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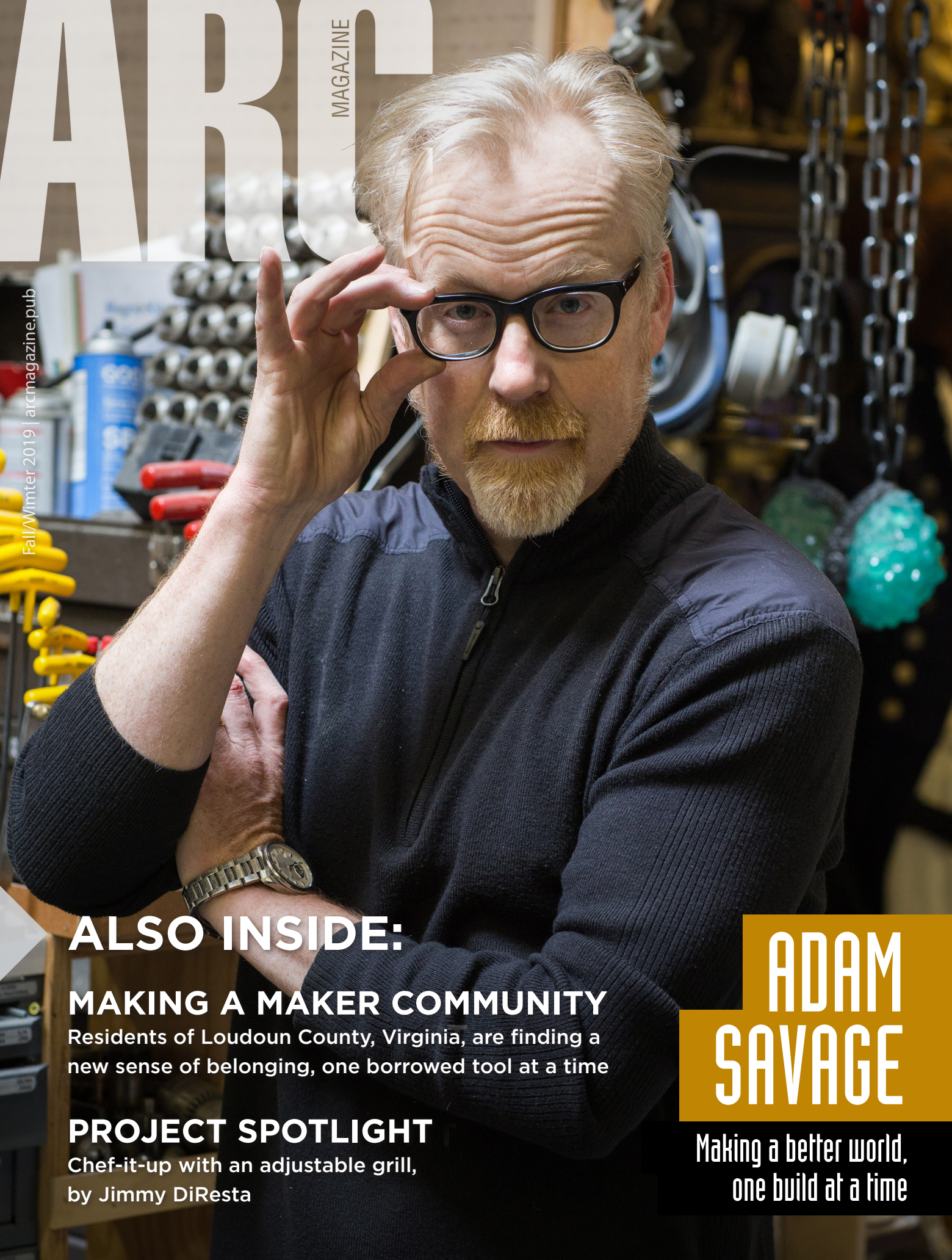

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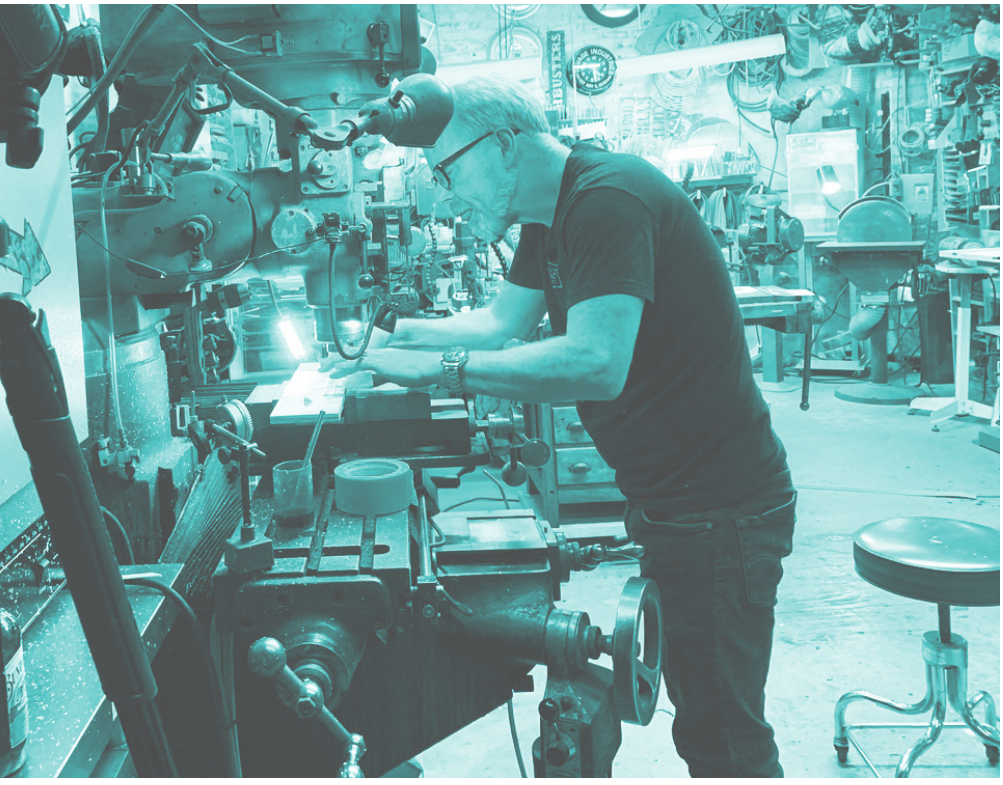

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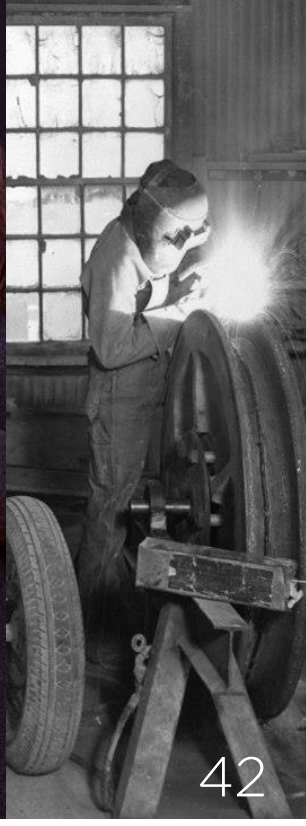

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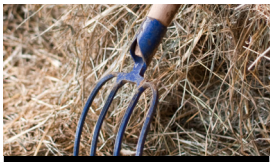
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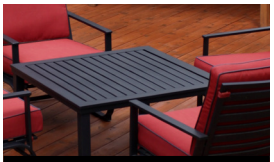
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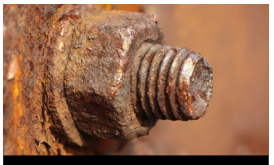
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LETTER FROM THE EDITOR

A TIME FOR EMPATHY

The clock goes round and round, the pages of the calendar fall away, and *ARC* comes to the end of another year. At this writing, the Midwest has already weathered its first snowstorm (in early November!) and the holidays are getting larger in the windshield. Despite the usual challenges of the year, and the hectic pace that's so often a part of the last months, we hope all of your projects – not just the ones in your shop, but the ones in every other aspect of your life – have been successful, and we hope you're finding some time to kick back and enjoy the season.

Of course, success can mean different things to different people – especially when it comes to welding, fabricating and any other form of making. Adam Savage, one of the most high-profile figures on the maker scene worldwide and the subject of our cover story in this issue, has some interesting thoughts on that topic.

You're probably familiar with at least some part of Savage's resume: decades of set and prop building for TV and theater; co-host of *Mythbusters* for 13 seasons; host of *Savage Builds*, which premiered this past spring; author of the bestselling *Every Tool's a Hammer: Life Is What You Make It*, a book he describes as a combination of autobiography, memoir and instruction manual.

For Savage, success in the maker movement shouldn't be a strictly individual pursuit. The real success comes when a culture divided by political and cultural rifts starts doing a better job of communicating, understanding and closing the gaps.

"It's important to me to constantly remember that there are people walking down any given street who live in a functionally different country than I do, because their experience is so different from mine," he says in his interview with *ARC*. "And to me, being easy to work with, or being a good collaborator with others, that's all part and parcel to the kind of empathy I'm talking about."

We sometimes ask ourselves, especially at this time of year, how much of a difference one person can actually make – if any at all. If we consider adopting a similar strategy to what Savage suggests here, the answer might surprise us.

On a final note, you've probably noticed a hiatus of sorts since the last issue of *ARC*. Some changes here earlier this year prompted us to suspend publication temporarily to give ourselves a chance to regroup and map out a plan for our future direction. In the end, you can rest assured that we plan to continue publishing the magazine as long as you continue to read it.

We wish all of you the best of the season, and we look forward to continuing the process of connecting and collaborating – and doing our part to close the gap – in the new year.

Happy holidays!

— John C. Bruening, Editor-in-Chief

Editor@arcmagazine.pub

CLARIFICATION:

Photography for the Alec Steele cover story in the Spring 2019 issue of ARC *was not properly credited. The following text should have appeared on the opening page of the article: "All images provided by Callan Ravesloot. All rights reserved." We apologize for the oversight.*

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QUESTION MARK

ARC taps into the vast experience of veteran tradesman, educator and author Mark Prosser (CWI/CWE). In addition to many years as a welder for the automotive and motorsports industries, Mark has also spent the last 15 years teaching welding at the college level, where he fields challenging questions from his students every day. He shares some of those questions – and his answers – with *ARC* readers.

Why won't my MIG welder run self-shielded flux core?

Keep in mind that there are two kinds of flux core wire: self-shielded and gas-shielded. MIG welding is done on DCEP polarity whether welding aluminum, steel, or gas-shielded flux core. However, self-shielded flux core requires DCEN polarity. In general, it is the only wire that requires this polarity. So if you are using self-shielded flux core wire on your MIG welder, you need to switch the polarity from DCEP to DCEN polarity. This is done by physically switching the work clamp cable and the welding gun cables around at the lug terminals on the machine. By switching the terminals, the electrode is now negative and the work clamp lead is positive. Your self-shielded flux core will then behave as it should.

Illustrations by Jeremy Lacy

Why should I use flux core wire instead of solid MIG wire?

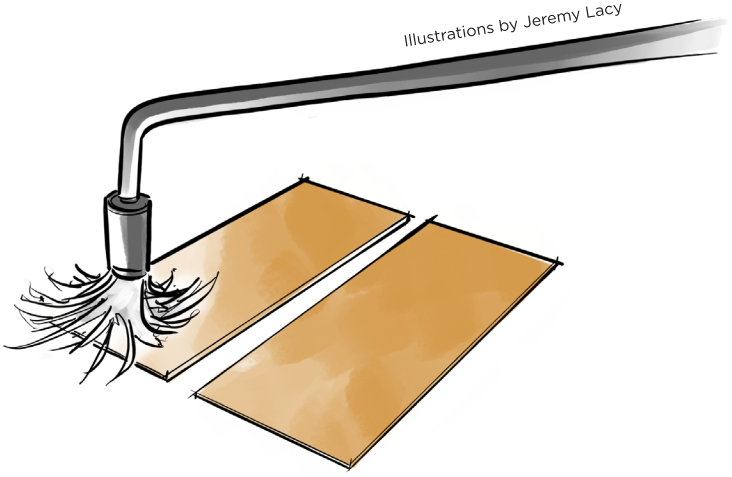
People don't like flux core because it produces more welding fume and requires chipping the slag. Thick and thin materials can be welded with flux core wire. It is manufactured in several different diameters for different material thicknesses. The advantage of flux core – especially on 3/16 and thicker materials – is that flux core is usually run at higher voltages and amperages. It creates a deep penetrating and fluid puddle. The flux helps hold the puddle in place when welding vertical and overhead. The flux also contains deoxidizing and cleaning agents to help remove impurities from the weld, but most importantly, the flux allows the weld to cool in a protected atmosphere much better than a solid wire.

Can I TIG weld dissimilar metals to each other, such as stainless steel and carbon steel?

You can, but you need to check the manufacturer's recommendations for the proper filler material. Common filler for TIG welding dissimilar metals is a 309L stainless. The L indicates low carbon, which helps in the joining of the two metals. Remember that stainless filler metal is mostly just steel with additions of chromium and nickel. It's possible to TIG weld different types of metals, but it's always important to do a little research and follow the recommendations before you start.

Can I TIG weld copper?

Yes, but with certain qualifiers. The issue with welding copper is the thermal conductivity of the material. Unless you're working with a sufficiently powerful welder, copper gets rid of heat faster than you can put heat into it. Because of this, copper usually requires some amount of preheating. Welding thin copper sheet is common, but when the material thickness increases just a small amount, the heat input required to reach the melting point increases exponentially. Once it reaches melting temperature, it welds just fine. It's important to be quick with travel speeds and accurate with dipping the filler. Any hesitation could allow it to hit the floor. So before you do your TIG weld, your best bet is to get some copper coupons, turn up the amperage on your machine and practice before welding your part.



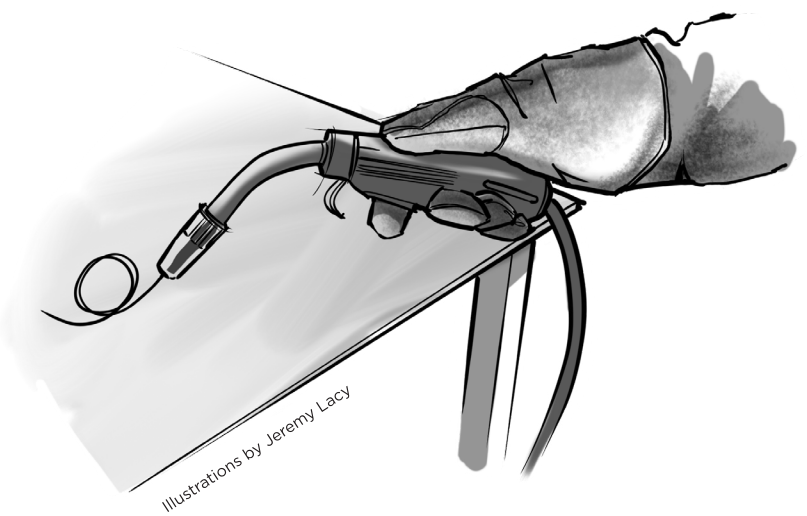
Illustrations by Jeremy Lacy

Can I weld aluminum with my MIG welder?

You can, but it will require different gas (100% argon) and usually a spool gun – or in the case of industrial duty, a push-pull gun. Simply switching the gas and wire to aluminum wire can work, but there are a couple considerations to keep in mind when you do this. First, small aluminum wire is very soft and hard to feed through a long welding gun. This is the reason why certain guns are made specifically for welding aluminum. Running aluminum wire through a gun that is usually used for steel wire can cause feeding problems. Aluminum requires special attention, but a push-pull gun or spool gun will enable you to make good aluminum welds with your MIG welder.

Why does the wire keep burning back into the tip on my MIG welder?

Burn back usually happens when there's a feeding problem with the machine. Many times I see this issue resulting from a lack of proper machine maintenance. The liner of the gun needs to be blown out with an air hose from time to time to remove the dust and shavings that collect inside. Feeding issues can also result from too much tension on the feeding rollers. Setting the tension on the rollers is a simple procedure: remove the work clamp, hold the gun at a 30- to 40-degree angle on the material and adjust the tension only until the wire feeds consistently. Only use as much tension on the rollers as needed.



Illustrations by Jeremy Lacy

SAVAGE CONVICTIONS_

TV host and author Adam Savage has spent a career gathering the tools to make a better world, one build at a time.

By John C. Bruening

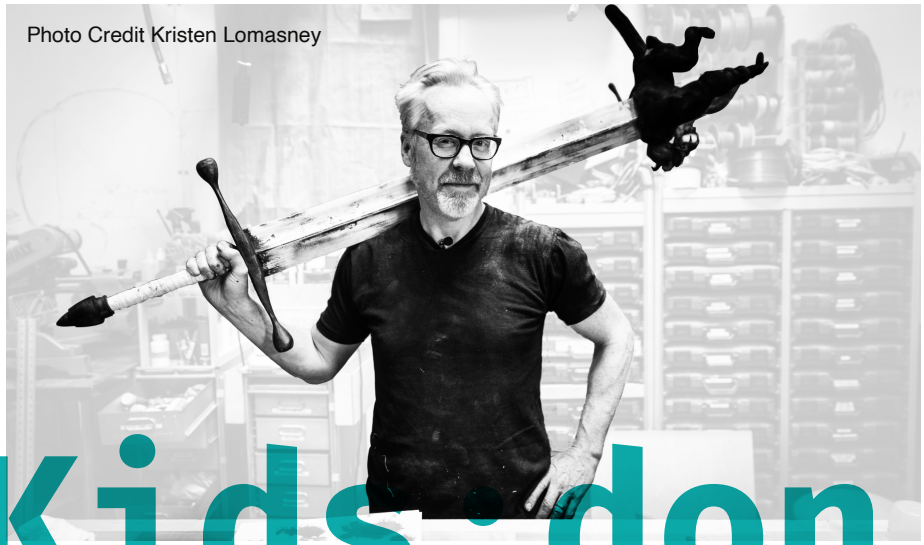
A middle-aged, bespectacled host of a new TV series about building and making is nearly vibrating with excitement at what's happening before his eyes. One of his associates is strapped into a bullet-proof suit of titanium armor fabricated by a sophisticated 3D printing system.

The armor alone looks pretty cool, and for good reason. It's built from specs provided by Marvel Studios, the Hollywood entity that launched a decade-long, multi-billion-dollar film franchise in 2008 with a movie called *Iron Man*.

You may have heard of Iron Man, the fictional billionaire genius/playboy/inventor/industrialist who dons a suit of high-tech, weaponized armor to save humanity from various existential threats – either as a solo act or as part of a team of similar do-gooders known as The Avengers. Iron Man and his colleagues have dominated the box office every summer for more than a decade, so it's likely you've heard of him, at least in passing.

But this guy hovering several feet overhead in the titanium suit is something different. This is no actor on a movie soundstage. This is no fictional story. The armor-clad associate is essentially Iron Man come to life. And just like Iron Man, he's actually airborne, with the help of jet packs mounted on his back and at the end of each arm.

Which is why the aforementioned TV host is nearly vibrating with excitement.



Adam Savage on *Savage Builds:* "It's an absurd engineering show, with different collaborators every week…It was a very weird and fun five months."

'Kids: don't try this at home"

This is what happens when a life-long maker – a guy who has spent decades building highly detailed and sophisticated props, sets, costumes and other appointments for film, TV and theater – launches the next dream job in what can only be described as a dream career.

The Iron Man suit is featured in the premiere episode of *Savage Builds,* which aired on the Discovery Channel is mid-June. At the helm of the show – that middle-aged, bespectacled guy – is Adam Savage, a life-long maker and the former co-host of *Mythbusters,* the popular science-entertainment program that ran for 13 years on Discovery.

The premise of *Savage Builds* is simple, and more than a little freewheeling: Savage comes up with an idea for an interesting build and brings in a guest collaborator to help him execute it. The host and the guest work on the build together, and the project either succeeds or it fails.

"It's an absurd engineering show, with different collaborators every week," says Savage. "Beyond that, the format is super-unformed. Things work, things don't work, my collaborators are across-the-board amazing – anyone from Simone Giertz, host of Youtube's Queen of Shitty Robots series, to German designer and maker Laura Kampf to my old *Mythbusters* colleague Tory Belleci to actor Gary Oldman to director Peter Jackson. It was a very weird and fun five months, with gears switching between all these different weird builds."

Over the course of the first season, other Savage builds have included weaponized post-apocalyptic vehicles inspired by the Mad Max film franchise, a sword forged with iron from a meteorite, and a rocket-powered "wheel of death" with potential military applications.

Kids: don't try this at home.

Hobbies and superpowers, tools and hammers

Savage Builds premiered just a few weeks after the May release of Savage's new book, *Every Tool's a Hammer: Life Is What You Make It.* The book is a chronicle of a career – a life, actually – that has been deeply rooted in the maker movement and the maker philosophy from which the movement emerged. In the first week after publication, it made the bestseller lists of the *New York Times* and the *London Sunday Times.*

Savage describes *Every Tool's a Hammer* as a combination of autobiography, memoir and instruction manual. It recounts some of the author's earliest childhood projects and his admitted obsession at a young age with cosplay and recreating props from some favorite movies.

"When I made stuff," he writes of his early years, "the world made sense to me. It felt like my superpower." He insists that it still does.

The book chronicles the ways in which Savage's passion to make sense of the world has persisted well into adulthood. The book is, among other things, "a permission slip to follow your weird hobby," he says.

For Savage, the weird hobby actually morphed into a career, beginning with his early experiences in theater and film set design, followed by *Mythbusters*, his platform for exploring the world, taking it apart and putting it back together with co-host Jamie Hyneman. *Every Tool's a Hammer* tracks all of this, but also takes a granular look at some of the basic tools and mechanics of said career. One chapter discusses the maker's shop as a direct reflection of the maker's personality and building style. Other sections are dedicated entirely to topics like cardboard, hammers, cutting tools and glue.

Savage's current shop – and there have been a couple in different locations throughout his career – provides an interesting window into his mind and his thinking style. It's a 2500-square-foot space in the Mission District in the San Francisco Bay area that he affectionately calls The Cave. "I've been there since 2011," he writes, "and its organizational scheme has never stopped evolving."

But finding time to get into the shop was hard enough in the midst of his *Mythbusters* schedule a few years ago. More recently, the book tour and the launch of a new TV show have cut even more deeply into his creative time, and he's starting to feel the effects.

"I've been doing a lot more videos and a lot more public appearances," he explains. "And then at the beginning of this year, we went back into production – five months of filming. And now I'm barnstorming around, doing tests of the things I've built, and what I'm noticing is that the one thing that's lacking is me having time to just build stuff for myself personally. Not filming it, not covering it, not photographing it, just spending time in the shop that's time for me. And at this stage of my life, I'm coming back around to seeing that I need a few hours of that every week in order to feel like I'm firing on all cylinders."

"When I made stuff, the world made sense to me. It felt like my superpower."

Savage calls his book, *Every Tool's a Hammer,*

"a permission slip to follow your weird hobby."

An act of faith, an act of power

But what exactly goes on in that shop? Or in any maker shop, for that matter? Savage makes no claim to being the last word on exactly what a maker is and does, but he adheres to a philosophy that extends well beyond the parameters of welding, fabrication, carpentry and the other trades that typically get mentioned in any maker discussion.

"I use the widest possible definition for maker," he says. "It's not simply gathering physical objects and putting them together in different ways or sculpting them from scratch. To me, making is what happens whenever you use your point of view to bring something into being that didn't exist previously. That can be anything from a speech to a dress, from a table to a car. When we do that, we are recapitulating our culture through our hands, through our voices, through our bodies, and we are participating. We are saying, 'This thing has enough value to me to bring it into being.' And that, in and of itself, is an act of faith and an act of power and an act of contribution."

He takes the idea a step further by suggesting that being a maker in a polarized era could even enrich one's

The Cave, Savage's current shop, is a 2500-square-foot space in San Francisco's Mission District: "I've been there since 2011, and its organizational scheme has never stopped evolving."

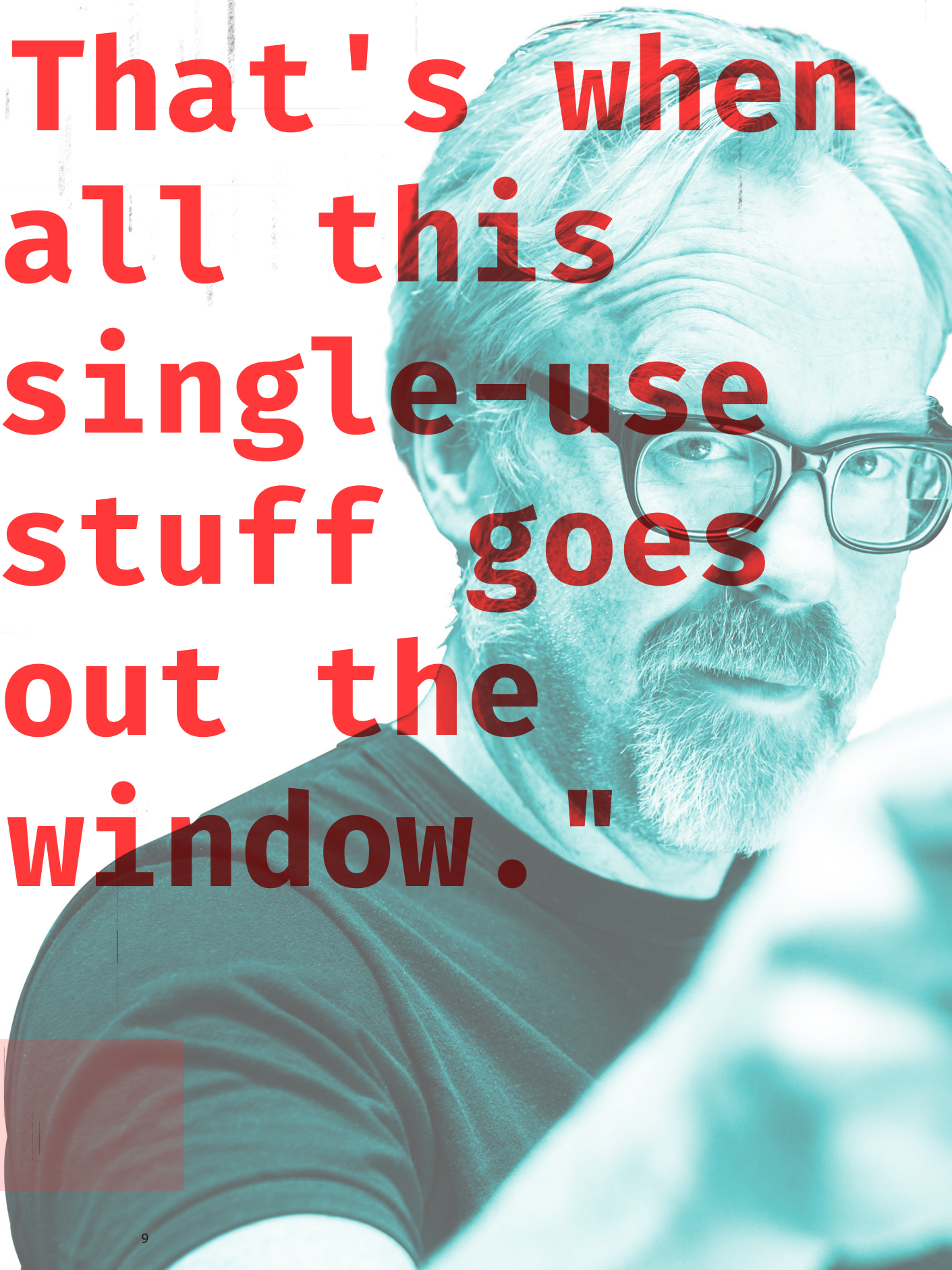
sense of citizenship and cultural unity.

"We're a very classist society," he explains, "and part of the difficulty of a classist society is that you have a group of people who can't understand what life is like for people who don't share their experience. We're also in a very difficult period in our country, and that's true no matter what side of the aisle you're on. But I feel strongly that the only way we are going to get ourselves out of this tree – if we do at all – is by listening to each other. Listening to each other requires empathy. It requires understanding someone else's frame of reference."

The first step toward closing the divide, he says, starts with the self. It's a strategy well suited to the maker movement and those immersed in it.

"It's important to me to constantly remember that there are people walking down any given street who live in a functionally different country than I do," he says, "because their experience is so different from mine. And to me, being easy to work with, or being a good collaborator with others, that's all part and parcel to the kind of empathy I'm talking about."

"That's when all this single-use stuff goes out the window."



Making a future

For all of its momentum in recent years, the future of the maker movement looks even more promising, says Savage. He looks to advances in 3D printing technology and software with a hopeful eye.

"The big sea change will happen when the CAD/CAM pipeline becomes more intuitive," he says. "Autodesk is working hard on this. They're working hard on improving the interface between your mind and a 2D screen and a 3D object…That transition is still very difficult for many people if not most people. I think that will be a huge change."

In addition, he sees the process once known as "rapid prototyping" and later called "additive manufacturing" as morphing into a third iteration that combines both concepts: rapid manufacturing. From this evolution, he foresees a world in which consumer goods have more of a connection to the humanity they are intended to serve.

"These machines that can make a part in a short time are advancing to a point where they can make them fast enough that it's cost-effective to build things with them and sell them," he says. "That gets me really excited, because if we really are able to create maker spaces that every kid has access to, we can raise a generation of digital natives to make up this world where the objects we use in our lives are built by people we know, so that we have more of a connection to them – and even an emotional connection. That's when all the single-use stuff goes out the window, and the things we make are built and designed for us and with us."

Separate and apart from what's on the horizon for maker technology in general, Savage is equally optimistic about his own future. He's looking forward to the possibility of a second season of *Savage Builds* if the TV powers that be choose to pursue it. But he also hopes to get back into The Cave. But that's not to say he plans to remain locked in his shop for the foreseeable future.

"There are hundreds of people I want to make stuff with," he says. "There are places I want to go and see what they're like. There are facilities that I'd love to visit, like the aquanaut station in Florida, where the astronauts live for a few days – sixty feet under water. There's the astronaut training facility at the Johnson Space Center in Houston. There are many other builds in my head that I would like to put into a show. Right now, I'm looking at a list in my notebook of 25 one-day builds that I'd like to do. That's at least two years' worth of programs."

Along the way, he continues to expand his creative network, as every good maker does. And in some modest way, he hopes his efforts will make the world a better place.

"I can't believe some of the things I'm getting to do these days," he says. "I've also been carefully building a team of collaborators that I work with on most of my projects, and that team gets bigger and better and tighter and more family like every single day. So for me, this present moment is something that I wouldn't trade for anything." ARC

The Savage strategy for navigating the cultural divide: "I feel strongly that the only way we are going to get ourselves out of this tree – if we do at all – is by listening to each other."

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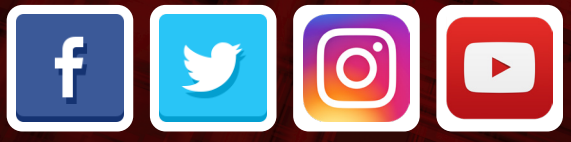

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RESIDENTS OF LOUDOUN COUNTY, VIRGINIA, ARE FINDING A NEW SENSE OF BELONGING, ONE BORROWED TOOL AT A TIME

BY JEFF HERRINGTON

Loudoun County, Virginia, has this uncanny knack for bringing people together.

During the American Revolution, it fielded Virginia's largest militia, comprising more than 1,700 men. In the 2000s, it knitted a worldwide community by becoming the hub through which 70 percent of all Internet traffic flows.

Today, Loudoun County is again uniting people in a way no one would have imagined 15 years ago. Its residents are strolling, cycling – even skateboarding – to a new type of factory that's sprung up in the towns of Leesburg and Purcellville. In these 'maker spaces,' they're learning how to use (and then borrowing) lathes, saws – even 3D printers – to turn ideas they can see in their minds into things they can hold in their hands.

"The next wave of manufacturing will be driven by speed, customization and one's ability to assemble a robust network of collaborators," says Pat Scannell, the founder and CEO of Makersmiths.


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"Instead of relying on consolidated data centers, it will rely on edge or fog computing. And instead of taking place in major metropolises like Shenzhen, China, it'll be taking place in rural towns like those right here in Loudon County, Virginia."

A GOOD IMAGINATION AND A PILE OF JUNK

Leesburg, Virginia, is 35 miles – and in some ways, a couple of centuries – from the clamor of Washington, DC.

From its Red Rock Wilderness Overlook, one can ponder the Potomac as the river ambles past post oaks and Atlantic white cedars. In its commercial center, you're more likely to encounter palm readers and quilt makers than meter readers and cell towers. In its downtown historic district, you can marvel at a colorful collage of Classical Revival, Greek Revival and Georgian structures so well-preserved, they're in the National Register of Historic Places.

A quaint historic district may seem like an odd place to locate a venture dedicated to the art of manufacturing. And yet it's here where the 3,000-square-foot Makersmiths operation has landed, behind a charming, powder-blue-and-white façade facing Royal Street.

Inside, one finds not some dirty, dusty space that assaults your eardrums with the sound of metal screaming on metal, but a warren of tidy, brightly lit rooms sporting well-ordered worktables, tall stools, ergonomic office chairs and neatly printed signs that pinpoint the exact location of the laser cutter or the workshop. Depending on the day of the week, you could stumble upon a gaggle of kids building a carbon fiber drone or adults finishing up a coat rack, park bench, or even a small metal robot that traverses a tabletop like a tarantula in search of food. Above one white board is a quote from Thomas Edison that could easily be Makersmiths' unofficial motto.

"To invent," it says, "you need a good imagination and a pile of junk."

Makersmiths provides 'the junk': lasers, circuit boards, welding equipment and CNC machines, as well as gloves, goggles and gregarious instructors who are happy to share their manufacturing know-how. Supplying the imagination are local residents – from artists and activists, to stay-at-home parents and commuter execs.

Residents like Sam Newberger, a former USMC officer with extensive experience in special operations and intelligence. Despite having earned a bachelor's degree in industrial management, "I wasn't really handy as a kid," he admits. But while serving in the military, he learned how to design and implement custom technologies. "So, when a newspaper article described what Makersmiths had planned for Leesburg," he says, "my reaction was, 'This is awesome!'"

In 2014, Newberger joined a handful of others who believed


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in the concept and were eager to help Pat Scannell fashion it from scratch. “Leesburg was sort of a perfect location,” he says. “It’s rural, but still easy for people throughout the region to access.”

That said, Makersmiths was not an immediate success. Its pivot point came several months in, when it relocated from an off-the-beaten-path industrial site to its current location downtown.

Kristen Umstattd, who now serves on Loudoun County’s board of supervisors, was mayor of Leesburg at the time. “I recall I found the idea intriguing, but I wasn’t sure it would work,” she says. “After its move, however, scouting groups started using it for their projects. Their parents who were crafters started taking classes there. Next thing you know, our ham radio community was hanging out there. It was fascinating to watch its popularity develop.

“However, I should have been more optimistic,” she says. “Farmers here in the 1800s would share a combine, which would go from one field to the next harvesting crops. Makersmiths updates that idea of sharing expensive technology in a way that brings people together.”

People like Erin Werling, for example, who has five daughters and a passionate drive to make stuff. “In our house, we like to hit things with hammers,” she says. “Now, I’m going to Makersmiths up to five nights a week to sew, make paper crafts, work with wood, even cut vinyl.

“After my husband and I attended Makersmiths’ first informational meetings, we knew this wasn’t going to be one of those maker spaces that look down their noses at people like me and say, ‘Why are you here when you could be making that at home?’ It was clear it wanted to serve all the making disciplines out there.”

Werling says that dedication to inclusivity has helped her forge bonds with people she probably wouldn’t have grown close to otherwise. “My favorite memory about Makersmiths,” she says with a laugh, “is my realizing after a while that I was frequently texting people I’d found really annoying when I first met them.

“Because of Makersmiths, the community my family loves is much bigger.”

Pat Scannell says the fact that Makersmiths fosters such a sense of community is no accident. “One way we differ from other maker spaces is that we have a flat hierarchy and an organic, grass-roots-up approach to managing things,” he says. “An injection molding class might come about because someone has donated the equipment for that, because someone has walked in saying they want to learn that, or because an expert on that has told us they’d like to teach it.

THE COMMUNITY MY FAMILY LOVES IS MUCH BIGGER

excellent to one another,'" says Scannell. "It's rules like that, I believe, that instill in everyone a sense of ownership."

Kristen Umstattd echoes Scannell's sentiment. "Everyone talks about how our country is so polarized," she says. "Well, an excellent way to prevent hostility among politically divided people is to bring them together in non-political ways.

"At Makersmiths, you work on projects alongside people different from you, and you learn from, or teach, people who are different from you. In that way, it's become one of Leesburg's most meaningful community centers."

If the personality of the Leesburg operation is that of a community center, the profile of its younger sibling in nearby Purcellville (pronounced with the emphasis on the first syllable) is more like that of a wrestling arena or rock concert hall. Here, forges, kilns and production-grade welding equipment hold sway in a brawny industrial building once known as the Old Town Shop.

"We didn't pursue Purcellville so much as the mayor asked if we would help revive what had become an underutilized asset," Scannell says. After a few tool donations, thousands of dollars of Kickstarter contributions and many months of renovation work (much of which was undertaken by nearby makers eager to use the space) the second Makersmiths operation celebrated its grand opening in 2018.

Mayor Kwasi Fraser says pretty quickly, Purcellville's vibe shifted from sleepy to peppy.

"Suddenly, there was this technology incubator in our backyard with great potential," he says. "By us infusing its potential into the psyche of our community, young people and their parents were soon coming there to learn, hand in hand, what will be the world's future trades."

The facility provided Jessee Maloney with a harbor of sorts that she'd not had before. "A lot of makers are isolated," says Maloney, who sometimes instructs classes at the facility. "Here, I get to talk about the things I like, with people who like the same things, and my age and my gender don't matter.

"That has meant so much to me. I needed that."

Sam Newberger believes maker spaces could even become helpful havens for a particular group of residents who grapple with a particular challenge.

"It's tough for veterans – especially those with PTSD – to make the transition from military to civilian life," he says. "I urge other veterans to seek out a maker space in their vicinity.

"It may only deliver something new for you to do with your life. But it might also provide that thing you're probably missing most – a community of like-minded people working toward a similar goal."

Newberger's involvement in Makersmiths has provided him with new skills, new friends and even a new way to earn a living. His new company, Arc34, unites artisan design and craftsmanship with cutting-edge technologies to help its clients deliver products at a fraction of what it costs when they use traditional manufacturing techniques. Increasingly, the firm is adopting the spirit of Makersmiths, he says, by lending space and high-end manufacturing equipment to smaller firms that can't afford them.

"We get a lot of our customer leads from Makersmiths," says Newberger. "And like Makersmiths, we're pivoting toward training people in the area more. On CNC machines, manufacturing-level sautering equipment and other tools."

Erin Werling says she may someday take what she's learned at Makersmiths and launch a craft-related business. If she does, she'd love for her 18-year-old daughter (who also spends time at Makersmiths) to be her office manager.

But for now, the value-add Makersmiths is delivering to her life is more educational than commercial.

"I just learned how to use a chop saw!" she exults. "And as far as I'm concerned, any day you learn something is a good day." ARC

ANY DAY YOU LEARN SOMETHING IS A GOOD DAY


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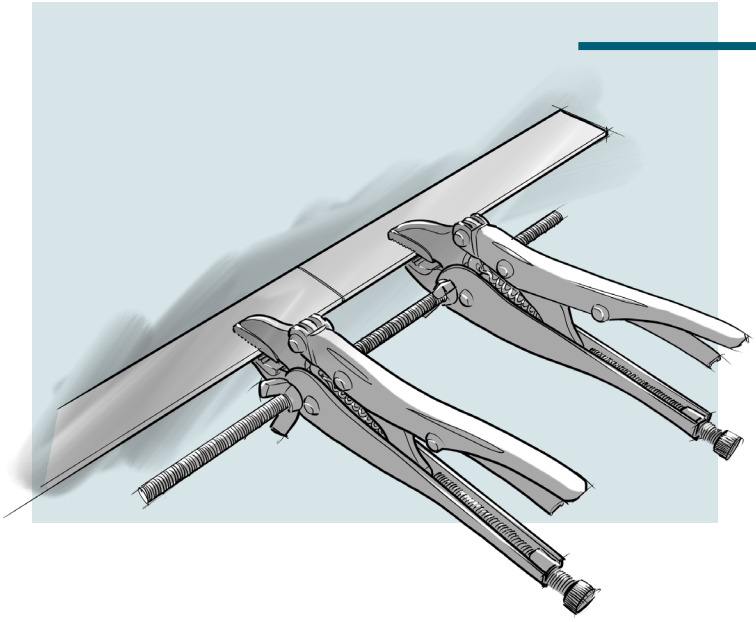
WELDING HACKS & TIPS

We've scoured YouTube to bring you time saving, money saving ideas to improve the quality of your projects, and the process by which you complete them. The complete versions of these tips and more can be found at ARCMagazine.pub.

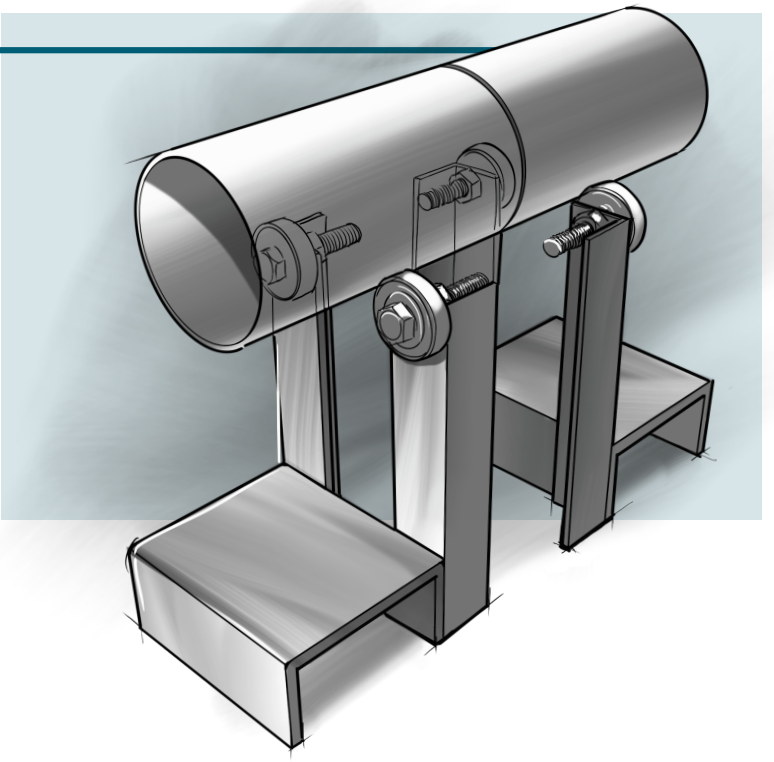


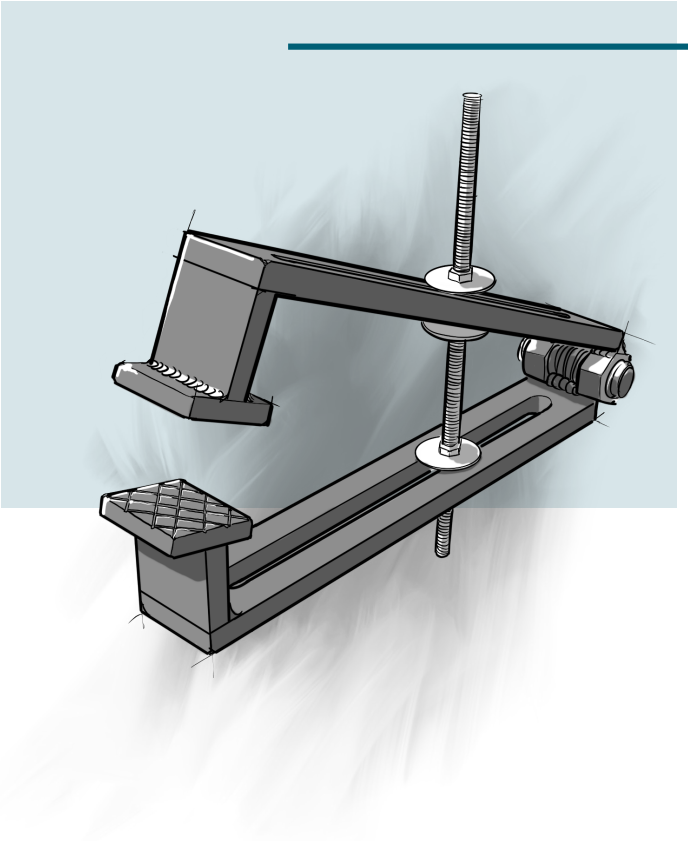
PLIERS AS PLACEHOLDERS

Even with small to medium-sized jobs, securing your pieces while keeping your hands free to weld can sometimes be a challenge. But with a simple assembly of two sets of curved-jaw locking pliers, a threaded rod and four butterfly nuts, you can create a handy clamping tool that enables you to spend more time welding and less time holding. Cut an eight-inch length of ¼-inch threaded rod. Drill a ¼-inch hole through the top of each set of locking pliers, then run the rod through both holes to connect the two tools. Once you've adjusted the space between the pliers to the desired width to accommodate your welding job, secure the assembly with butterfly nuts on either side of each wrench. With the two sets of pliers holding your pieces in place, your hands are free to focus on the business of welding. Thanks to Mr. Deswal for the tip.

KEEPING PIPE IN PLACE

Lining up straight-edged parts and clamping them in place to make a clean, even weld can be hard enough. Holding two pieces of pipe together can be even more difficult if you don't have the proper tools to hold one piece flush with the other. With a few strips of angle steel you can build a two-piece tool to prop up two segments of pipe that you're jointing together. A set of rollers at the end of each piece enables you to turn the pipe as you work your way around the perimeter. You can bolt the uprights into place, but you might also consider making the structure of the tool a little more solid and permanent with a few tack welds instead. However you assemble it, you'll have a solid platform to hold two adjoining pipe pieces and turn them steadily as you weld them into one. Remember to properly balance each piece of pipe on the rolls to prevent them from falling off as you weld.





A SIMPLE HINGED CLAMP

Clamps come in all shapes and sizes. If you need to secure metal or wood parts to your shop table, you can build an effective hinged clamp with just a few strips of ¼-inch steel. Start with two seven-inch strips and cut a slot down the center of both. Cut a tab at one end of one of the strips. Weld a threaded rod to the tab (perpendicular to the strip) and run a nut on either side of the rod. Weld the remaining strip to this hinge to connect the two strips. Cut two 1-inch squares, then use a grinder to cut some cross-hatched treads into the squares. Weld these pieces to the end of each arm of the clamp. Run a threaded rod (about 8 inches), through the slots in both arms of the clamp. Thread two nut-and-washer combinations to secure the rod within the slot. The resulting tool is small, lightweight and ideal for securing small to medium-sized pieces for welding, cutting and other procedures.

LAVERN SCHMIDT

IN TOUCH WITH WELDING

By John C. Bruening

Lavern Schmidt has made efficiency his prime directive throughout his long career. Whether he was building and repairing farm equipment in the 1970s, inventing and developing more efficient toolboxes in the '80s, or teaching others to weld in more recent years, he's always been committed to quality, efficiency and basic common sense.

Schmidt learned to weld when he was a boy on his father's farm in Montezuma, Kansas, in the 1940s. In his younger days, he put those welding skills to work as a maintenance supervisor for the 4000-acre Gallo Winery Ranch near Modesto, California. In the '80s, he returned to farm work in Kansas and developed the Montezuma Toolbox, a storage unit with a patented design that keeps tools organized even when the box is being transported on the back of a bouncing truck moving over rough terrain.

Schmidt retired in 2007, but he's been teaching welding classes in the shop on his property in Montezuma ever since. He figured it was time to pass on some of the trade secrets he'd learned over the course of his five-year career. He sees welding as a skill that integrates four of the five basic senses.

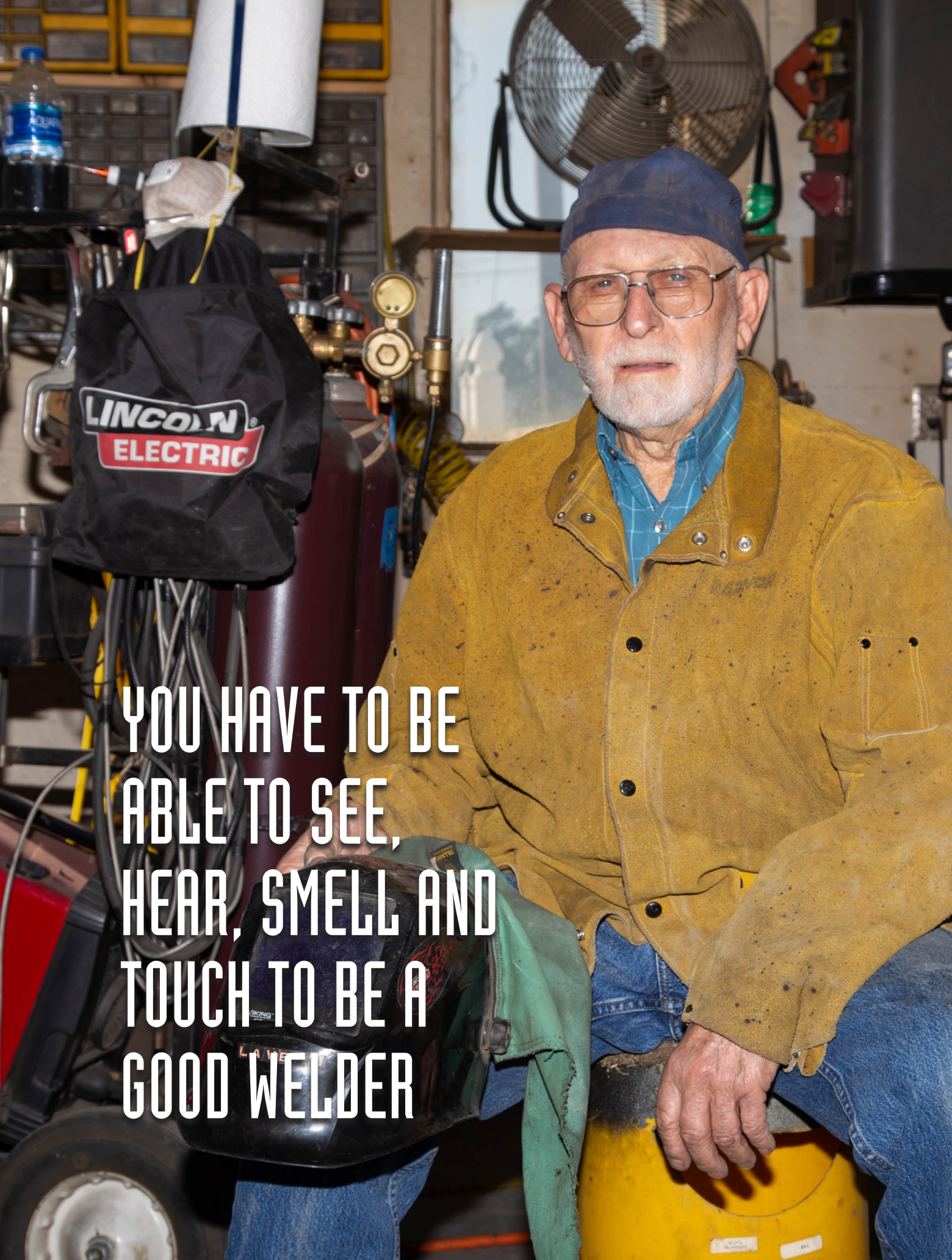
"My motto is, 'You have to be able to see, hear, smell and touch to be a good welder,'" he explains. "So I use those four things when I'm teaching. For example, if you're welding with a stick rod, you have to be able to feel and sense the rod touching, feel it resonating clear back to the stinger. You have to be able to see the puddle. All of that is extremely important. I was taught hands-on, so my method of teaching is hands on."

It's a method that has worked for Jerrell Nichols, a former student of Schmidt who considers himself a tactile learner. Even after running his own auto repair shop for 15 years, Nichols took a 50-hour class with Schmidt several years ago as a means to, as Nichols puts it, "up my welding game a bit." In the process of refining his stick, TIG, MIG and oxy-acetylene skills in Schmidt's shop over the course of five weeks, Nichols learned that the most frustrating moments can also be the most enlightening ones.

"I discovered in Lavern's class that when you run into that wall, that's the moment when you're ready to learn something," says Nichols, who has since left the auto repair business and now heads RANS Bikes, a Montezuma-based manufacturer of high-performance recumbent bicycles for a worldwide market. "When you run into that wall and something doesn't work, and you can't figure out how it's going to work, that's not failure. It's actually an opportunity to advance… That's helped me out quite a bit. I have to remember that there's no need to get too frustrated or despondent. That's probably more of a psychological strategy than a technical tip, but it's been very helpful to me."

Revelations like these are some of the most important moments for Schmidt, who says he gets just as much inspiration from his students as they get from him.

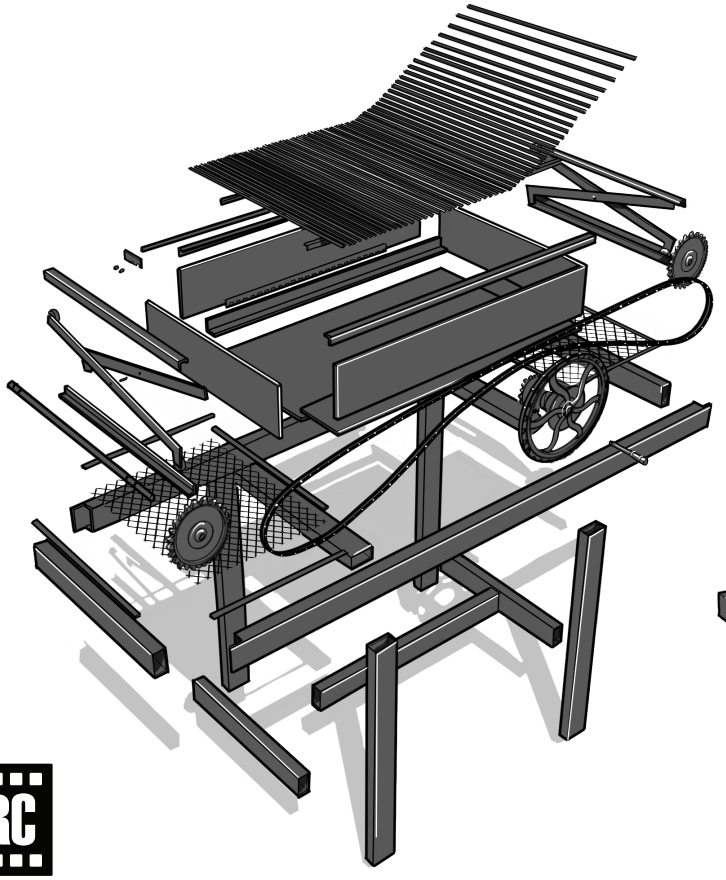
"I love to explain something new to them, or show them something that they haven't learned before," he says. "If you look in their eyes and watch them closely, you can just tell when the light comes on. There's that moment when they say, 'Wow, I didn't know that! That's great! I want to know more about that!' That's the moment that inspires me." ARC

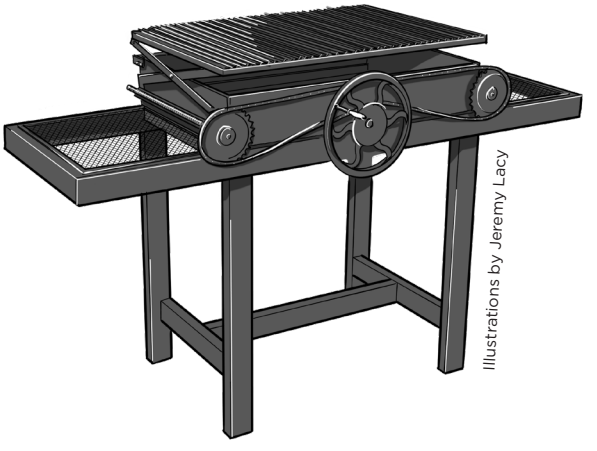


YOU HAVE TO BE ABLE TO SEE, HEAR, SMELL AND TOUCH TO BE A GOOD WELDER

CHARCOAL- AND WOOD-BURNING BARBECUE WITH ADJUSTABLE GRILL

By Jimmy DiResta



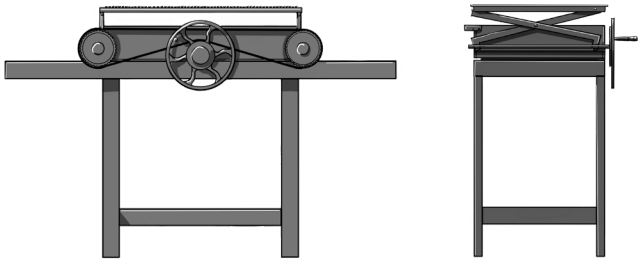


Illustrations by Jeremy Lacy

Watch exclusive footage at arcmagazine.pub

Of the many builds we've featured by Jimmy DiResta, most have had a mechanical aspect to them. In some way or another, his completed projects usually involve moving parts, as opposed to being merely static pieces of shop gear, furniture or decorative items. This sense of functionality and utility in conjunction with aesthetics is often the feature that sets his projects apart.

In this issue of *ARC*, DiResta takes this mechanical sensibility to a new level with a wood- and charcoal-burning barbecue. The unit features a chain-driven adjustable grill that can be raised and lowered to better control the cooking process, and a moveable flap to allow easy cleaning of ash and other debris from the base of the unit.



Illustrations by Jeremy Lacy

SAFETY FIRST

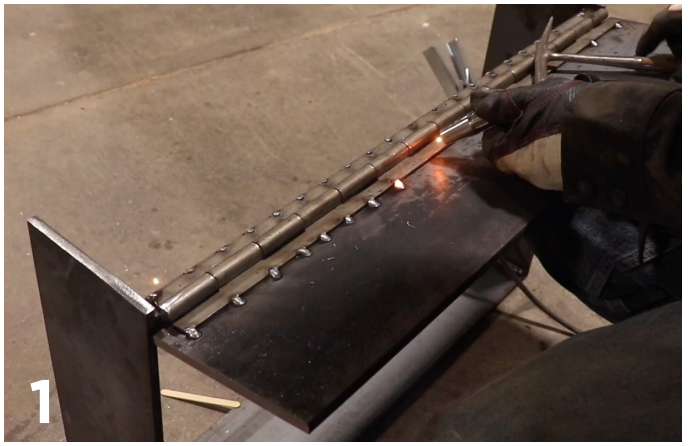
Before you start any project involving welding, make sure you have the right Personal Protective Equipment (PPE), which includes, at least, an ANSI-approved welding helmet, safety glasses, appropriate welding gloves for the process you're using, and a flame-resistant shirt, jacket, or sleeves to protect from UV rays and burns. You should also keep a fire extinguisher close at hand. Use adequate ventilation when welding. Use an approved respirator if exposure to welding fume cannot be controlled, or if welding outside and natural air movement is not sufficient to keep welding fume out of your breathing zone.

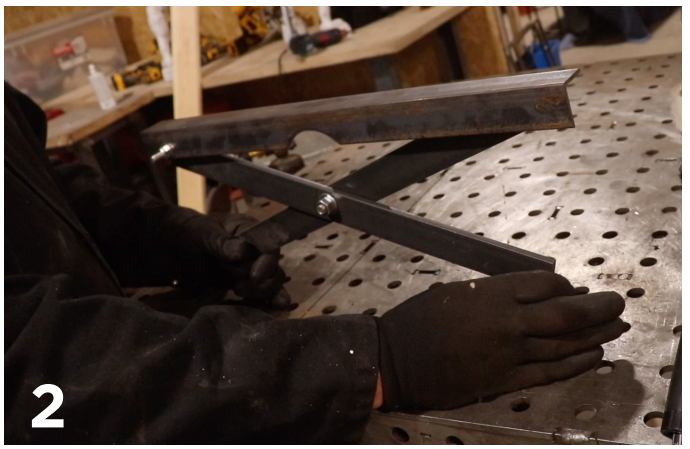
MATERIALS

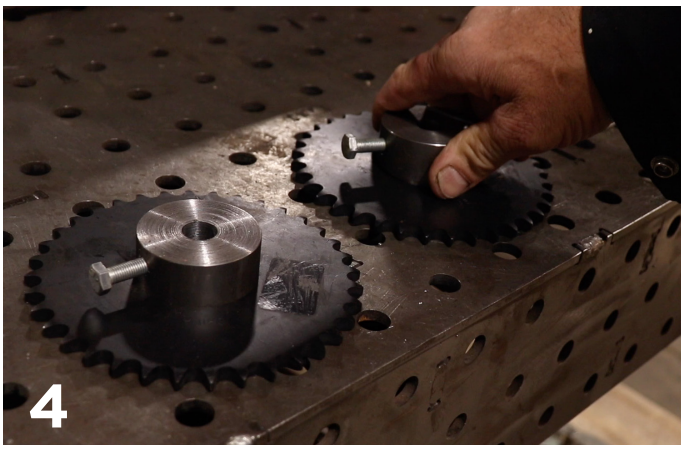
6 x 3/8 inch flat steel (acquired in 5 and 6 foot lengths)
Rectangular steel tubing
All-steel hinge (cut to desired length)
Threaded collars
Slide collars
Roller chain
Sprockets
Round steel bar
3/8 inch bolts
3/8 inch nuts

WELDING/CUTTING EQUIPMENT AND TOOLS

Lincoln Electric MP 140
Band saw
Lincoln Electric Tomahawk® 625 plasma cutter
Drill
Lathe
Angle grinder
Drill
Angle grinder
Cutting and flap disks







Step 1: Cut and weld the grill housing and opening flap

Use a band saw to cut the 3/8 x 6 flat steel to the desired length and width of the grill housing. Use a jig to keep the angles properly aligned as you weld three of the four sides. Then weld the hinge into the fourth side, and tack weld the fourth steel panel to the hinge to create the flap that will open to empty ash and other debris from the grill. Use a plasma cutter to cut the 6-inch lengths to fit the space that will be the bottom of the grill housing. Stitch weld these pieces into place at various points around the perimeter and along the joints. You don't need to lay in a complete weld all the way around.

Step 2: Cut and assemble the scissor lift

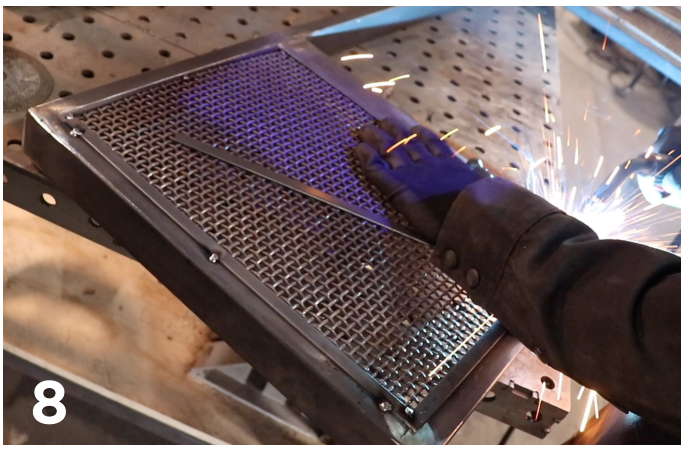
Cut and weld the L-shaped arms of the scissor lift that will raise the lower the grill on both sides. Drill a 3/8-inch hole at all of the pivot points in each arm. Then weld the nut-washer-bolt assemblies into each of the holes. Once the assemblies are in place, saw off the head and shaft of each bolt. Weld a nut to either side of the L-shaped track to set it off from the outer side of the grill housing, then tack the nuts to the side of the grill to create a track for the bearings of the scissor lift.

Step 3: Build and attach the draw bar assembly

Weld half-inch bolts to the threaded collars and the slide collars, then weld both collars to the scissor arms along either side of the grill housing to create guides for the draw bar. Run the draw bars through the collars, then attach sleeves to the end of both draw bars. Weld a steel bar to the sleeves, creating a stabilizing bar across the front of the grill and perpendicular to the draw bars.

Step 4: Assemble the sprockets and attach them to the draw bars

Cut the round steel bar into two 1-inch (approximate) chunks. These will be the hubs that attach to the end of each threaded rod to hold the sprockets. Use a lathe to fit the hubs to the holes at the axes of the sprockets, then drill a hole into the perimeter of each hub and insert a bolt into each hole. Tack weld the hubs into the center holes of the sprockets, then attach the hub-and-sprocket assemblies onto each of the threaded rods on either side of the grill.



Step 5: Attach the chain and tighten it with a center crank

Stretch the roller chain across the width of the grill and wrap it around the sprockets. If there's slack in the chain that cannot be tightened by removing links – as there was in this project – center a crank handle between the two sprockets and mount it on the side of the grill. I attached an old S-spoke gear to the crank handle, then machined a brass handle and bolt it to the S-spoke gear to make it easier to turn.

Step 6: Attach the hooks to secure the flap

On either side if the grill, weld 3/8-inch sections of steel bolts to both the main housing and the hinged flap. Cut two small rectangles of steel to serve as hooks that will hold the flap in place. Drill a hole in each hook and mount them to the bolts on either side of the grill housing. The hooks should hold the flap in place until you're ready to clean ash out of the grill.

Step 7: Assemble to top grill

Assemble the grill by lining up 25 or 30 lengths of angle iron. Space them evenly by separating them with a strip of wood about a half-inch wide. Weld these pieces to two lengths of the same angle iron running perpendicular. Weld the entire grill assembly to the top of the scissor lift.

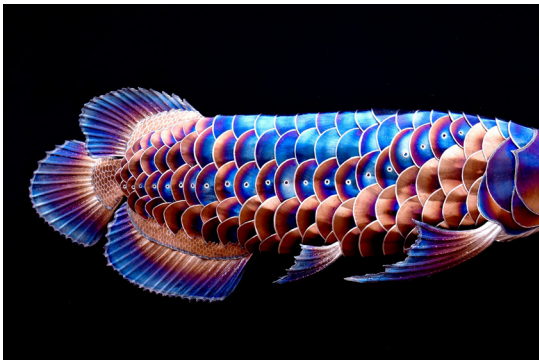
Step 8: Build the grill base using rectangle tubing

Using the rectangle tubing, build the trestle table that will serve as the base of the overall grill. I recommend cutting caps into the corner joints of the framework rather than welding V joints. V joints use too sharp of an edge, which immediately recedes as soon as you weld it. Tack joint ¼-inch 16-gauge wire mesh into the sections of the grill table that extend from either side of the grill itself. If your fit-up of the mesh is off slightly, tack in some ½ x 1/8-inch rods to dress up the overall appearance.

A detailed drawing and cut list for this project can be downloaded at **arcmagazine.pub.**

Mundane to Magical

By Dan Cromaz and John C. Bruening



Aiden Dale's personal history as a maker began with the practical and has since evolved into the natural and even the mythical.

Splitting his boyhood years between Durham and Chapel Hill in North Carolina, Dale built tables, lamps and other utilitarian household items using whatever materials were available. In high school, a week-long metalwork internship ignited his passion for welding and fabricating. He majored in studio art with a focus on sculpture at Hampshire College, where his thesis project integrated metal sculpture, woodworking, jewelry making, book binding, portrait art, printmaking and more.

After college he focused primarily on metalworking, which he does to this day. His subject matter tends toward the scaly, spiny complexities of fish and crustaceans, but he's made forays into other wildlife as well – some of it more mythical than real.

"I am endlessly inspired by the natural world," he says. "Plants, animals and the human form are all deeply beautiful to me. I have an ongoing list that I keep of future projects, and whenever something strikes me in my life, I add it to the list."

His most recent commission was a dragon sculpture, "which was a fun challenge and incredibly rewarding," he says. "I'm thinking maybe a griffon next, or maybe an angel. We'll see."

Dale's process usually begins with reference photos and real-life encounters with wildlife – at least in those instances where the wildlife actually exists in real life. He develops numerous sketches to get a handle on the overall form, then projects the sketches on a wall to the preferred size of the finished piece. The projection serves as a guide for making paper forms that become templates for cutting sheet metal.

A combination of grinding and heating (different temperatures to yield different colors) creates the desired texture and tone for each piece of metal. Then the individual pieces are welded together, and a new sculpture is born.

There are as many reasons for making art as there are artists. Dale sees his work as something to inspire a deeper appreciation of the magic of the natural world

"It challenges, inspires and helps create meaningful spaces," he says. "It's such a magical feeling to know that I can be inspired by the world around me and use that energy to create something that enables me to make a living. It's such an honor to know that people I will never meet have my work in their home." ARC

Master Class

A discussion of advanced materials and techniques for the seasoned welder.

PURGING STAINLESS

By Charlie LaRiche

Purging is the introduction of a gas on a weld of stainless steel or nickel alloy to remove atmosphere. The technique is typically used to improve not only the strength, integrity and reliability of a weld, but also the overall aesthetics.

When welding on stainless, we need to remove the atmosphere and replace it with a non-reactive gas to avoid the buildup of chromium oxide on the back side of the weld. This CrO_3 buildup is commonly referred to as "sugaring." When it occurs, the facing side of the weld will look good, but the opposite side will have at least a tint or be covered in a black crust, with voids where the weld did not fuse together properly.

Purging is a technique that's typically used to improve not only the strength, integrity and reliability of a weld, but also the overall aesthetics.

It's important to avoid sugaring wherever possible, especially in specific industries where the tolerance for any contamination whatsoever is very low. In the food and pharmaceutical industries, for example, cracks in the processing system could potentially expose the product to bacterial contamination. The same holds true for the pipeline industry, where aqueous contamination can make its way into the crevices caused by sugaring. In a corrosive environment, this contamination can result in a leak of dangerous chemicals. Even stainless steel engine headers for automobiles and airplanes – parts that are subject to intense vibration – are prone to fracturing and malfunctioning if not properly purged.

And in any of these manufacturing scenarios, cracked welds can lead to contamination of materials inside the process, and also result in dangerous chemicals leaking into the environment where personnel are working.

Depending on what code you're welding to, there will be a specification governing parts-per-million of oxygen on the backside of the weld. In most cases, the operator will attach a monitor to the pipe or tubing to measure that. Some codes, such as AWS 18.2, even have color charts for visual inspection of heat tint/sugaring.

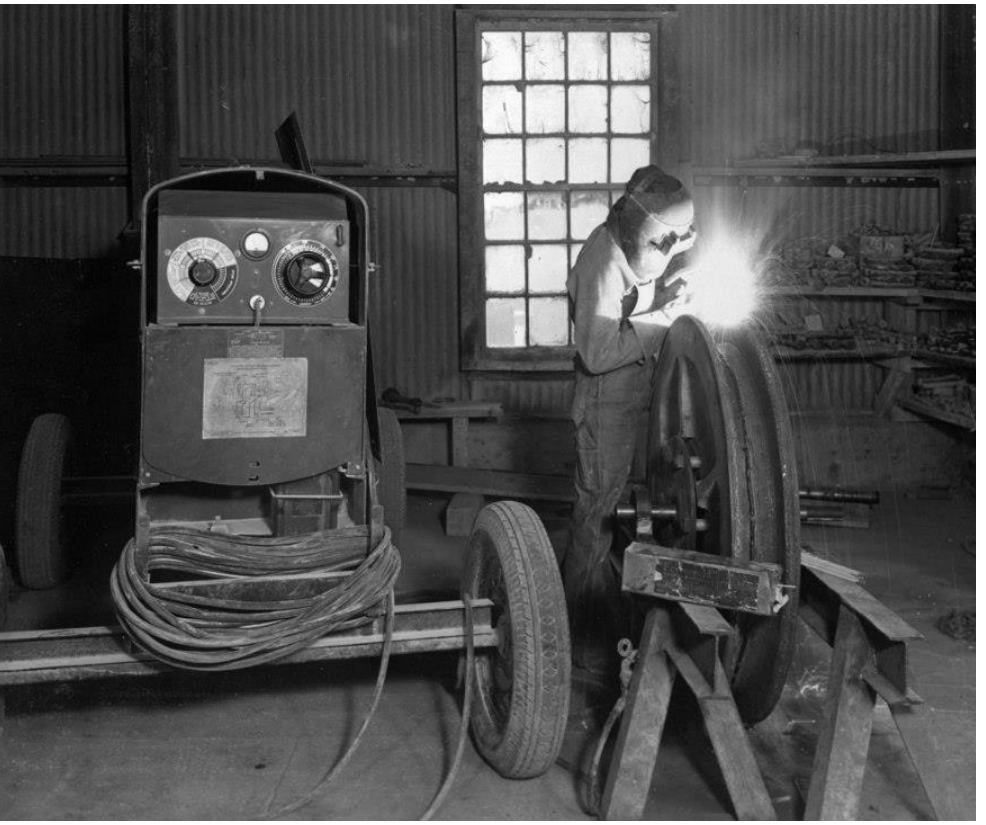
Some extra equipment you will need will be a bottle of 100% argon, dual flow meter, an extra gas hose to run to your purge, a purge block, and painters tape or foil. In the video I will be doing a butt joint on 0.0625 stainless set up in a purge block. Argon gas will purge the bottom side while the torch provides the primary shielding from the top. If you are working with tubing or pipe, consider applying tape on one end with holes poked through for venting on that side while taping a tube to the opposite side to provide the argon.

When making your weld, make sure the purge hose is secure and does not fall out. Allow sufficient time for the gap to fully purge the piece.

If your purge was done properly, the back side of the piece should look clean, with a silver color throughout the weld. The welded surface should be free of cracks and crevices. If any of these factors appear to be amiss, your purge was probably not successful. You may be able to grind the base metal and retry. Otherwise, you'll need to scrap the part and start over. ARC

Watch exclusive footage at arcmagazine.pub

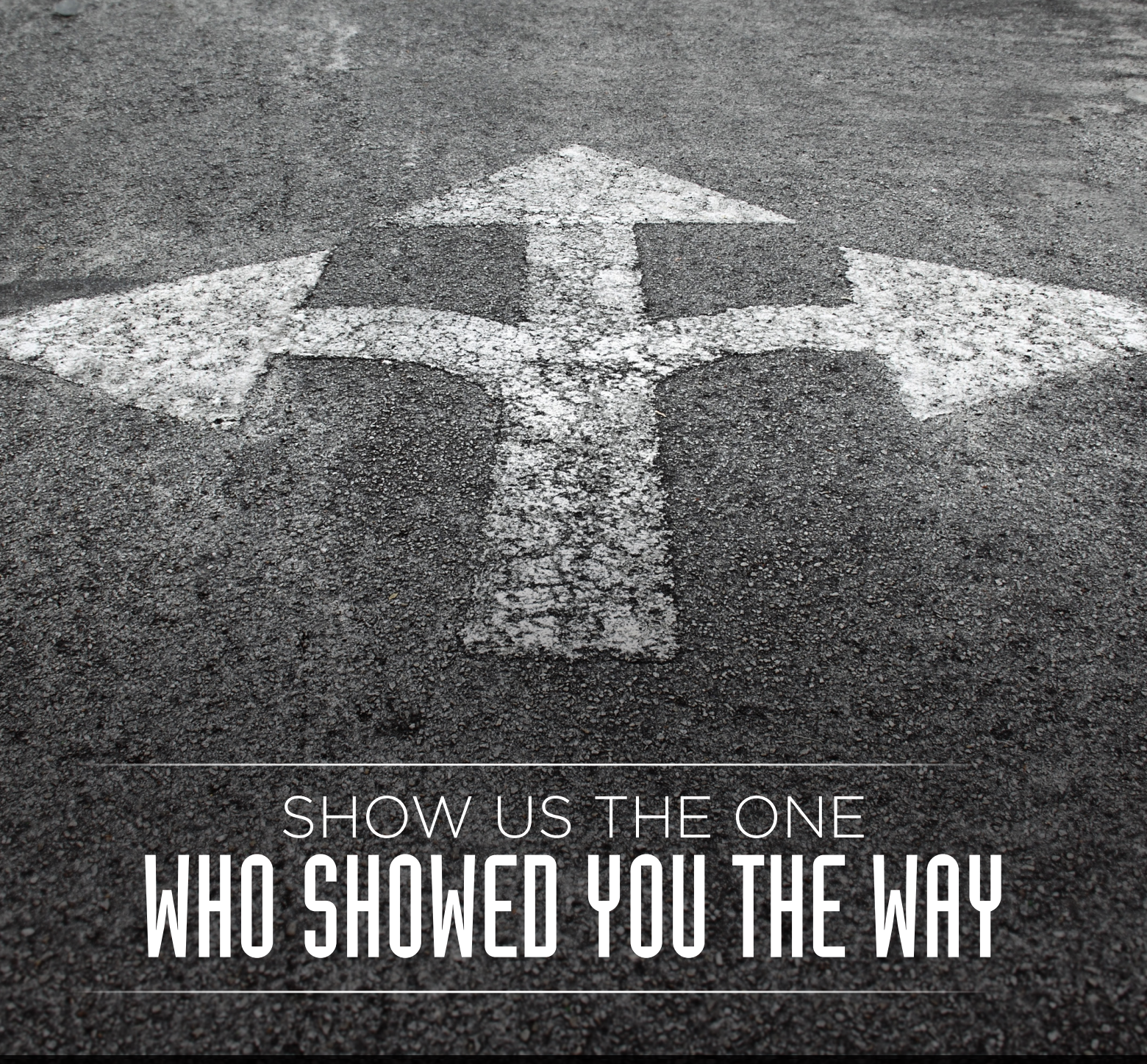
Reinventing the (Power) Wheel



January 1940

A maintenance shop worker at San Antonio Portland Cement Co. reclaims a power wheel for a ten-ton crane in the company's cement mill in San Antonio, Texas. A new wheel would have cost $550 ($10,000 in 2019 USD), but by building up the cableway, the total cost of the reclamation was only $125 ($2,300 in 2019). The portable engine driven welder shown here was used for maintenance application in this shop and around the plant. ARC

Have any vintage (pre-1975) photos you'd like to share? Email them in jpeg format to editor@arcmagazine.pub with a date the photo was taken (actual or approximate), a brief description (three or four sentences), and an email address where we can reach you for additional information.



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