky for me, I was already there.

—Brian Barrett

## BOEING

**EVERETT, WASHINGTON**  
**90 minutes; \$20 (adults), \$14 (age 15 and under)**

When you're stuck in the middle seat and the baby behind you is wailing, it's easy to forget what a miracle an airplane is. You won't after visiting Boeing—the largest building in the world, big enough to fit Disneyland with 13 acres to spare—and witnessing 30,000

employees assemble millions of parts and miles of wiring into 747s and other jumbo jets.

## CHEVROLET CORVETTE

**BOWLING GREEN, KENTUCKY**  
**One hour; \$10 (adults), \$5 (ages 10 to 16)**

So you're buying a Corvette Z06. First off, congratulations. A supercar. You're a lucky man. But why stop there? For an extra five grand you can hop on the assembly line at the Bowling Green factory and help build your 650-hp engine, which gets emblazoned with a plaque commemorating the experience. For those on a budget, \$10 gets you the standard factory tour—still thrilling, just no keys at the end.



**HARLEY-DAVIDSON**  
**YORK, PENNSYLVANIA**  
**Two hours; free or \$35**

There's a free tour, but it keeps you on the periphery of the shop. Pay the \$35 for the Steel Toe Tour and you get to walk up and down the aisles, right next to the workers as bike parts are delivered to them, on-demand, by a trolley that follows magnetic tracks in the floor. At the end, the guys put each finished Harley on a dyno machine and steadily bring it up to 77 mph, running the bike through all the gears.

# FENDER GUITARS

**CORONA, CALIFORNIA**  
**One hour; \$10 (adults), \$8 (seniors), \$6 (ages 13 to 17), free (ages 12 and under)**

The first time I saw a Fender Telecaster up close was in 1979 on the stage of the Hollywood Palladium. I was 14, and Joe Strummer was next to me pounding out the chords to The Clash's "White Riot"—the two of us shouting the lyrics along with a few other teenage punks who had also scrambled onstage during the encore.

Strummer was thousands of miles from his London home that night. But his battered axe? That wondrous machine had been born less than an hour south, in Fullerton, California, where in the early 1950s self-described tinkerer Leo Fender revolutionized the electric guitar. Since that encounter with Strummer, I've seen hundreds of other Fenders—as a music journalist as well as in my short time as a drummer, which included a stint with punk legends Bad Religion. But I didn't fully appreciate their magic until I strapped on a pair of Devo-like safety goggles and took my first tour of the Fender Factory.

It all starts with unremarkable blocks of alder and ash. From this wood, about 400 employees—more than a few aging longhairs among them—shape, sand, seal, and paint the classic Telecaster and more angular Stratocaster bodies. They then fit the necks, attach the wound pickups, and connect the knobs. Finally, each instrument is plugged in to a row of new Fender amps to check the sound quality.

In the summer, crowds for the twice-daily tour average 50 people. On the April morning I visited, there were only six of us, including two middle-aged Swedes. Afterward, browsing a showroom filled with memorabilia of Fender-playing guitar gods, I asked the guys what made them travel all this way. One clearly didn't understand English. The other only a little. He smiled, pointed to a poster of Jimi Hendrix, and simply said, "Him." Returning the gesture, I pointed across the room, to a display about punk. The centerpiece: a replica of Strummer's banged-up Telecaster.

—John Albert

## LODGE CAST IRON MANUFACTURING

**SOUTH PITTSBURG, TENNESSEE**  
**Last weekend in April, 45 minutes; free**

You can't get in while the factory is running—it's way too dangerous—but once a year (during April's National Cornbread Festival, naturally) Lodge opens its doors to tourists. Hard to say what's more amazing: the electromagnet that can lift five tons, the furnace that burns at 2,800 degrees Fahrenheit, or the pouring machine that uses ancient sand-molding techniques to create as many as 8,000 skillets an hour.

Each two-ounce bottle of Tabasco contains a minimum 720 drops of hot sauce.



## WOOD-MIZER

BATESVILLE, INDIANA  
30 minutes; free

I live in rural Indiana, in the north part of a farm county. Out here, the sight of a Wood-Mizer, the industrious portable saw mill, passing by behind a pickup or being towed up onto someone's acreage for a few days of transformative deep-woods lumber milling, is a moment of awe, rare and powerful, like catching sight of a panther or something. In the right conditions, three men and a Wood-Mizer can mill enough lumber to build an entire pole barn or a fishing cabin in just a day. It is a tool of thrift, profit, and creativity. I don't own one—I'm just another fanboy—but I do have a hat. And the logo alone gets me silent nods of respect from farmers who otherwise want nothing to do with me.

I bought the hat after going on the Wood-Mizer factory tour in Batesville, Indiana. (It was cheaper than the sawmill.) The six-month-old plant churns calmly forward, the assembly line formed in the shape of a U. There's no shouting. No rushing. No alarm registered along any of the snug, worker-designed assembly. There's notable focus in the workforce—risen from pride, taken from ownership (the 34-year-old company is entirely worker owned)—that permeates the movement and pace from loading dock to shipping dock. For me, the moment I recognized the familiar machine occurred right in the turn of that U, after the powdered orange paint was kiln-dried onto the steel frame. Then the wheels were attached

and the custom motor mounted.

And then I couldn't help myself. "There's the big cat," I exclaimed, like some kid seeing a ballplayer parking his car. The guy on the line heard me. "You gonna build something?" he asked, assuming I was a buyer. I smiled and pointed to my factory-supplied earplugs. "I'm just on a tour," I said, but he couldn't hear me. "Build something great," he said. He was standing over a new Wood-Mizer, so it sounded like a promise.

—Tom Chiarella

## NOKONA

NOCONA, TEXAS  
One hour; \$5

When Hall of Fame pitcher Nolan Ryan was seven, his father took him to a hardware store in downtown Alvin, Texas, to buy his first baseball mitt. It was a Nokona. Since 1934, the family-owned company has made gloves the same way: hand-lacing and stitching American rawhide, then beating it to hell with a mallet until the pocket is ready to snag a one-hop grounder.

## JELLY BELLY

FAIRFIELD, CALIFORNIA  
40 to 60 minutes; free for the self-guided tour, \$47 for a guided tour that takes you on the factory floor

The thousands of jelly beans tumbling in hoppers may sound like bingo balls, only here every one drawn out is a guaranteed winner—except maybe the buttered popcorn. You can taste them at every stage of the tour, but save your appetite. The factory store at the end offers unlimited samples. If you paid for the guided tour, called Jelly Belly University, this is where you make up for your tuition.

## TABASCO PEPPER SAUCE

EVERY ISLAND, LOUISIANA  
One hour; \$5.50

When I was growing up in the Cajun Triangle, any time a relative or college friend came to town, my family trotted out one of three old chestnuts: tours of swamps, plantations, or the Tabasco factory. I always hoped for the peppers—because I am afraid of alligators and ghost stories but mainly because, like all good Louisianans, I am obsessed with hot sauce.

Avery Island is only three miles wide, so most of the growing happens in South America. But this is where the rust-colored mash is packed into old bourbon barrels—about 50,000 are stacked in the warehouse—and left to ferment for three years. When ready, it is mixed with vinegar and aged for another month. Finally, the sauce gets bottled and shipped off to 180 countries.

The smells of the tour are as good as the sights—all that spice mixing with nearby forests of azalea trees. But the best part comes afterward, at the free tasting, when someone inevitably volunteers to try the inferno-level habanero sauce. That someone will always be me.

—Katie Macdonald

## KENYON'S GRIST MILL

WEST KINGSTON, RHODE ISLAND  
July 23 to 24 and October 22 to 23; free

Two giant slabs of granite—each more than 150 years old and weighing more than 2,000 pounds apiece—pulverize whole grain and corn

into meal and flour. That's it. A simple, centuries-old process that retains all the nutrients of the original grains and corn. Make sure to bring home some Johnny Cake mix.

## KOHLER

KOHLER, WISCONSIN

Three hours; free

Lowell Kappers, the 80-year-old former Kohler employee who led our tour, worked at the Wisconsin factory, north of Milwaukee, for 44 years—31 of them as a cast-iron grinder. Three decades machining crankshafts and rail-track components. Three decades wearing a respirator helmet to keep pulverized iron dust out of his lungs. He retired in 1999 but still shows up two or three mornings a week to give tours. The factory has been offering them since 1926, a couple of decades before Kappers's dad started working there.

The tour is epic: four buildings, three hours, two and a half miles. You sidestep moving forklifts. You cross beneath conveyors shuttling tubs. You watch molten iron flow. In a cavernous brick loft called the pottery, liquid clay pumped from basement tanks filled plaster-of-paris molds before getting glazed and fired in 2,450-degree industrial kilns. In the enameling shop, an employee in a silver heat shield coated a cast-iron shower floor in enamel powder, then slid it into the orange maw of another kiln.

There are so many kilns. But Kappers didn't break a sweat, despite the heat and constant walking. The only time he really lingered was when we got to the aisle where he had worked, the spot where he jockeyed that heavy grinding wheel all those years.

"Noisiest place in the factory," he said. He wasn't complaining. He was proud. And then he was off again.

—Phil Hanrahan

## R.L. WINSTON ROD COMPANY

TWIN BRIDGES, MONTANA

45 minutes; free

I learned to fly-fish on a fiberglass five-weight that my dad bought at Abercrombie & Fitch in the '60s. With his tongue sticking out in a pose of concentration, he showed me the basic ten and two. Wait for the glass to finish its slow backward flex, wait for the line to unfurl, then launch your forearm forward. *Be patient, son.*

This was the early '90s. By then, Dad's A&F beauty was a relic. Space-age graphite had made fiberglass obsolete. Trouble was, graphite is much stiffer than glass. Graphite rods cast like rocket launchers, and spooky trout require a delicate approach. Based in



For some factory tours, requiring goggles and closed-toed shoes can seem excessive. Not at Kohler.

Twin Bridges, Montana, at the confluence of three legendary trout rivers, 87-year-old R.L. Winston Rod Company has figured out an alchemy that transforms graphite into velvet. The key ingredient is its staff of 40—roughly 10 percent of the population of Twin Bridges. They secure line guides with hand-wrapped thread. They balance rods by feel and sight alone. They hand-fit the ferrules connecting the rod sections to within one thirty-second of an inch. When customers send in broken rods for repair, Winston rebuilds the damaged segments from scratch.

"We've got a machine for attaching guides that's sitting upstairs collecting dust," said my tour guide, production manager Joe Begin. "We find that our employees are more efficient and make fewer mistakes."

This tireless, meticulous labor accounts for the cost of the rods: ranging from \$500 to \$3,000. That might sound pricey, especially when a perfectly serviceable rod will run you about \$200. But near the end of the tour, I was frantically crunching numbers in my head, trying to figure out how many meals I could

skip in the coming month. Fortunately, the gift shop sells only hats and sweatshirts.

—Elliott Woods



▲ FILSON

SEATTLE, WASHINGTON

30 to 40 minutes; free

One look at the sewing floor and it's easy to see how the garment and bag company that C.C. Filson started in 1897 to outfit Gold Rush prospectors has continued to thrive. Veteran employees, some who've been there 30 years, operate antique treadle machines customized to work with the brand's hallmark rugged twill. **PM**

# STAR TREK

at

If wisdom comes with age, then Star Trek—the series that's taught us diplomacy, morality, and workplace ethics since 1966—has to be up there with Kant and Nietzsche by now. With this summer's release of the thirteenth movie, Star Trek Beyond, the franchise makes us look forward to its future as much as we appreciate its past.

PAGE 88

**A TRIBUTE:**

# I LIKE STAR TREK.

when they were fresh off late-night crying jags. I took in *Deep Space Nine* in fits and starts while writing books, and *Voyager* during my divorce. I finally watched all four seasons of *Enterprise* on Hulu in a weeklong jag last summer.

*Star Trek* matters. It is badass high adventure told in quick, artful strokes, featuring eternal conflicts with evolving, ongoing protagonists and beautifully over-the-top villains. Dickens asked that much of himself, and people remember the achievement of it. Spool out *Star Trek* year to year and it forms a highly serialized whole. A picaresque, somewhat nautical journey across decades of metaphoric sociopolitical exploration. The Cold War. The perils of colonization. The question of true freedom. The needs of the many outweighing the needs of the one. The puzzle of the Mirror Universe. And logic. Beautiful, beautiful logic. All of it so good that we now pay money to watch these glorious new movies in which the actors are cast in large part because they look like the original cast members. Keep in mind: These people are acting like the actors, acting as characters from fifty years ago. That is a tribute.

All of it. The original series, the movies, the various spinoffs, the rebooted movie franchise. Each version of *Star Trek* has filled some niche in my life. I watched the original show with my father, a guy who had little use for television otherwise. I went to the movies early and often as an aimless youth. Watched *Next Generation* as a young parent, holding one of two indifferent bottle-sucking infants

Sure, the franchise had its foibles. Movement is too easy. The ships never lack for headroom, and the hallways are better carpeted than most Marriotts. Space itself is like a wide Sargasso Sea rather than a murderously cold, radiation-laden vacuum. And traveling at any warp speed is about as troublesome as driving a Passat wagon on an otherwise empty desert interstate. At the speed limit. Haircuts are too neat, uniforms too snug, and there never seems to be any garbage. At all. But there were also plenty of moments of magnificence. I need mention only the relentless, ghostly, paradoxically slow-moving Borg, who lived as a hive on their cubed-up ships, as a representative example.

By my count, I have about forty-six real friends in the world. And I can name forty-four of them (the other two are just faces in my past). I sense that maybe that's all I'm capable of. Forty-four names. And yet I recently listed, by name, ninety-nine *Star Trek* characters, from across the maw of narrative created by television, movies, and novels. I remember them all. Rather easily too. Ninety-nine names. Ninety-nine becostumed souls. A population of explorers, men and women, stationed right there at the front of my mind. I'm not at all embarrassed to say I remember them all, that I've known them each, in my own small ways, for fifty years. And beyond.

—Tom Chiarella



## THE HECK IS A BARCO ESCAPE?

A new kind of movie screen brings *Star Trek* into the future. The real one.

➤ From its very inception, *Star Trek* vowed “to explore strange new worlds.” Apparently now that includes the theater. *Star Trek Beyond* (out July 22) will be available on about fifty Barco Escape screens: three adjacent screens—the traditional center display plus one on either side—that offer a panoramic, wraparound viewing experience. It's like a horizontal IMAX.

While fifty screens may not sound particularly impressive, movie studios hope Barco Escape will one day be able to compete with 3D, IMAX, and 4DX (which involves seat motion, flashing lights, and scents) to reinvigorate the theatrical experience. And though the experience was available for the first two *Maze Runner* films, *Star Trek Beyond* will be the real test of the possibilities. Already bullish, 20th Century Fox signed a five-

year deal with the company last year to release several more films in the expanded format.

To take advantage of the extra width—Barco screens can be up to 120 feet wide—producer J.J. Abrams and director Justin Lin remastered more than twenty minutes of *Star Trek Beyond*. “It's very common when you make a movie not to use all of the footage,” says Barco Escape CEO Todd Hoddick. “The aspect ratio that they used to shoot *Star Trek Beyond* was very wide. When we looked at the materials, we said, ‘My gosh, we wanna take these.’” The result is *Star Trek*, but with the kind of vistas you might expect in *Lawrence of Arabia*. Time will tell if action movies actually benefit from such artistic treatment, but if there's anywhere better able to take advantage of more space it's probably space. —Tim Grierson



### A FEW FAMOUS FANS

“I worked on a mission called Deep Space 1, which was the first interplanetary mission to use ion propulsion to travel around the solar system. And the first time I ever heard of ion propulsion was in the *Star Trek* episode ‘Spock’s Brain.’”  
—MARC RAYMAN  
CHIEF PROPULSION ENGINEER, NASA, JPL, DECEMBER 2009

“I like *Star Trek* because it shows a utopian future. Things aren't horrible in the future. There are so many bloody postapocalyptic futures that it's like, Okay, can we have one that's nice?”  
—ELON MUSK  
OCTOBER 2014

“I loved Spock.”  
—BARACK OBAMA  
FEBRUARY 2015



**Names for this screen shape that would be better than Barco Escape:**  
Open Cupboard // Popcorn Box // Pamphlet // Three Screens in a Row With Two Slightly Tilted

# SHIP SPECTACULAR

In addition to the *Enterprise*, which will have new escape pods inspired by the destruction of the *USS Kelvin* in the 2009 movie, *Star Trek Beyond* will feature two other vessels: tiny swarm ships flown by the enemy Krall and the *USS Franklin*, an early prototype ship that was the first to reach Warp 4.

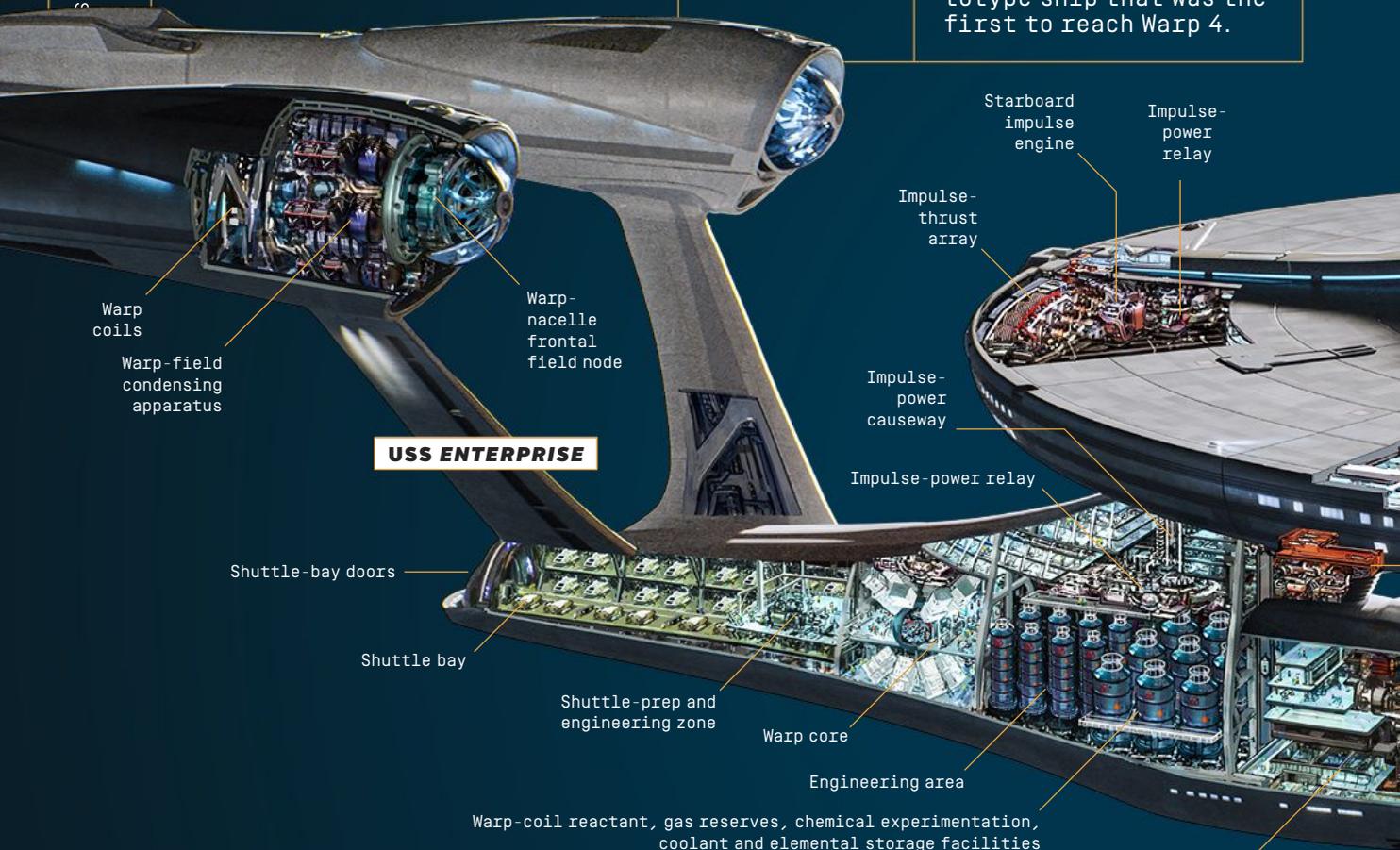
POPULAR  
MECHANICS

ISSUE

07/08.16

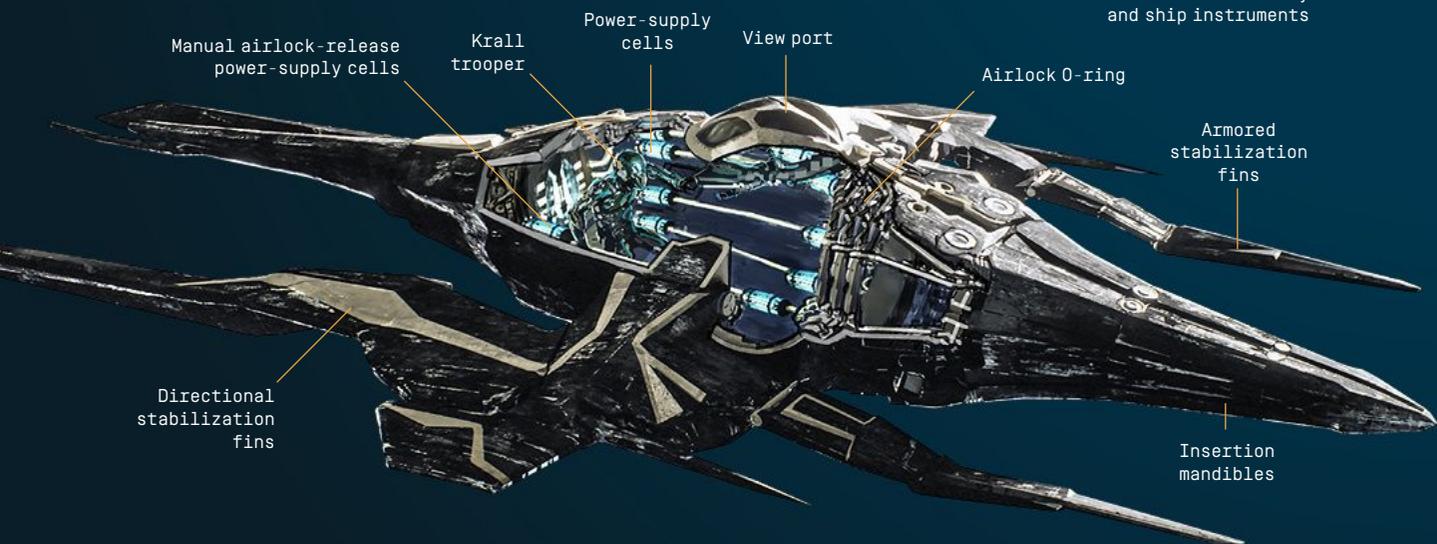
PAGE

90



## USS ENTERPRISE

## KRALL SWARM SHIP



Manual airlock-release power-supply cells

Krall trooper

Power-supply cells

View port

Airlock O-ring

Armored stabilization fins

Directional stabilization fins

Insertion mandibles

Science area, located close to sensor array and ship instruments

Warp-coil reactant, gas reserves, chemical experimentation, coolant and elemental storage facilities

Engineering area

Warp core

Shuttle-prep and engineering zone

Shuttle bay

Shuttle-bay doors

Impulse-power relay

Impulse-power causeway

Impulse-thrust array

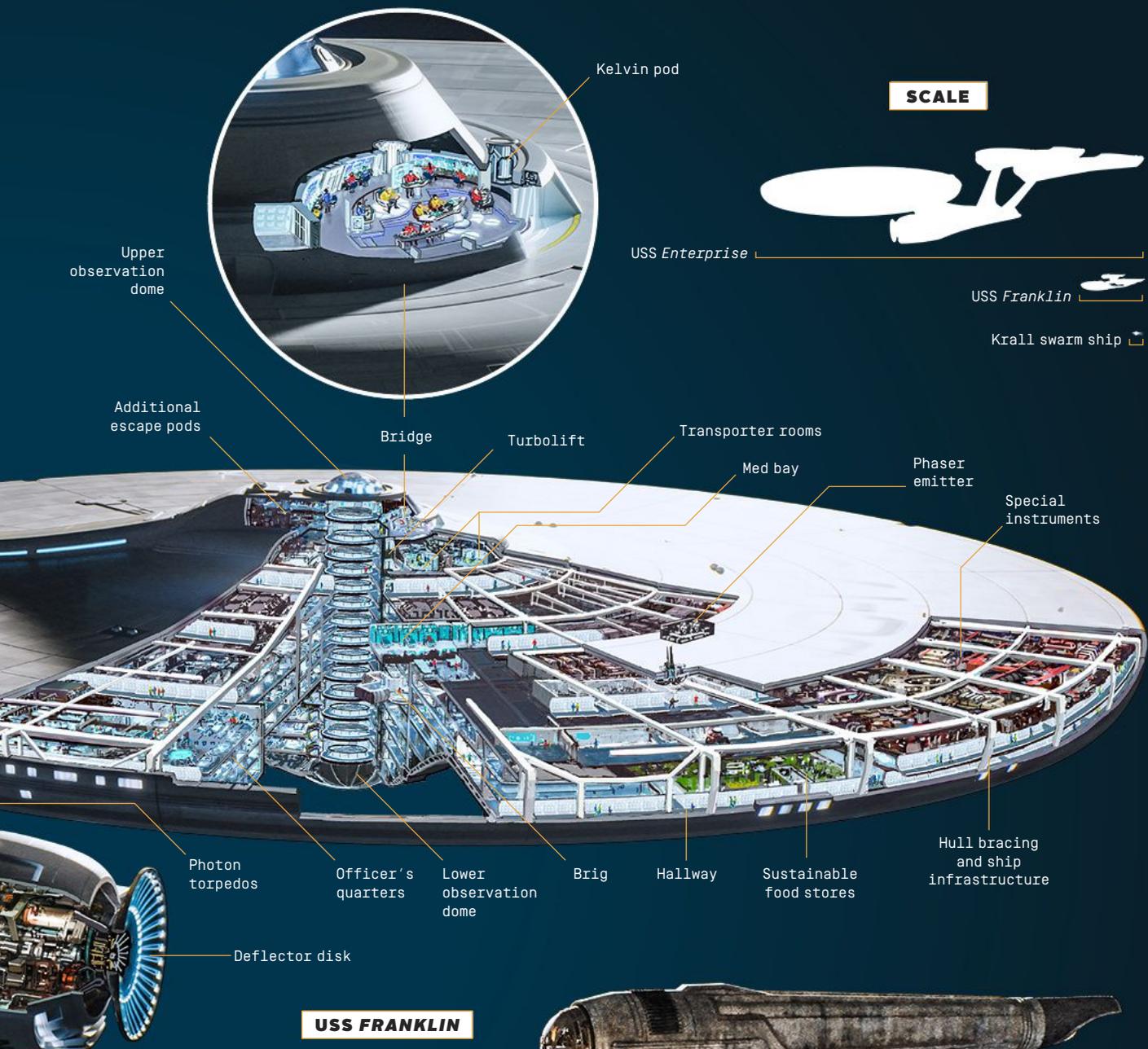
Starboard impulse engine

Impulse-power relay

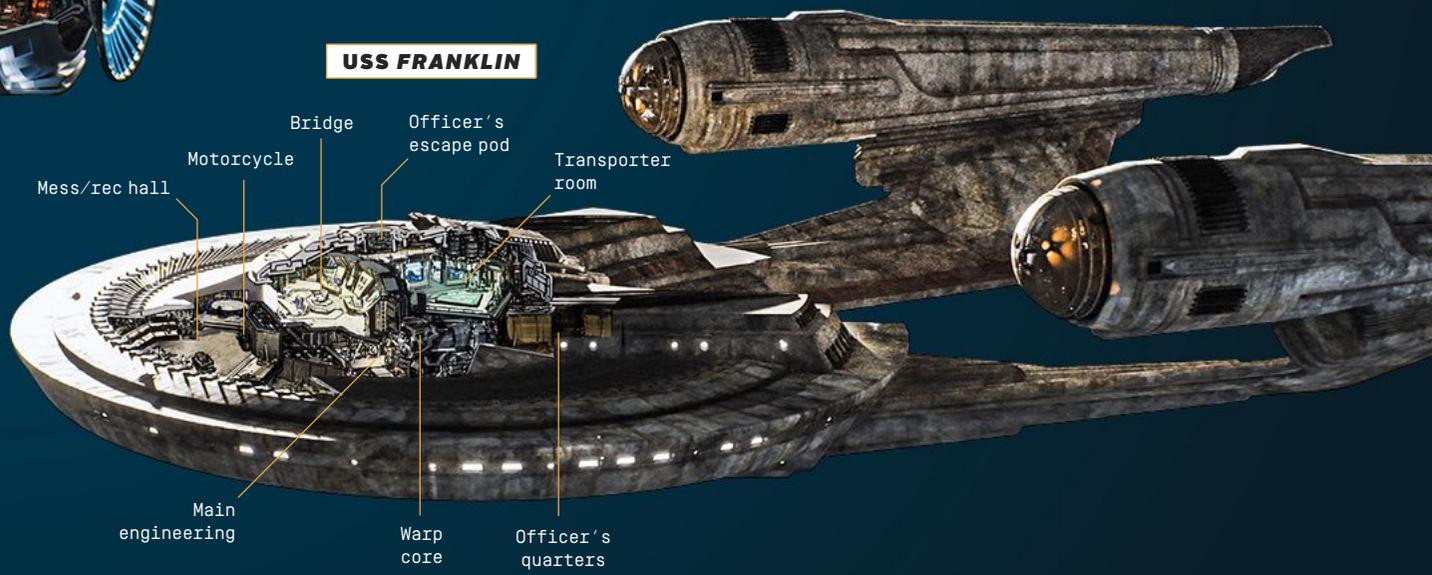
Warp coils

Warp-field condensing apparatus

Warp-nacelle frontal field node



**USS FRANKLIN**



**ABOUT THE ARTIST WHO CREATED THESE AWESOME IMAGES**

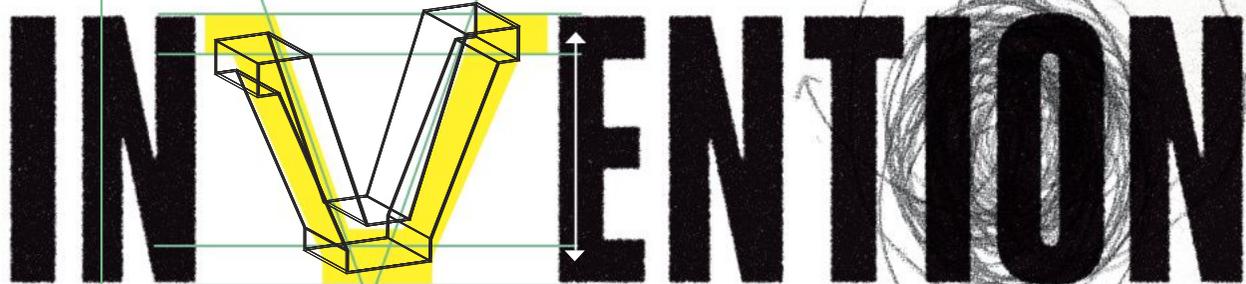
**KEMP REMILLARD** is a graphic designer who started out drawing scenes for the video game Lair. He's created concept art for dozens of games and movies, including *Skyrim*, *G.I. Joe*, and *Transformers 1 and 2*, and for Star Wars ships in the book *Star Wars: The Force Awakens Incredible Cross-Sections*. To draw these images, which were created exclusively for Popular Mechanics in cooperation with J.J. Abrams's production company, Bad Robot, Kemp watched clips of the new movie and superimposed the details on existing 3D renderings from set designers.



The United States Patent and Trademark Office in Alexandria, Virginia, issues more than 150,000 patents each year.

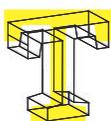
# THE GREATEST AMERICAN

# INVENTION



Once a haven for innovation, over the last two decades the **U.S. PATENT AND TRADEMARK OFFICE** has been rocked by the velocity of technological change and roiled by “patent trolls.” Could it be that the biggest impediment that innovators now face is the very system that was created to protect them?

BY SCOTT EDEN // PHOTOGRAPHS BY RICHARD BARNES

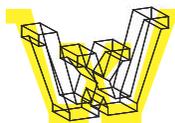


**ROY NORRED WAS ON HIS WAY HOME** for Thanksgiving in 1998 when he had his flash of genius. It was the middle of the night, his wife was driving the family car, and his four children were asleep in the back. He'd just finished his shift at the hospital, where his workweek often exceeded a hundred hours. Two days shy of thirty-one, Norred was a fellow in the cardiology program at the University of Missouri. For more than a year he'd been stewing over an idea, and so powerful was his sudden insight now—*surface area in the aortic root!*—that he told his wife to pull over. He made a sketch on a napkin. That sketch would become the breakthrough that led to U.S. Patent No. 6,482,228, “Percutaneous Aortic Valve Replacement,” granted in November 2002 by the United States Patent and Trademark Office. It would also become the basis for an idea that Norred would spend the next four years failing to interest anyone in financing the development of—not his superiors in the cardiology department at Missouri, not the venture-capital firm that flew

him to Boston to hear his pitch, not the cutting-edge innovation guru at Stanford who initially encouraged him but then ended the conversation, not the product-development people he signed non-disclosure agreements with at Medtronic, Edwards Lifesciences, Johnson & Johnson, Guidant, and others. The idea was for a collapsible prosthetic aortic valve that could be fished up through an artery with a catheter and implanted in the hearts of patients who suffered from failing aortic valves.

By September 2003, Norred had all but given up on his dream when he and a colleague were strolling the exhibition hall at an important cardiology congress held annually in Washington, D.C. They came upon a booth occupied by a California startup called CoreValve. With increasing alarm, Norred studied the materials at the booth. He turned to his colleague: "That's my valve!"

According to documents filed in a legal case that lasted more than three years and wound its way through multiple federal courts, Norred tried unsuccessfully to discuss a licensing deal with CoreValve. He says he reached out to the startup's then chief executive, a Belgian Congo-born medical-devices entrepreneur and investor named Robrecht Michiels, who told him that a license would need to wait until after CoreValve had grown out of the startup phase. (Michiels denies saying any such thing.) Norred tried to follow up with CoreValve, but his calls and letters went unanswered. Years passed. Norred settled into private practice and then, in 2009, he saw the news online: CoreValve had sold itself to Medtronic for \$775 million in cash and future payments. Today, collapsible prosthetic valves fished up through an artery with a catheter and implanted in the aorta are well on their way to becoming the standard method of replacing worn-out heart valves. The annual market has already surpassed \$1.5 billion and is expected to grow in the coming years by orders of magnitude.



**WHEN NORRED** first saw CoreValve's version of his patented invention, he did not know

that the U.S. patent system had entered an era of drastic change. Starting in the early 2000s, the rights and protections conferred by a U.S. patent have eroded to the point that they are weaker today than at any time since the Great Depression. A series of Supreme Court decisions and then the most important patent-reform legisla-

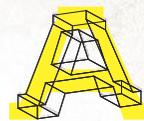
tion in sixty years, signed into law in 2011, have made it so. The stated purpose of the reform has been to exterminate so-called patent trolls—those entities that own patents (sometimes many thousands of them) and engage in no business other than suing companies for patent infringement. The reforms have had their desired effect. It has become harder for trolls to sue. But they've made it harder for people with legitimate cases, people like Norred, to sue, too.

According to many inventors, entrepreneurs, legal scholars, judges, and former and current USPTO officials, the altered patent system harms the independent, entrepreneurial, garage-and-basement inventors,



Dr. Troy Norred filed for a patent for a replacement aortic valve in 2000. Despite versions of his invention accounting for billions in sales, he has not profited.

who loom as large in our national mythology as the pilgrim and the pioneer. In the words of Greg Raleigh, a Stanford-educated engineer who came up with some of the key standards that make 4G networks possible, "It has become questionable whether a small company or startup can protect an invention, especially if the invention turns out to be important." Some call it collateral damage. Others maintain it was the express purpose of the large corporations to harm inventors. But, in the end, the result is the same. The Davids have been handicapped in favor of the Goliaths. Those who believe that innovation's richest sources lie as much in garages as in corporate R&D labs have grown fearful. "We clearly had the world's best patent system, based on the results," says Palo Alto venture capitalist Gary Lauder. "And that is going away."



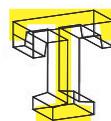
**AS A RESIDENT AT** the University of Oklahoma Health Sciences Center in the mid-1990s, Troy Norred saw an elderly male

patient who was in all ways healthy except for a failing valve in his aorta. At the time the only way to treat that condition was to open up the man's chest, stop his heart, bypass it, carve out the old valve and suture in a rigid artificial one. The patient was too old for such a procedure. He died. "Why can't we replace his valve in a way that would not create such havoc on his system?" Norred asked himself. "What would such a replacement look like?" Most important, he realized, the valve would need to withstand the tremendous pressure of blood pumping constantly through it.

On that Thanksgiving drive, he thought he had figured it out. His idea involved the surface area of the tubular aortic root and an expandable nitinol stent, also tubular, with a pig valve attached to it. The stent would expand against the tissue wall of the ascending aorta, anchoring the new valve in place and creating a seal without the need for barbs or staples or sutures, which tend to break over time. The surface area was the key. The more area the stent could expand against, the stronger it would adhere and the better it would keep the valve in place.

The insight invigorated him. He went to a local slaughterhouse and had the packers chainsaw-cut the hearts out of pig carcasses. He dropped the hearts—famously similar to human ones—into vats of liquid nitrogen. He stored them at home in the fridge, exasperating his wife. He talked his way into a cold lab at the university's agricultural engineering department and made epoxy models of pig hearts and pig aortas and pig aortic valves. He built prototype artificial valves and inserted them into the models. With the help of a materials engineer, he mathematically modeled his invention. The key to the math turned out to be a load-bearing equation.

All that work, however, was for naught. For his fellowship research project, he proposed a set of experiments that would further test his invention. The estimated cost was high: \$70,000. The proposal was rejected, and would continue to be, in other venues and by other entities, until Norred eventually gave up.



**THE TERM "PATENT TROLL"** was invented at Intel in 1999. This was the heyday of the PC-computing era, and Intel's office of general counsel was con-



U.S. PATENT BOUND VOLUMES  
9,029,110 THRU 9,081,312

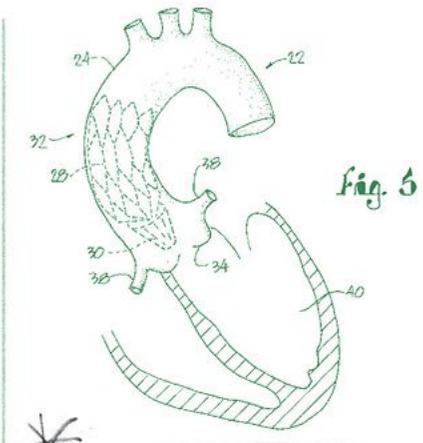
U.S. PATENT BOUND VOLUMES  
8,976,390 THRU 9,029,109

Although the archive has since been digitized for improved searchability, the USPTO retains paper copies of every patent filed.

stantly receiving threats from people who wanted to sue for patent infringement. Some were established competitors angling for cross-licensing deals. Some appeared to be failed startups trying to wring something from their last remaining assets: their patents. Others were lone-wolf inventors no one had ever heard of. And still others were groups of lawyers who'd accumulated patent "portfolios" and were now seeking a return on their investments.

None of these plaintiffs were looking to create and sell products based on the inventions described in the patents. They were "nonpracticing entities," or NPEs, and their main goal was to use the menace of a lawsuit to pry a licensing fee from the company.

Intel's legal department wanted to come up with a term that would suitably vilify these new irritants. Citing the "Three Billy Goats Gruff" folktale and its avaricious goblin crouched underneath the bridge, an underling on the Intel legal team had an idea. Patent troll. Everyone loved it.



An image from Norred's patent application. Unlike previous valves, Norred's stent disperses the force needed to hold it in place against the aorta's walls, requiring no sutures.

"Make no mistake," says Ron Epstein, a lawyer in Intel's patent and licensing department at the time, "it was a pejorative term consciously created to make people feel bad about asserting their own patents."

The plan worked beyond anyone's imagining. Perhaps no figure is more reviled in Silicon Valley today than the patent troll. Often that disdain seems to cross into a

loathing for patents themselves. According to Terry Rae, a former deputy director of the USPTO, "There's an anti-patent feel" in Silicon Valley. "It's almost religious." The attitude is perhaps most typified by Elon Musk, who has declared the ideas contained inside Tesla's patents free to anyone for the taking. Echoing Henry Ford, who openly pined for the abolition of the patent system, Musk has described patents as "intellectual property land mines" that inhibit progress.

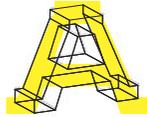
That attitude has spread, like technology itself, from the West Coast to the rest of the country. A largely collaborative project evolved among Silicon Valley's giants to lobby Washington. They formed Beltway pressure groups with names like the Coalition for Patent Fairness. Their message was clear: Something must be done to combat the scourge of the troll. Those pressure groups funded studies, including one conducted by legal scholars at Boston University in 2011 that proclaimed lawsuits by trolls to be "associated with half a trillion dollars of lost wealth to defendants from 1990 through 2010, mostly from technology companies"—assertions that have been undermined by subsequent studies. Even so, a report from the President's

Whenever an independent inventor sues for infringement today, an immediate suspicion attaches to the case. The anti-patent feeling is such that to assert one is to become stigmatized as a troll or, worse, a con artist or a quack.

Council of Economic Advisors in 2013 repeated those same claims.

But according to Epstein and other Silicon Valley insiders, the real goal of these lobbying efforts wasn't to kill trolls or even to curtail patent litigation. Though big tech corporations still spend many billions a year on R&D, the outlay has shifted from the R to the D—that is, the developmental work of bringing to market that which has already been invented. This means that big companies increasingly obtain their innovations not from their own efforts, but by acquiring them from startups, small inventors, and universities.

One way to make those acquisitions cheaper is by weakening patent protection. You make it harder to sue. If a patent no longer protects an invention as strongly as it once did, a big tech company is in a much better position to negotiate a lower price for licensing a patented invention.



**AFTER COREVALVE WAS** sold to Medtronic in 2009, Norred's attorney, James Kernell, sent a letter to the company, seeking a license. Norred and Kernell were optimistic. After all, in April 2010, Medtronic had lost in spectacular fashion an infringement lawsuit brought by its archrival, Edwards Lifesciences. Edwards had asserted a patent for a catheter-implanted replacement aortic valve that was much less similar to CoreValve's device than was Norred's. (Medtronic would eventually pay Edwards close to \$1 billion.) A yearlong back and forth between Norred and Medtronic ensued. Early on things looked promising, especially when, Kernell says, he verbally floated a fig-

ure of \$40 million that a Medtronic attorney indicated was in the ballpark. "I thought we pretty much had a deal in place," Kernell says. Norred was ecstatic. But then communication began to slow, and in December it stopped entirely. Calls and emails went unreturned. Medtronic had gone dark.

Just a few weeks later, in January 2011, a new bill was introduced in the U.S. Senate. This was the America Invents Act, the jauntily named patent-reform law that was the culmination of years of lobbying by many large companies led by those in the technology sector. On its way to the White House, the bill received more bipartisan support than any piece of legislation yet voted on during the Obama administration. It was designed to undermine the business model of the patent troll, and it contained a potent new mechanism for voiding nettlesome patents. But it also had an unintended consequence: The new bill drastically handicapped inventors in

The National Inventors Hall of Fame sits off the soaring atrium lobby of the USPTO. There are museum exhibits and a gift shop.



## TROLL OR INVENTOR?

### PATENT HOLDER

GORDON F. BREMER

VS.



### CLAIM

Sued for infringing his patents describing Bluetooth.

### POSSIBLE ISSUE

Jaap Haartsen was inducted into the National Inventors Hall of Fame in 2015 as the inventor of Bluetooth.

S.I. HOU

VS.



Sued for copying his fuel-injection technology and using it in the F-150.

Hou's patent was filed in 2002. Fuel-injection technology has been used in cars since the 1980s. (Although Hou claims to have had the idea back in 1985.)

THOMAS WILKINS

VS.



Sued, claiming to be an uncredited inventor on two wind-turbine patents.

Lost the case. The court found Wilkins to possibly be a pawn of Mitsubishi (which was being sued by GE for patent infringement on the very patents Wilkins sued over) who had "no credibility."

BEN GROBLER

VS.



Sued for infringing upon the technology for data vending used in iTunes and PlayStation Network.

None, really. After filing an IPR petition, Sony settled with Grobler and dropped the petition, leaving Apple as the sole defendant, unable to file an IPR petition of its own.

MARTIN DAVID HOYLE

VS.



Sued for infringing on his invention of targeted banner ads on the internet.

Hoyle's company, B.E. Technologies, has never shown any inclination to license its patents. It only sues, and in this case, its suit is based on technology that may have existed before the patent was issued in the early 2000s.

favor of big companies. Inventors like Norred, Medtronic, it turns out, was one of the bill's many corporate proponents.



**NORRED WASN'T** a troll, and the decision to sue did not come easily for him. His lawyer told him that the cost to litigate could exceed half a million dollars. Norred did not have half a million dollars. He considered letting it drop and moving on with his life, but in the end he couldn't. "It's hard to give up on something you've worked so hard on," he said. His attorney agreed to work on a contingency basis. On February 6, 2013, Norred asserted his patent.

Whenever an independent inventor sues for infringement today, an immediate suspicion attaches to the case. The anti-patent feeling is such that to assert one is to become stigmatized as a troll or, worse, a con artist or a quack. But there's another way to look at these litigants. It could be that an inventor-plaintiff is a modern-day Bob Kearns, the Michigan engineer who spent decades fighting the global automobile

manufacturing industry over the intermittent windshield wiper. They made a movie about it called *Flash of Genius*.

Though individual inventors such as Norred are the plaintiffs in less than 10 percent of the total number of patent infringement suits filed in the U.S., they are, like Kearns, tenacious—even more so than conventional patent trolls, or even the huge companies that sue and countersue and make headlines (*Apple v. Samsung v. Apple*). That 10 percent figure comes from a study led by a legal scholar at the University of Illinois named Jay Kesan. It would appear that most inventors who sue believe they're in the right to such a degree that they're willing to battle until the bitter end, Kesan says. There's an obvious reason why. "They have so much of their personal selves bound up in their inventions."



**NORRED CURRENTLY** lives with his wife and teenage son—three other children are away at college—in rural Ada, Oklahoma, where he's had his cardiology practice since 2002. Aside

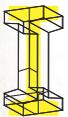
from his McMansion of a house, Norred's twenty-acre property contains a complex of outbuildings: a garage, a chicken coop, a barn, and a workshop, where he spends most of his time when not seeing patients.

To get to the workshop you walk past a swimming pool and, nearby on the patio, a large wood-burning oven that resembles a stone igloo. (Norred designed the oven. He once tried to heat the pool with it.) An exercise room with mirrors on the walls occupies one of the outbuildings. Equations scrawled in grease pen cover the mirrors as Norred works out a problem involving "anaerobic thresholds" and "capillary density" related to another of his inventions—an exercise contraption that would combine an elliptical with a lateral pull-down machine. His wide-open workshop has smooth, gray, poured-concrete floors. There are drill presses, a miter saw, a lathe, a table saw, a MIG welder, a massive workbench. Various brands of nitinol stent are laid out on the workbench; Norred has been systematically subjecting them to stress tests. A cabinet contains drawers full of cardio medical devices that he brought in



Prior-art searchers go through the USPTO's nearly ten million patents, looking for anything that can be used against an inventor.

here and deconstructed. A bench press sits in the middle of the shop. ("I've got an idea for a new type of bench press," he says.) An enormously heavy lead vat turns out to be a nuclear processing station, with which Norred once made his own nuclear isotopes. Somewhere in storage he has an entire cath lab that he acquired from a clinic in Georgia. He wanted to use it to conduct tests on his valve. A cardiologist friend of Norred's said, "He has a tendency to get to talking about something and you look at him and think: You're out of your mind."



**IN OCTOBER 2013**, eight months after filing his lawsuit against Medtronic, Norred got word of a troubling development. His patent had been IPR'd. The letters stand for *inter partes review*, which refers to a sort of extrajudicial system that exists inside the USPTO. Any party can petition a special tribunal within the Patent Office to challenge the validity of any already granted patent. The petitioner effectively says: This patent is junk, and here's why, forcing the patent's owner to defend it in a trial before a panel of three administrative judges—people with both technical

and patent-law backgrounds, often former patent examiners. For a patented invention, an IPR is an existential test. To lose is to vanish from the system as an invention. Most of the time the entity making the IPR challenge is a company that's been sued for patent infringement. The motivation is obvious: Get the patent invalidated and the lawsuit disintegrates. So that's what Medtronic tried to do.

IPRs were established with the America Invents Act in 2011. A large portion of the AIA addresses the issue of so-called patent quality. During the '90s and early 2000s, amid the blossoming of so much groundbreaking technology, it is widely understood that the USPTO granted a raft of patents it shouldn't have. Historically, this is not uncommon. Whenever explosions of technology have occurred in the past, the Patent Office has struggled to keep up with the resulting surge in applications. The fuel trolls feed on is the vague, too broad, illegitimately issued patent. A company couldn't launch a new product, it seemed, without potentially infringing scores of other patents. IPR tribunals were seen as a way to clear the system.

But they also have had an unfortunate side effect. IPR tribunals make it easier for sophisticated defendants to kill patents held by legitimate inventors. The first IPR challenges started rolling in to the USPTO in September 2012, and the first decisions

were handed down a little more than a year after that. By July 2014, in the middle of Norred's IPR ordeal, the tribunals were invalidating 70 percent of the claims in the patents that went to trial. Randall Rader, at the time the chief judge of the Federal Circuit—which is, among other things, the nation's appeals court for infringement suits—has called the tribunals "patent death squads." Not surprisingly, large corporations have a different view. As Medtronic's chief patent counsel said publicly at a Washington event last year, "We love the IPR system."

The term "trial" in the IPR context is more figurative than literal. Both sides present evidence and the testimony of witnesses. But all of it is done through deposition and digitally filed documents, with the exception of a single physical hearing at which both sides' attorneys give oral arguments. Still, it can get expensive. The IPR alone ended up costing Norred more than \$100,000.

On October 8, 2014, Norred was deposed at one of his lawyers' offices in Kansas City. From the get-go, the encounter was tense. It became clear that a major pillar in the company's argument would be that Norred's valve was an amalgamation of already invented technology and hence not a patentable idea. In a very real sense Norred was now required, for a second time, to prove that his invention was a real invention.

Title 35 of the United States Code con-

tains a sequence of conceptual tests an idea must pass before it can be deemed patentable. The idea must not be a naturally occurring thing or a scientific principle. The idea must be “novel.” And the idea must not be “obvious” “to a person having ordinary skill in the art.” That is, your idea—if, say, it’s for a prosthetic heart valve—cannot be an amalgam of bits and pieces of already invented technology, what’s called “prior art,” whose combination would be obvious to an authority in prosthetic heart-valve design.

Back in 2000, when Norred first submitted his patent application, he didn’t realize that someone had already patented an idea for an aortic valve that could be implanted without surgery. Dr. Henning Rud Andersen, a Danish cardiologist, has said that the idea for a “transcatheter” valve first came to him in 1989. The lead patent examiner working Norred’s case indicated that Andersen’s patent represented major “prior art” that Norred and his patent attorney had to contend with in order to have the

damental of patent-infringement defenses. When sued, big companies unleash swarms of high-paid lawyers, who hire still other people tasked with searching the planet for any lethal prior art that might assassinate a patent. There are those who specialize in this. It is an actual profession: prior-art searcher.

Off the lobby of the main USPTO building in Alexandria, Virginia, is the Public Search Facility. If the country’s patent archive could be said to have a home, this is it. On its way to accepting its ten millionth patent, the digital archive is immense and getting only bigger—a kind of Borgesian library of civilization’s creep. Finding prior art is therefore both difficult and easy. There is so much to sift through yet so much to choose from. Late in the afternoon on almost any weekday, sitting at the cubicles and staring at the computer screens in the search facility’s large main room, the prior-art searchers are there. They can charge more than \$100 an hour.

The oral hearing for *Medtronic v. Norred* took place on an afternoon in late Janu-

one set of lawyers trying to pick a patent’s language apart, and the other desperately trying to defend the words as they stand in the original. “The IPR isn’t an effort to figure out whether an inventor invented something,” says Ron Epstein, the former Intel attorney. “It has turned into a process where you use every i-dot and t-cross in the law to try to blow up patents.” He adds, “There isn’t a patent that doesn’t have some potential area of ambiguity. If you set up the office so that no ambiguity is allowed, no patents will survive.”

At the oral hearing, Norred’s attorneys argued that the prior art cited by Medtronic was irrelevant. One of those pieces of art, a valve patented by an inventor named DiMatteo, wasn’t designed for use in aortas. Though the words “aortic valve” do appear in the DiMatteo patent, the invention, which has not been developed into a commercial device, is actually designed to replace the *venous* valve. And the other prior art describes surgically implanted valves, not ones that would go in with a cath-

At first Norred freaked. He’d been scooped. But as he read through the Andersen patent, he grew calmer. His valve was different in a fundamental way.

patent approved. At first Norred freaked. He’d been scooped. But as he read through the Andersen patent, he grew calmer. His valve was different in a fundamental way. Andersen’s valve is anchored to the aortic wall by a kind of “brute force,” Norred says, like a suspension rod. “Whereas I rely upon dispersing that force over a larger surface area. The reason that’s important biologically—you’re talking about tissue that’s not rigid, and the more force you put on it, the more likely you are to tear it.” The USPTO agreed. Patent granted. (Dr. Andersen eventually licensed his patent to Edwards Lifesciences, which then used it to sue Medtronic-CoreValve for patent infringement, extracting that \$1 billion payout.)

Now Norred was being forced to go through the process all over again. Only this time Medtronic was hurling prior art at him that he either had never seen before or had considered irrelevant. Taking those inventions together, Medtronic argued, Norred’s valve was obvious.

In many ways, there was nothing new about Medtronic’s tactics. Arguing that a patent is invalid is the oldest and most fun-

ary 2015. Inventors themselves almost never attend oral hearings, and neither did Norred. It’s just lawyers and their documents and their words. Typically each side gets about an hour to present its case, including rebuttals. Judges often telecommute to these things, so the lawyers at the podium end up addressing their arguments to flat-screen TVs outfitted with videoconferencing systems that sometimes go on the fritz.

To an outsider, an IPR hearing can seem almost totally incomprehensible. You understand the individual words coming out of the lawyers’ mouths, but any larger unit of meaning fails to find cognitive purchase on your mind. Partly that’s because of the highly technical nature of the inventions, and partly it’s because of the nature of patent law itself. A patent is made up of a set of claims, and the claims are chunks of prose that are meant to describe the parts of an invention. When the claims of a patent overlap with those of a prior one, the claims are said to “read” on the prior art. And so an IPR hearing becomes a painstaking interpretive exercise in linguistic analysis, with

eter, as Norred designed his valve to do.

Three months later, in April 2015, the tribunal ruled: “Petitioner has shown, by a preponderance of the evidence,” that DiMatteo was lethal to three of the twenty-four claims in Norred’s patent. Unfortunately for Norred, those three claims were the core of the invention. Without them, his patent collapsed into meaninglessness and Medtronic was immune to his challenge. Norred’s attorneys immediately appealed the tribunal’s decision. In May 2016, the appeals court ruled against him. It was over.

Back in Ada, Norred was of course dejected. It was as if he had been wiped clean from history. It was as though he had never invented anything at all. The notion galled him. Around the time of the IPR decision, Norred was working extra hours at a hospital outside Pittsburgh in order to pay for his legal costs. One of the other cardiologists there mentioned to Norred that he wanted to train in transcatheter aortic valve replacement. Norred couldn’t resist mentioning his invention. The doctor gave him a look of disbelief. “I’ve never heard of you,” he said. **PM**

# SCIENCE YOUR KIDS CAN PLAY WITH!

Popular Mechanics has partnered with Groovy Lab in a Box, a great new company that makes science kits for kids and mails them to your door.

Hands-on STEM learning with challenging experiments and fun final projects!



**SUBSCRIBE  
TODAY!**

at [groovylabinabox.com](http://groovylabinabox.com)!

# PROJECTS

## HOW TO BUILD A FENCE

You can have a house and you can have a yard, but neither are really yours until you have a fence to mark them off.

BY RYAN D'AGOSTINO

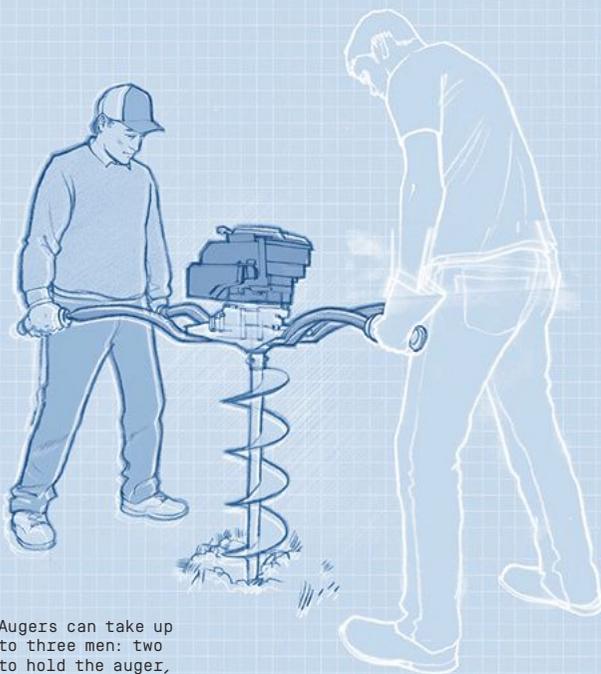
**W**hen we bought our house—an old house, beautiful little place—it needed a lot of work. Still does. But it's a sweet yellow house with a red barn out back and a creek running alongside. An endless field behind the barn gives the boys room to run, and the house has the original blown-glass windows, wide-plank floors, and the odd low door for whacking your head on.

Early on, I had as many items on my to-do list as I do now. Replace the base-

ment toilet. Install stairs to get to the attic, which was basically inaccessible. Paint all the mauve and Buick-blue trim. Weatherproof the windows. Spread mulch. Retile the upstairs bathroom floor. Figure out what kind of bugs are living in the barn. Fix the leaky shower faucet. Build a fence.

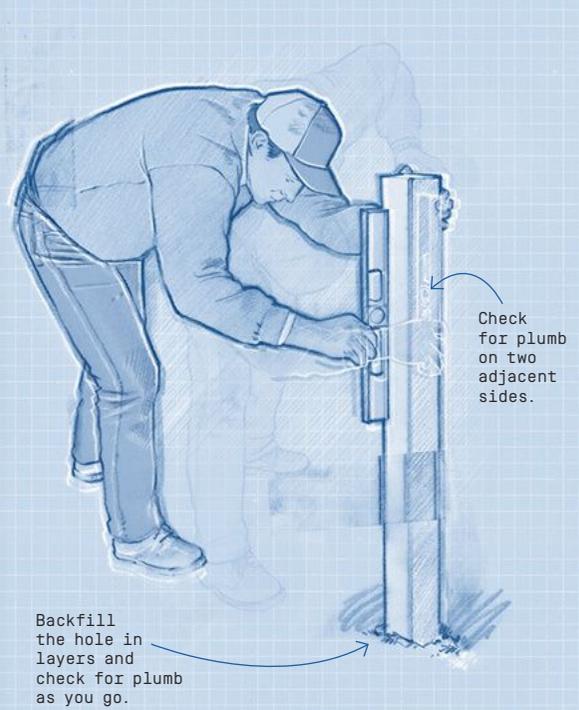
That last one kept rising to the top. The house, quaint as it is, sits a little close to a moderately busy road. And the only thing between the house and the road was a pathetic row of scraggly yews,

half-eaten by the deer that roam this part of the planet in astonishing numbers. Our town is largely a commuter town, so in the mornings, when everyone's rushing to the train station, and in the evenings, when everyone's rushing home for dinner, people tend to fly. We have two young sons who chase each other around the yard constantly, and I figured a fence would create a border they wouldn't cross. Instead of "Don't go over there by the road!" my wife and I could say "Don't go past the fence!"

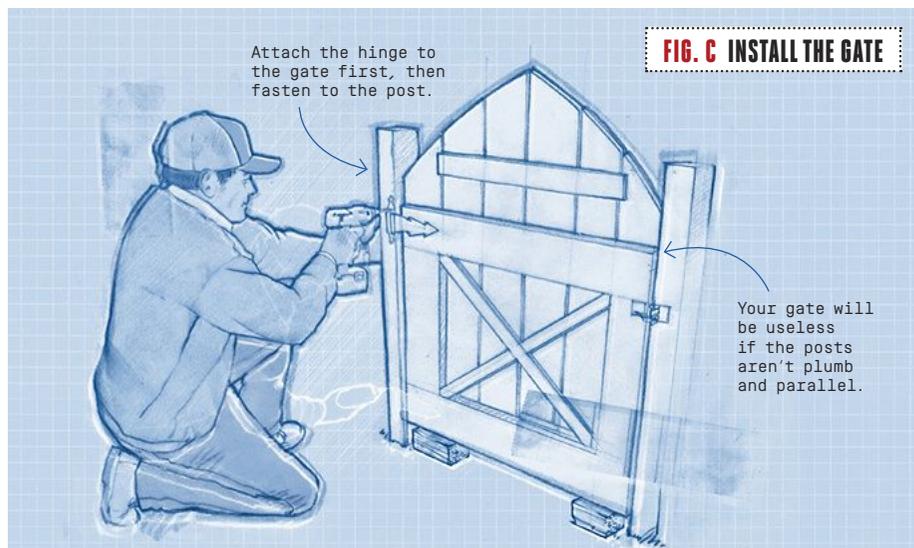


Augers can take up to three men: two to hold the auger, and one to pull out rocks.

**FIG. A DIG A HOLE**



**FIG. B SET THE POSTS**



But I think there was a deeper reason I put the fence job first. A man needs a fence around his land. How else would people know it was his? Maybe it's pride in the claim he has staked, not to mention the life savings he has given to the bank. Maybe we are territorial by nature. Like dogs peeing on trees. We bought this house, and I wanted to demarcate its borders for all to see. On the other side of the fence would be the business of the world—noisy, confusing, filled with other people living other lives. On our side of the fence: us. Our house, our memories, our chipping paint, our green grass, our secrets, the sound of our laughter and the sweet smells of the food we cook, our arguments and consolations, my falling asleep on the couch with ice cream dripping down my shirt, our movie nights and basement games, our bedtime routines, our morning rituals. Our home.

The fence I planned was simple: cedar picket, fifty feet, with a swinging gate in the middle. A classic look that suits the house, which was built in 1854. This is what I did.

## 1

### MEASURE

My first step, over the course of several weekends, was to do a lot of standing around in the yard rubbing my chin, staring at hypothetical, nonexistent fences. I measured—how far back from the road it should be, how long it should be, where it might turn a corner. Lots of walking around measuring. Richard, my neighbor, who, when I got this job a couple years later, would become a frequent contributor to this magazine, would often see me wandering around the yard and would come wander around too.

## THE VOCABULARY

Three constants that shape the building universe.

**LEVEL:** Parallel to the line of the horizon. The tool that checks for this is the level, of course.

**PLUMB:** The line of gravity perpendicular to the horizon. To check for this, you set a level on two adjacent vertical faces or on the corner where they meet.

**SQUARE:** The condition in which two lines meet or intersect at 90 degrees. The corner of two runs of fence should be square.

Eventually, I settled on a straight line parallel to the facade of the house (as opposed to the road), about sixteen feet from the street (to allow for parking between the fence and street), beginning at the property line I share with Richard and extending across the front yard to a point just shy of the driveway. With a gap in the middle for a gate. I marked the line with metal stakes.

## 2

### BUY MATERIALS

I wanted cedar, because it resists rot and splintering. You don't even have to treat it, although I planned to paint it white. I bought the fence and posts at Ring's End, a Connecticut-based chain of high-quality hardware and lumber stores. The fence is cedar gothic picket, four feet tall, available in panels of eight-foot lengths. I used five-inch-square posts, which are sturdier and, I think, better looking than four-inch, which look spindly by comparison. I bought Federal cedar caps for the top of each post and, since I hadn't yet bought my F-150, picked it all up using Richard's pickup truck, to avoid the delivery fee. Although I did gas up the truck, which was like sixty bucks.

## 3

### DIG THE HOLES

My plan was to dig each hole, set the post, then measure eight feet (the length of each fence panel) from the center of the post, and dig the next hole. The measurements had to be exact; if the posts were off by even a few inches, the lengths of fencing would be left dangling.

The books I had read—including *Time-Life's Porches, Decks & Fences* (six dollars in a used-book store)—and common sense told me

### HOW TO SET A POST



**First, dig the hole** as neatly as you can. An easy rule of thumb to determine hole size: Postholes are typically dug two to three times the post's diameter. For holes deeper than three feet, drop a plumb

bob [a conical weight attached to a string] into it to give you some sense whether the hole itself is plumb and uniformly shaped.

If you use wood posts, place some gravel in the bottom of the hole to keep the end grain off the soil and reduce the amount of

moisture the post wicks.

Place the post in the hole. Backfill with six inches of dirt, check that the post is plumb, and tamp down the dirt. Backfill with another six to eight inches of dirt, check that the post is plumb, and tamp down the dirt.

Fill the rest of the hole.

### TWO THINGS TO DO BEFORE YOU BUILD A FENCE

1. Call 811 to find out if there are buried utilities.
2. File for a zoning permit.

that the postholes needed to be dug so that their bases would fall below the frost line, otherwise the posts could heave and loosen in the winter. Where I live, that means at least thirty-two inches. And with the number of rocks in our soil, I knew a posthole digger wouldn't be enough. I drove to Home Depot to rent a two-man auger for \$100. An auger of this size is essentially a five-foot steel corkscrew with a 160-cc engine on top that spins it with tremendous force, driving it into the earth while two men hold it in place, trying not to get thrown to the ground or have their arms ripped off.

Fortunately, I had two guys helping me that day, both colleagues at *Esquire*, where I worked at the time. They'd overheard me talking about the fence project at the office and actually asked if they could help. They both gave the same reason: They felt like they were getting soft living in city apartments. They wanted some hard labor. I know, crazy, but they both showed up.

Three men was good. Two on the auger, one removing the melon-size stones that kept getting caught in its blades. First hole: not bad. The corkscrew went into the soil like an ice pick through a hamburger. Second hole: also a piece of cake. Like an ice pick through a piece of cake. Third hole: horrible. Rocks. Every time the auger hit a rock, the two auger guys had to lift it out (it was heavy) and the third guy had to dig the rock out of the hole by hand. On this hole we seemed to hit a rock every couple inches.

It went like that. Sometimes you get on a run. Sometimes you hit seventeen rocks that jam the auger every ten seconds.

It was hot. One guy had to leave after lunch—his girlfriend's parents were having a barbecue or something. So that left two of us. Now when the auger got stuck, one of us had to kneel down and dig the rock out. We were drenched with sweat. My hands were sweating through my gloves.

Sixth hole: tree root. Giant root. A python. The auger kept stopping abruptly, jerking our arms out of their sockets each time. I grabbed my chainsaw from the barn and, probably against the advice of the

# Paint Removal and Cleanup Made Easy



© 2016 Stoner, Inc.

To buy direct call: 1-800-346-1633

Available at:



For professional results every time...



# PEDAL DOWN. PULSE UP.



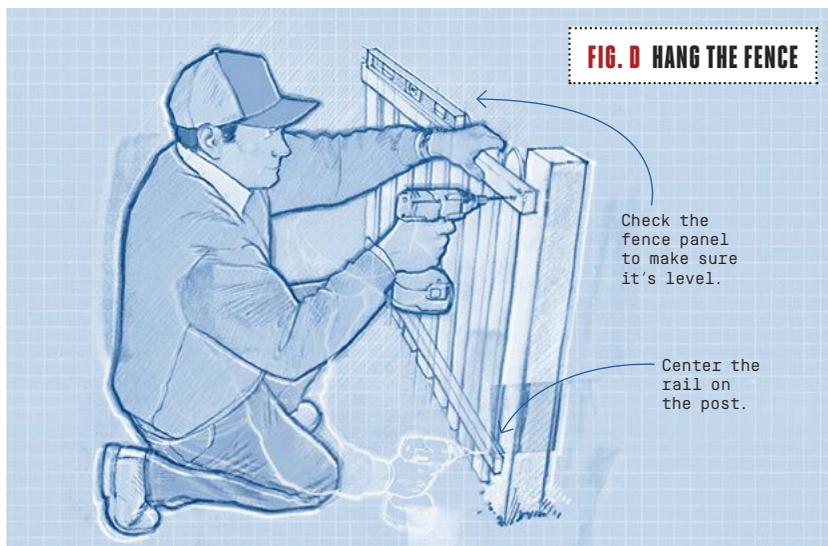
**NOW ANYTIME CAN BE GO-TIME.** K&N® High-Flow Air Filters™ are designed to increase horsepower with up to 50% more airflow. And with five-minute installation, better performance doesn't get much easier. Order yours online today.

KNFILTERS.COM | 800-858-3333

# K&N

**SUPERIOR AIRFLOW.  
SUPERIOR PERFORMANCE.®**

## PROJECTS



instruction manual, aimed the bar into the half-dug hole and cut the root out.

4

### SET THE POSTS

The most important tool in setting the posts is a level. I used a four-foot level and, for extra leveling power, a fifteen-dollar Stanley post level, which straps around a square post and tells you whether it's leaning forward or back or side to side. Cool tool.

The bottom of the post should rest on a couple of inches of gravel for drainage. (See "How to Set a Post," page 102.) Then I had to decide whether to set the posts in concrete. With all the roots and rocks we pulled out of the holes, many of them really disturbed the soil. In some places the soil was surprisingly weak and sandy. In others, it was like granite. We opted for concrete.

We shovel-mixed bagged concrete in a wheelbarrow and packed it around the bottom of each post. I plumbed the posts and used scrap lumber to brace them while the concrete cured. We did eight posts in about ten hours and almost died but didn't. At the end we went swimming in the creek and ate steaks.

5

### INSTALL A GATE

I had left a four-foot gap between two of the posts for a gate, aligned with an existing flagstone path. I was out there rubbing my chin one day, trying to design a gate, when

Richard wandered over. He had a beer for me. "What are you doing?" he asked.

I told him I was trying to come up with some kind of plan for a gate. He rubbed his chin. "Hang on a minute," he said, wandering off again. "I might..."

Five minutes later, he reappeared carrying a beautiful wooden gate—a sturdy frame with vertical planks hand-cut to form a curved peak, echoing the pickets themselves. It even had nice hinges. I could not have imagined a better gate myself.

He looked at me, blankly. I blinked.

"What...?"

"I made this... God, years ago," he said. "Fifteen years?"

"It's perfect," I said.

He walked it over to the gap. It slid between the posts as if it had been made for the space. An unbelievable fit. It looked amazing.

"Great," he said. "I'll get some screws."

I just looked at him.

He looked back and said, "What?"

This is what it's like having Richard as a neighbor.

6

### HANG THE FENCE

For a few days, or like about two months, the posts stood erect in the yard, fenceless. Friends in town started to ask things like, "So, is that it?"

I finally bought the picket fencing and screwed the ends of each horizontal backer to the posts using three-inch self-tapping wood screws. The screws were expensive,

## FENCE

### ESSENTIAL FENCE-BUILDING TOOLS



#### MASON'S LINE

Provides a bright visual reference.



#### SLEDGEHAMMER

Breaks rocks, drives marking stakes.



#### IMPACT DRIVER

Drives screws and lag screws with ease.



#### LEVEL

Levels panels and plumbs posts.



#### EARTH AUGER

Quickly digs postholes.



#### ROUND-POINT SHOVEL

Cleans up postholes, shovels dirt and concrete.

in part because they are large, but also because they're treated with a rust-resistant coating. You want that coating, otherwise the fasteners can rust through, and your fence can sag and fall apart, rust stains dripping down the crisp painted face.

My wife and I stained the whole thing with white Benjamin Moore Premium Exterior Stain, which was recommended by the guy at my local paint store. There was a professional painter in line in front of me buying paint, always a good sign. Some hardware stores sell only one brand, but this place has all kinds of paint, so I felt confident I was getting an honest recommendation.

Now I have a white picket fence. **PH**

## Come To Your Own Rescue With A Portable Jump Starter

A dead battery can leave you alone and stranded. Stay safe with the lightweight Portable Power Pack from Battery Tender®. Jump start your own car and never wait for a tow-truck again.



Featured Product P/N  
030-0001-WH

**IF YOU CAN'T START IT,  
YOU CAN'T DRIVE IT.**

Battery Chargers. Batteries. Jump Starters.

BatteryTender.com



amazon **THE HOME DEPOT**



# T-REX®

## FEROCIOUSLY STRONG TAPE®

**ALL WEATHER | WORKS LONGER | HOLDS STRONGER\*™**

**MADE  
IN THE  
USA**



**trextape.com**

\*than standard duct tapes

©ShurTech Brands, LLC 2016/65400

# WeatherTech®

New!



Size: 16" x 36"



Sizes: 24" x 39" | 30" x 48" | 30" x 60"

## BootTray™ | InDoorMat™ | OutDoorMat™

Available colors: brown, grey, black and tan

**WeatherTech.com • 800-441-6287**



For US Customers :

**WeatherTech.com**

©2015 MacNeil IP LLC



For Canadian Customers :

**WeatherTech.ca**



For European Customers :

**WeatherTechEurope.com**

## CREDITS

p. 3 Gatlin: Peter Bohler; factory: Getty Images; Star Trek: Kemp Remillard; books: Richard Barnes; p. 6 Pasquale: Getty Images; p. 8 hot dog, baseball player, Viking 1, shish kabob, Olympic flame, garage-sale sign, national park, Perseid meteor shower: Getty Images; Rocky: Everett Collection; Suicide Squad: Warner Bros.; Star Trek Convention: courtesy Creation Entertainment; p. 10 airport: Getty Images; p. 14 ice cream: Getty Images; p. 32 Monroe: Getty Images; p. 36 Devon Jarvis/Studio D; p. 40 tree: Corey Olsen; hammer holster: Devon Jarvis/Studio D; p. 45 Getty Images; p. 46 pork shoulder: Getty Images; casing, curing salt, sausage pricker: The Sausage Maker Inc.; meat grinder: LEM Products; p. 47 salami: Getty Images; p. 57 frog: Getty Images; p. 75 Johnson: Getty Images; p. 76 CoxBox: Jon Patterson/Studio D; Wynn: Getty Images; Kiefer: Getty/Hulton Archive; p. 78 Miller, Felix: Getty Images; p. 79 Nothstein: Getty Images; p. 81 Hsing, Keflezighi, Franklin: Getty Images; paddle and shoes: Matthew Faisetty; Westbrook: Peter Westbrook Foundation; p. 83 Hatch Show Print: Getty Images; blanket: Woolrich; p. 84 Coors Brewing Company: Getty Images 1xrt; p. 85 Fender Guitars: Allen Schaben/Los Angeles Times; Harley: iStock; p. 86 Tabasco bottles: courtesy Tabasco; p. 87 Kohler: courtesy Kohler; bag: courtesy Filson; p. 89 Musk: Getty Images; p. 105 shovel: Getty Images; p. 112 Barman: Barman; Bedjet V2: Bedjet.

**POPULAR MECHANICS** (ISSN 0032-4558) is published monthly except for combined July/August and December/January, 10 times a year, by Hearst Communications, Inc., 300 West 57th Street, New York, NY 10019 U.S.A. Steven R. Swartz, President & Chief Executive Officer; William R. Hearst III, Chairman; Frank A. Bennack, Jr., Executive Vice Chairman; Catherine A. Bostron, Secretary. Hearst Magazines Division: David Carey, President; John A. Rohan, Jr., Senior Vice President, Finance. ©2016 by Hearst Communications, Inc. All rights reserved. Popular Mechanics is a registered trademark of Hearst Communications, Inc. Periodicals postage paid at N.Y., N.Y., and additional entry post offices. Canada Post International Publications mail product (Canadian distribution) sales agreement no. 40012499, CANADA BN NBR 10231 0943 RT. POSTMASTER: Send all UAA to CFS. (See DMM 7074.12.5); NON-POSTAL AND MILITARY FACILITIES: send address corrections to Popular Mechanics, P.O. Box 6000, Harlan, IA 51593. Printed in U.S.A. **EDITORIAL & ADVERTISING OFFICES:** 300 West 57th Street, New York, NY 10019-3797 **SUBSCRIPTION SERVICES:** Popular Mechanics will, upon receipt of a complete subscription order, undertake fulfillment of that order so as to provide the first copy for delivery by the Postal Service or alternate carrier within 4 to 6 weeks. >>> Subscription prices: United States and possessions: \$24.00 for one year. Canada and all other countries: \$40.00 for one year. >>> Should you have any problem with your subscription, please visit service.popularmechanics.com or write to Customer Service Department, Popular Mechanics, P.O. Box 6000, Harlan, IA 51593. Please enclose your mailing label when writing to us or renewing your subscription. >>> Popular Mechanics is not responsible for unsolicited manuscripts or art. None will be returned unless accompanied by a self-addressed stamped envelope. **MAILING LISTS:** From time to time we make our subscriber list available to companies who sell goods and services by mail that we believe would interest our readers. If you would rather not receive such offers via postal mail, please send your current mailing label or exact copy to Popular Mechanics, Mail Preference Service, P.O. Box 6000, Harlan, IA 51593. You can also visit <http://hearsted4.net/profile/login.cfm> to manage your preferences and opt out of receiving marketing offers by email. **AS A SERVICE TO READERS,** Popular Mechanics publishes newsworthy products, techniques, and scientific and technological developments. Because of possible variance in the quality and condition of materials and workmanship, Popular Mechanics cannot assume responsibility for proper application of techniques or proper and safe functioning of manufactured products or reader-built projects resulting from information published in this magazine.

PROMOTION

# POPULAR MECHANICS WORK/SHOP

A COLLECTION OF PRODUCTS & OFFERS FROM OUR PARTNERS



## DIRTY CABIN AIR FILTER?

Improve airflow through your vehicle's A/C, heat and defrost system while protecting your nose, throat and lungs with a new Cabin Air Filter from RockAuto.com. Replacing the Cabin Air Filter is typically easy and should be done annually.

Visit [www.RockAuto.com](http://www.RockAuto.com) for more information.



**WOW SUPER COUPON**

**SAVE \$90**

Customer Rating **★★★★★**

**2500 LB. ELECTRIC WINCH WITH WIRELESS REMOTE CONTROL**

LOT 61258 shown  
61840/61297/68146

**BADLAND**  
comp of \$159.99

**\$69.99** ~~\$89.99~~

5855739

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**20% OFF**

ANY SINGLE ITEM

LIMIT 1 coupon per customer per day. Save 20% on any 1 item purchased. \*Cannot be used with other discount, coupon or any of the following items or brands: Inside Track Club membership, extended service plan, gift card, open box item, 3 day parking lot sale item, compressors, floor jacks, saw mills, storage cabinets, chests or carts, trailers, trenchers, welders, Admiral, Badland, CoverPro, Dayton, Diablo, Franklin, Hercules, Holt, Jupiter, Predator, Slik-Tek, StormCat, Union, Vanguard, Viking. Not valid on prior purchases. Non-transferable. Original coupon must be presented. Valid through 10/21/16.

58550035

**How Does Harbor Freight Sell GREAT QUALITY Tools at the LOWEST Prices?**

We have invested millions of dollars in our own state-of-the-art quality test labs and millions more in our factories, so our tools will go toe-to-toe with the top professional brands. And we can sell them for a fraction of the price because we cut out the middle man and pass the savings on to you. It's just that simple! Come visit one of our 650+ Stores Nationwide.

**WOW SUPER COUPON**

**FREE**

WITH ANY PURCHASE

**PITTSBURGH**

**6 PIECE SCREWDRIVER SET**

LOT 61313/62583/62728  
47770/62570 shown

**\$7.98** VALUE

LIMIT 1 - Cannot be used with other discount, coupon or prior purchase. Coupon good at our stores, HarborFreight.com or by calling 800-423-2567. Offer good while supplies last. Shipping & Handling charges may apply if not picked up in-store. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one FREE GIFT coupon per customer per day.

58556561

**WOW SUPER COUPON**

**16 OZ. HAMMERS WITH FIBERGLASS HANDLE**

**PITTSBURGH**

CLAW LOT 69006  
60715/60714

RIP LOT 47873 shown  
69005/61262

**\$3.99** comp of \$17.99

58511385

LIMIT 8 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**2.5 HP, 21 GALLON, 125 PSI VERTICAL AIR COMPRESSOR**

LOT 69091/67847 shown  
61454/61693/62803

**CENTRAL PNEUMATIC**

Customer Rating **★★★★★**

**SAVE \$339**

**\$159.99** comp of \$499

58537682

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

Customer Rating **★★★★★**

**18 VOLT CORDLESS 3/8" DRILL/DRIVER WITH KEYLESS CHUCK**

**drillmaster**

LOT 62868/62873  
69651/68239 shown

Includes one 18V NiCd battery and charger.

**SAVE 65%**

**\$16.99** ~~\$22.99~~

comp of \$49.21

58544710

LIMIT 5 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**RAPID PUMP® 1.5 TON ALUMINUM RACING JACK**

**PITTSBURGH**

LOT 69252/60569 shown  
68053/62160  
62496/62516

Customer Rating **★★★★★**

• 3-1/2 Pumps Lifts  
• Most Vehicles  
• Weighs 34 lbs.

**SAVE \$60**

**\$59.99** ~~\$89.99~~

comp of \$119.99

58553715

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**3-IN-1 ELECTRIC BLOWER VACUUM MULCHER**

**MULCHER**

LOT 62469  
62337 shown

Customer Rating **★★★★★**

**SAVE 29%**

**\$44.99** comp of \$63.88

58525143

LIMIT 4 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**TRIPLE BALL TRAILER HITCH**

**HaulMaster**

LOT 61914

Customer Rating **★★★★★**

**SAVE 77%**

**\$19.99** comp of \$89.99

58523014

LIMIT 6 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**6.5 HP (212 CC) OHV HORIZONTAL SHFT GAS ENGINES**

LOT 68120/60363/69730  
68121/69724 shown

**PREDATOR ENGINES**

Customer Rating **★★★★★**

**SAVE \$228**

**\$99.99** ~~\$119.99~~

comp of \$328

58526135

LIMIT 9 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**3 PIECE DECORATIVE SOLAR LED LIGHTS**

one stop gardens

LOT 95588/60561  
69462 shown

Customer Rating **★★★★★**

**SAVE 70%**

**\$8.99** comp of \$29.99

58553803

LIMIT 9 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**US GENERAL**

Customer Rating **★★★★★**

**30", 5 DRAWER TOOL CART**

LOT 69397/61427  
95272 shown

704 lb. capacity

**\$169.99** comp of \$349.99

58510162

LIMIT 5 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**FOLDABLE ALUMINUM SPORTS CHAIR**

LOT 62314/63066  
66383 shown

Customer Rating **★★★★★**

**SAVE 55%**

**\$21.99** comp of \$49.97

250 lb. capacity

58549793

LIMIT 3 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**HARDY SPLIT LEATHER WORK GLOVES WITH COTTON BACK 5 PAIRS**

LOT 66287 shown  
60450/62371  
62716/62714

Customer Rating **★★★★★**

**SAVE 73%**

**\$5.99** comp of \$22.45

58533375

LIMIT 8 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**7500 PEAK/7000 RUNNING WATTS 13 HP (420 CC) GAS GENERATORS**

76 dB Noise Level

Customer Rating **★★★★★**

**SAVE \$449**

**\$549.99** comp of \$999

58541405

LIMIT 6 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.

**WOW SUPER COUPON**

**GENTECH AUTOMATIC BATTERY FLOAT CHARGER**

LOT 69594/69955/42292 shown

Customer Rating **★★★★★**

**SAVE 82%**

**\$5.99** comp of \$34.99

58521017

LIMIT 6 - Good at our stores or HarborFreight.com or by calling 800-423-2567. Cannot be used with other discount or coupon or prior purchases after 30 days from original purchase with original receipt. Offer good while supplies last. Non-transferable. Original coupon must be presented. Valid through 10/21/16. Limit one coupon per customer per day.



# PING PONG CANNON

A project to build with your children.

DESIGNED BY JAMES SCHADEWALD



**OUR BUILDER:**  
Abraham Nixon is a nine-year-old from Pennsylvania.

**Difficulty:**  EASY | REASONABLE | HARD

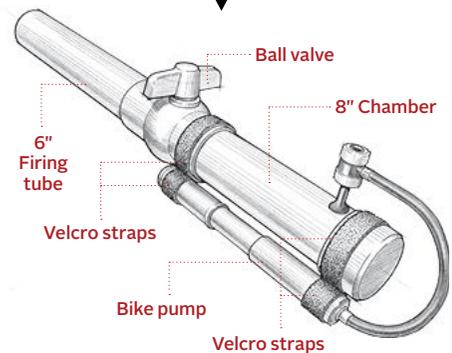
**Time:** 1 hour **Ages:** 9+



## Shopping List

QTY	DESCRIPTION
1	1½" x 24" PVC pipe
1	tubeless tire valve (part TR415, .625 rim hole)
1	1½" PVC slip cap
1	1½" PVC ball valve
1	¾" x 60" peel-and-stick Velcro roll
1	package PVC glue and primer
1	package ping pong balls or foam practice golf balls
1	travel bike pump

### DIAGRAM



### PROJECT NOTES

**OUR FIRST INCLINATION** was to make a ping-pong-ball shooter out of wood and rubber bands. The prototype was easy to build, but not very accurate. When the rubber band smacked the ball, the ball flew in any direction. The gun wasn't powerful enough, either. Unless you used a very large rubber band, stretched to its limit, most balls flew no more than two feet. Plus, the farther back you stretched the band, the more unpredictable the flight of the ball. So we started over.

Using PVC for the barrel greatly improves accuracy. And power is limited only by how much air you can pump into the chamber. This ping pong cannon can fire a ball up to 70 feet, but not with so much force that it will cause injury. We confirmed it on ourselves, taking direct hits from various distances. Just be careful if you use it indoors. We accidentally broke a glass.

**80¢** OVER 6 MILLION SOLD



1-888-641-9798  
www.discountssawblade.com

**KINEKT**  
INTERACTIVE JEWELRY

GEAR RING &  
GEAR NECKLACE

FREE SHIPPING & LIFETIME WARRANTY  
kinektdesign.com | 888-600-8494

*sold separately*

**MONKEYRACK®**  
LADDER STABILIZATION SYSTEM



WE  
HOLD  
EXTENSION  
LADDERS

941.747.8697 *Order Today!*  
www.monkeyrack.com



**TerraTrike**

Rediscover the joy and freedom of cycling!  
FREE CATALOG: 800-945-9910 TerraTrike.com

**5-Minute Fence Stain**



- Stain 100 ft of fence in just 5 minutes!
- Sprayer attaches directly to garden hose.
- No masking, simply hose off over-spray.
- One quart covers 600 square ft.
- Select from three natural wood tones; Natural Cedar, Dark Cedar or Redwood.

**BestStain.com**

**Automatic Plasma Torch Height Controller**

**kyndill**  
controller

- Save Money
- Save Time

**Better Cuts**

kyndillcontrol.com



**NEW and IMPROVED DR® Field and Brush Mowers**

*Faster, Easier...Lower-Priced!*

Mow fields, brush, even saplings with never-before ease!

**Plus**  
Tow-Behind Models starting at **\$1,399<sup>99</sup>**

**FREE SHIPPING 6 MONTH TRIAL**

SOME LIMITATIONS APPLY

Call for **FREE DVD and Catalog!**

TOLL FREE **888-212-8592**  
DRfieldbrush.com



92385X © 2016

**The EASY DR® Way to TRIM and MOW!**



**NEW LOW PRICE!**

**TRIMS, MOWS** thick grass and weeds without bogging down—the **ONLY** trimmer guaranteed not to wrap!  
**ROLLS** light as a feather on big, easy-rolling wheels!  
**THICKEST, LONGEST-LASTING** cutting cord (up to 225 mil) takes seconds to change.

**FREE SHIPPING 6 MONTH TRIAL**

SOME LIMITATIONS APPLY

Call for **FREE DVD and Catalog!**

TOLL FREE **888-212-8592**  
DRtrimmers.com



92386X © 2016

VISIT **WWW.EHEAT.COM** OR CALL **1-800-807-0107**

**envi**<sup>TM</sup>  
WALL-MOUNTED ROOM HEATER



**ENERGY SAVING**  
heats room as little as 4 cents per hour!

**SILENT**  
fanless design, auto dimming power light

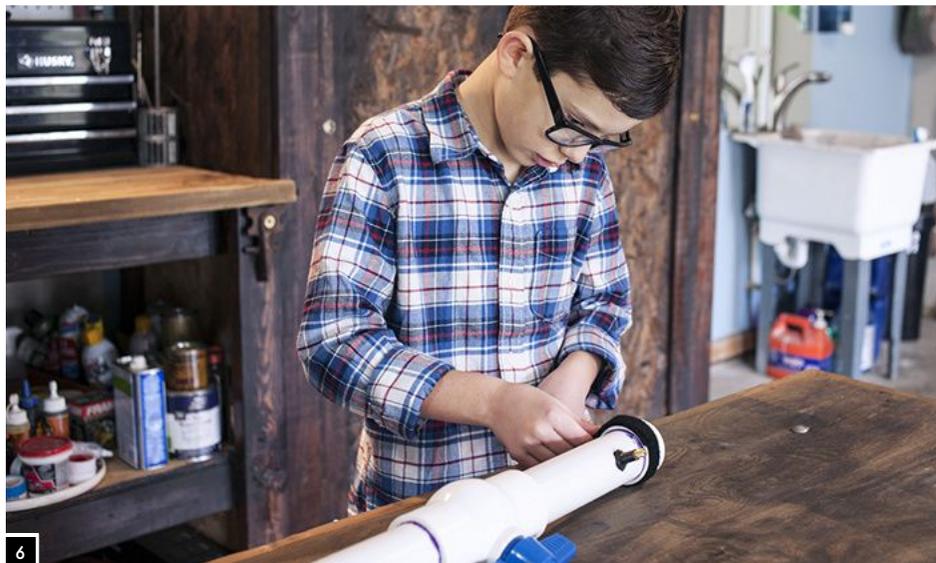
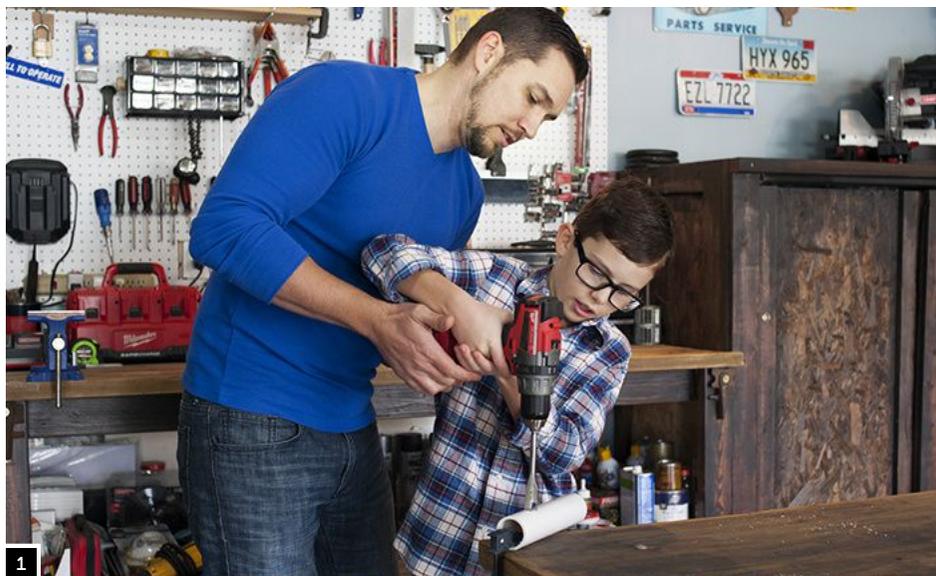
**ULTRA-SAFE**  
leave unattended 24/7; cool to the touch

**STYLISH AND SLEEK**  
slim space saving design, 19" w x 22" h x 2" thin!

**HEALTHY**  
fanless - doesn't blow dust or dry the air, great for those who suffer from asthma or dry eye

**EASY INSTALL**  
installs in minutes, no drill required; 6 foot cord 120v & 220v hardwired and plug-in models available

10% off coupon : PMJA1610 | 2 or more 15% off coupon: PMJA1615 | and get **FREE SHIPPING** to the continental USA & Canada\*



## Instructions

- kid only
- parent only
- parent and kid

- **1.** After crosscutting the PVC pieces to length, secure the 8-inch piece to your workbench by inserting the jaw of a clamp into the pipe. Use a holesaw or spade bit running at a slow and constant speed to make a  $\frac{3}{8}$ -inch hole for the tubeless tire valve,  $2\frac{1}{2}$  inches from the end of the pipe.
- **2.** Slip the tubeless tire valve through the end of the pipe and work its stem up through the hole you just drilled. Pull the valve into position with pliers, being careful not to damage the threads. You won't need glue, but you will need to ensure that the upper flange of the valve is completely outside the pipe.
- **3.** Apply PVC primer followed by PVC glue to the end of the pipe closer to the valve. Do the same on the end cap. Press the parts together, then give the end cap a small twist to distribute glue into the joint.
- **4.** Lubricate the ball valve with a few drops of oil.
- **5.** Apply primer and glue to the mating surfaces of the ball valve, one end of the 8-inch pipe, and one end of the 6-inch pipe. Press the parts together and twist slightly to distribute the glue. Make sure you twist far enough that the tire valve isn't directly in line with the ball-valve handle.
- **6.** Run a length of peel-and-stick Velcro around the end cap and another between the ball valve and the tire valve. Wrap corresponding pieces of Velcro to the bike pump, the same distance apart as the Velcro on the cannon. Attach the pump head to the tire valve. To operate, pump as much air as you can into the cannon, then turn the ball valve to fire!

**GIVE**

Start a child you know on a lifetime of projects with a gift subscription to Popular Mechanics. Go to [popularmechanics.com/gift](http://popularmechanics.com/gift).

# Chips Happen

PAINT CHIP REPAIR KITS

NO PAINT BLOBS . PERFECT MATCH

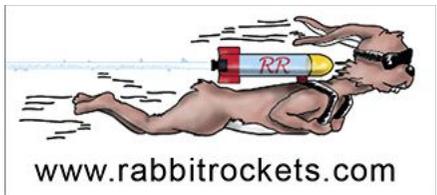


RATED #1 BY THE WALL STREET JOURNAL



Phone: 866-372-2548  
ORDER YOUR KIT ONLINE:  
WWW.DRCOLORCHIP.COM

DR. COLORCHIP™  
AUTOMOTIVE PAINT CHIP REPAIR SYSTEMS



www.rabbitrockets.com

SOON THE GOVERNMENT will enforce the "MARK" OF THE BEAST as CHURCH and STATE unite!  
**OFFER GOOD IN USA ONLY**  
Need your mailing address for FREE BOOKS / DVDS  
TBSM, Box 99, Lenoir City, TN 37771  
thebiblesaystruth@yahoo.com. 1-888-211-1715.

TEXT **PM2DAY** to **617-657-4212**

★★★★★  
—Tesla owner  
Free 2-Day Shipping

Out/Indoor **SELECT-FIT** only \$99.95  
Indoor **SELECT-FLEECE** now \$139.95  
Get both **FIT + FLEECE** car covers for \$230.00

**MICROBEAD**  
MicrobeadCarCovers.com  
**888-627-1129**

WACHES TAVERN  
GRILL  
BAR AND GRILL  
EST. 1919

CLUB SCHMITZ BEER

**DIVE BAR SHIRT CLUB**

Sorta We're OPEN

**Join the Club!**  
You'll get a new T-shirt every month from the best bars you've never heard of!

**DiveBarShirtClub.com**

**Underbed Dressers**

Put Up to 24 Drawers Under Your Beds

**ultimatebed.com**

**Best. Scraper. Ever.**  
Cleans while you're using it! All of the waste goes into your vacuum!

Connects to your shop vacuum.

The **Viper** Scraper  
Ideal for dust-free scraping including:

- Paint Scraping
- Lead Abatement
- Hardwood Floors
- Stucco Removal
- Popcorn Ceilings
- and Much More!

Proudly Made in the USA

Pat. Pend.

Hose and cuff not included.

Totally compatible with the Dust Deputy® to protect your shop vacuum's filter!

**It's the tool that home renovators can't be without!**

Like **Call Today for Information!**  
**1.800.732.4065**

**Oneida Air Systems**

**See the Products in Action!**  
**www.oneida-air.com**

**NEW!**

**Oil Vanish**™  
Oil Stain Remover

Before After

Available at these fine retailers

**AutoZone**  
**amazon.com**  
**MENARDS**  
**Do it Best**  
**BOND** AUTO PARTS  
**THE HOME DEPOT**

Quickly dissolves oil stains from driveways, garages and parking areas. Penetrates deep to lift the toughest stains - new or old.

Easy-to-Use: Apply, Scrub and Rinse.

Removes Oil & Grease Stains from Concrete Driveways, Garages & Parking Areas

Visit **OilVanish.com**

# STUPID or AMAZING

THIS  
MONTH

## TABLETS

BY  
KEVIN DUPZYK



STUPID



AMAZING

**WHEN STEVE JOBS** unveiled the original iPad in 2010, he proclaimed it a first-of-its-kind device that would “connect users with their apps and content in a much more intimate, intuitive, and fun way than ever before.” But the man in the black turtleneck overlooked one important thing: Everyone already had an intimate, intuitive, and fun relationship with a device they had on them at all times: their smartphone. Six years later, our favorite pocket-size assistant (and security risk) has become even more indispensable. Meanwhile, tablet sales have tanked—they were down 10 percent in 2015, hitting a low in the first quarter of this year not seen since 2012 (when they were on the way up).

But that doesn't mean the tablet is going anywhere. All the headlines proclaiming the uselessness and impending death of the tablet are based on a false assumption: that smartphones and tablets are supposed to serve the same functions; that a tablet is just a more cumbersome smartphone, minus the phone. But that's just it. Tablets were never meant for phoning. They were meant for writing (and watching movies and reading books and playing games, but mostly writing—and never taking pictures at concerts). Their forefather is not the landline but the spiral notebook. And for that purpose, tablets have become more astounding and essential than ever before.

Take worker efficiency. Last year the states of Washington, Texas, and Minnesota shared the results from a joint pilot program in which they equipped road inspection crews with tablets. The crews' old method was to jot down everything on paper, then head back to the office to type it up. Using tablets, they could more easily

record data (with the virtual keyboard), upload reports (with the cellular data connection), and even take pictures (with the built-in camera). The crews not only captured more detail, they did it faster—shaving nearly two hours off their workday. Across the three states, this resulted in a projected annual savings of \$27 million.

In healthcare, tablets are proving particularly invaluable. At hospitals in the U.K., electronic charts provide a way to automatically calculate patient risk levels. By removing human error, death rates dropped by 15 percent at two early-adopter hospitals. Here in the U.S., in 2013

Manhattan's New York-Presbyterian Hospital started putting tablets in some patients' rooms. They can be used to view medical records and review medications and to call nurses. Software development cost \$500,000 and tablets are only about \$500 each—a bargain compared to the \$40 million estimated cost of overhauling the hospital's existing call system.

Of course, tablets can be used for fun stuff, too. Anyone who's been on a cross-country flight knows binge-watching *Game of*

*Thrones* and playing Candy Crush is way more enjoyable on an iPad or a Surface than on a smartphone. But ultimately the greatest benefits of tablets are not in the form of entertainment. Tablets make us better at any task that requires writing or typing or drawing or painting, because now all those things can be spell-checked and hyperlinked and data-mined. And in Apple's case, they've gotten even easier to use—and even more like paper—since the introduction of the Apple Pencil late last year. Sure, Jobs was never a fan of selling a stylus, complaining it would be too easy to lose. But we're pretty sure traditional pencils had that problem, too. PH

**Headlines proclaiming the death of the tablet make a false assumption: that a tablet is just a more cumbersome smartphone, minus the phone.**

Instagram on... TABLETS



tiny\_dancer\_cat

FOLLOW

79 likes

13w

tiny\_dancer\_cat All these cats care about is surfing the web and playing on their iPads. #kidsthesedays #screentime #ipad #appleaddict #putdownthepad #catsplaying #catipad #teenagers #youths #catsofinstagram #cats #catstagram #cute #adorable #blackandwhite #instagram #love #play #catchthemouse #mainecoon #mainecoonkitten #beardedlady #whitecat

♥ Add a comment...



ELSEWHERE IN STUPID OR AMAZING . . .

### TRAPTAP

This widget for speeders crowdsources red-light-camera and speed-trap warnings, and its screenless design keeps your eyes on the road. You know, for safety.



STUPID

AMAZING

### THE BARMAN

An LED coaster weighs your mixing glass and flashes when you've added the right amount of each cocktail ingredient. Is it for bad bartenders or hosts who don't want to impress their guests?



STUPID

AMAZING

### BEDJET V2

A thin layer of cooled or heated air under the covers offers nighttime climate control. Comparison to electric blankets: Con—tickles your toes. Pro—avoids self-immolation.



STUPID

AMAZING

**“PROPANE.  
IT’S MAN’S BEST FUEL.”**



Making my rounds filling propane tanks with the person who feeds me, I've learned a few things. Like how propane is a clean, reliable, and efficient energy source. It also fuels some great outdoor living (and I should know about outdoor living).

Learn more at [proudlypropane.com](https://proudlypropane.com)

**PROUDLY  
PROPANE**

CLEAN AMERICAN ENERGY



©2016 Apple Inc. All rights reserved.

by Aaron P.



Shot on iPhone 6 

