

23 PROJECTS & SKILLS: Raspberry Pi, Arduino, Micro:bit

Make:



OUTSIDE
THE BOX:
Build This
LED Cube Orb

DIGITAL FABRICATION 2023

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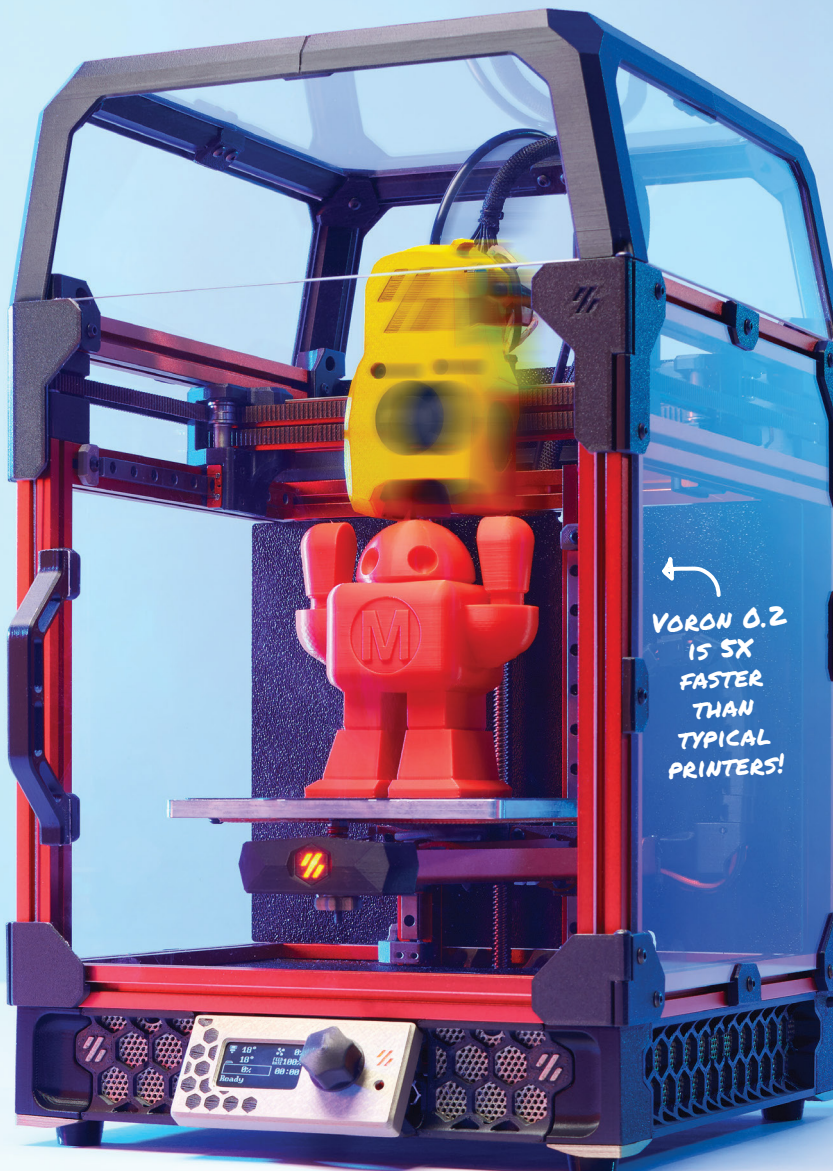
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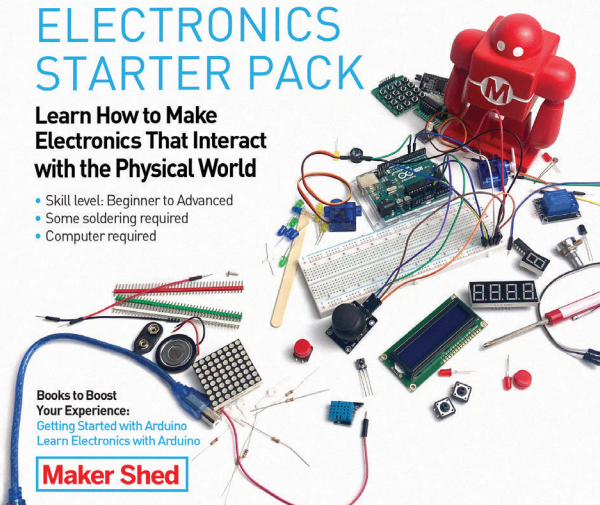
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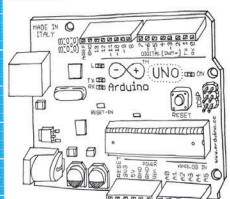
Books to Boost Your Experience:
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Make:

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The Open Source Electronics Prototyping Platform
by Massimo Banzi co-founder of Arduino
and Michael Shiloh

Make: Arduino Electronics Starter Pack & Getting Started with Arduino, 4th Edition book



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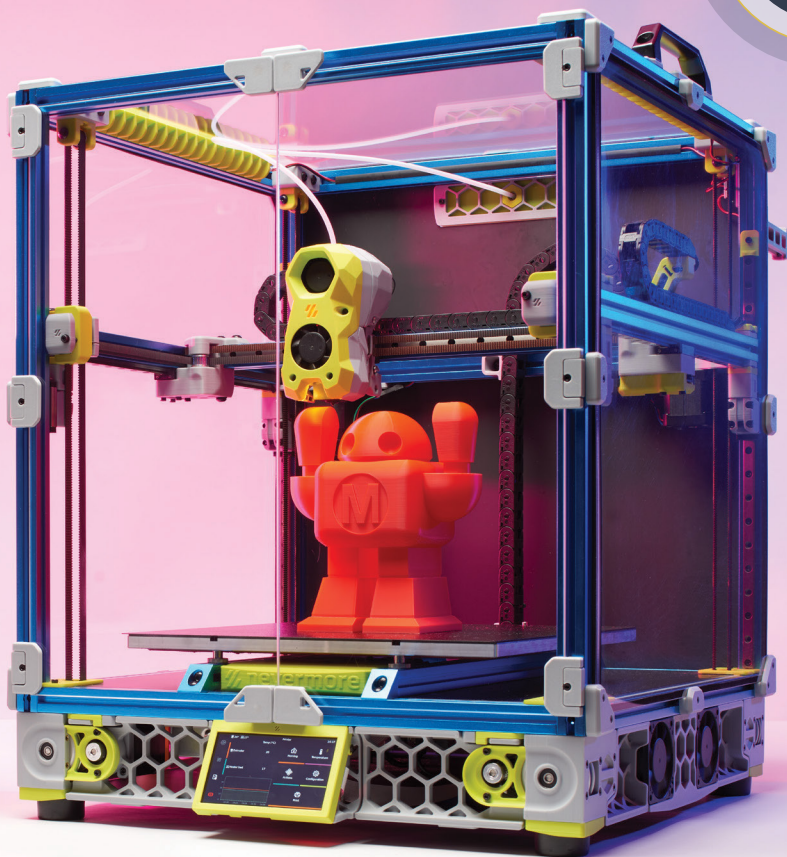
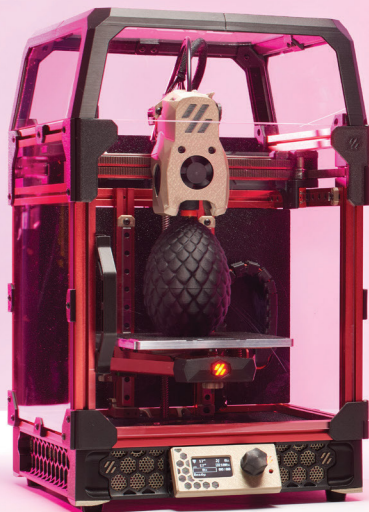
Maker Shed

On the Cover: Portable and wicked fast, the Voron 0 is the little pony that started it all (seen above with its bigger and even faster cousin the Voron 2.4).

Photos:

Mark Madeo and Debra Ansell

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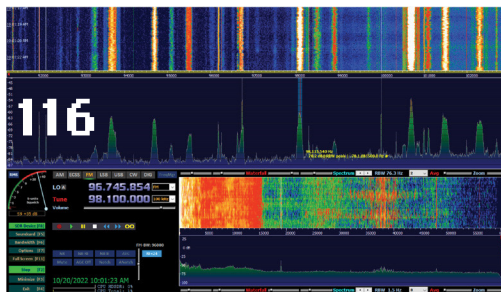
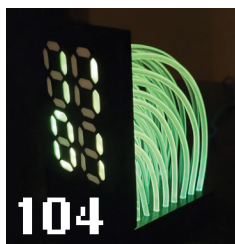
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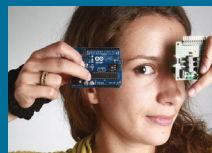
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*What's a project you
"keep meaning to get to"
but never quite do?*



Stefania Druga
Berkeley, California
(Generative AI for Makers)
I always wanted to build a
collaborative drawing
robot that can complete
my drawings or draw
side-by-side with me
using a webcam attached
above our canvas and
computer vision.



Anuradha Reddy
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I keep meaning to make
3D printing designs
from scratch, not simply
modding a design
I downloaded from
Thingiverse.

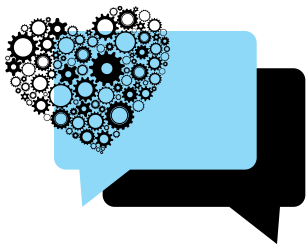


Daniel Connell
Edinburgh, Scotland
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So. Many. To choose one,
the low-tech adiabatic air
coolant refrigerator / air
conditioner.

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FROM THE EDITOR'S DESK

READER INPUT

TEACHING CHAOS, DURING CHAOS

I just wanted to say thank you to one of your writers, Charles Platt. I really appreciate their article on Chaotic Pendulum — cat toy edition (“Chaotic Cat Toy,” *Make*: Vol. 58, page 72). I found this article very, very useful when we had to switch to remote labs in our physics class.

—Dana L, via email



ON WORKING WITH MAKE:

I quickly wanted to thank everyone involved. It was amazing to see BFree in the physical copy of *Make*: magazine (“Perpetual Battery-Free Weather Station,” Vol. 82, page 82). I never had access to the magazine as a kid, as it was more a U.S. thing, but the website and also later the YouTube channel got me started in electronics, so it was super cool to be featured in *Make*!

Thanks a lot. It was a fascinating process.

—Vito Kortbeek, Netherlands





Phil Shapiro
@philshapiro@mastodon.social

Makers, teachers, librarians, community builders – we need to apply the ethic of *MAKE* magazine right here on Mastodon, making the social media we want and deserve. To that end, follow @makemagazine and @calebkraft and any of the other very wonderful folks associated with the maker movement. Birdsite was theirs. Mastodon is ours. Let's build it – step by step – every day. First step – spread the word, in person and online.

Dec 16, 2022, 11:28 · 14 · 21

NEW SOCIAL SPACES

MASTODON.SOCIAL

We've been having a blast on Mastodon: the free, open-source micro-blogging platform (à la Twitter), where anyone is free to spin up a server with its own culture and moderation policy. Join us at mastodon.social/@makemagazine.

DISCORD

Our Discord server is growing! Join the #make-chat channel and talk about what you're making and see what others are making, too. Discord is a real-time chat platform where users can congregate in channels to discuss topics or share interests. We've also been using Discord to host our “after parties” for online events, like the recent Volume 83 Launch Party and our monthly Hangout & Nerdout. Join the party at makezine.com/go/discord.

LIVESTREAM EVENTS

Speaking of Hangout & Nerdout, picture this: 3 hosts + 3 nerds × 1 topic! Our joint livestream with Hackster covers subjects like Wearables, Art, Space, and Music, and features familiar faces from the pages of *Make*:, like Anouk Wipprecht and Sophy Wong — as well as some new faces that we can't wait for you to meet! The first portion consists of presentations and panel discussion, which is then followed by a fully interactive meetup where you can ask our guests all your burning questions about that month's theme. Dates and times vary, so check out events.hackster.io/hangoutnerdout for details on our next event!

The Amateur Enthusiast

by Dale Dougherty *KN6WJKW*, President of Make: Community

Adobe Stock-lubov

I recently deleted my Twitter account and I got a call sign.

To become a licensed ham radio operator, you have to pass a test. To prepare you, local amateur radio clubs offer courses like the two-and-a-half day one I took. One of my instructors told me he was a ham because his friends went to Maker Faire Bay Area and came back enthused about becoming hams and he joined them. The lead instructor had been a ham for 48 years, which says something about how endlessly fascinating some people find the art of amateur radio.

What came across in the class was not just the technical information you needed to pass the test but the lore of the ham radio community, its norms and enthusiasm for the practice:

How lucky we are that the U.S. government 100 years ago decided to allocate portions of the radio spectrum for amateurs, explicitly to encourage experimentation. You can imagine what that spectrum's worth today, but we get to use it for free. Look at all the things we can do with it, especially in emergencies. We can't believe there are fewer than 800,000 who accept this responsibility and get these amazing privileges as ham radio operators.

Then the way they talk about radio waves and antennas — it's science that explains how it works, but it's magic that it does. It reminds me of the way I talked about the internet in the early 1990s: *Through your computer, you can make a connection to somewhere far away instantly!*

David Lang's article "Unleash the Amateurs" on page 14 of this issue illuminates the early days of radio and how experimentation by amateurs led to technological innovations. In the early 1900s, he writes, "There was hardly a delineation between amateur and professional as everyone was trying to build better equipment." Amateurs also formed clubs to train people, which had particular value as the U.S. entered World War I and suddenly needed trained radio operators.

Today much of what ham radio equipment does can be done in software, which is called Software Defined Radio (SDR). On page 116, Tim Deagan

writes about how to use the inexpensive RTL-SDR USB dongle to create a powerful radio listening station at home. These devices — developed by amateurs in the 2010s — convert analog radio waves into digital signals that can be processed in software like CubicSDR to tune in an enormous range of frequencies. All of this can be done on a Raspberry Pi. The limit of RTL-SDR is that you can receive but not transmit. Transmission requires a ham radio license.

We can also see what amateur makers brought to 3D printing, from early homebrew efforts like RepRap and MakerBot, to today's new "speed demon" 3D printers featured on page 25. "Way more powerful firmware that computes acceleration/deceleration, smarter extrusion, and the machine's own vibration/resonance much better than before, to achieve 200mm/sec speeds instead of being satisfied with 60mm/sec," *Make:* editor Keith Hammond told me. "It's all coming from the amateur community." Klipper is the open source RasPi firmware, and Voron is the leading open source machine that deploys it.

Also in this issue, Forrest Mims, perhaps the world's foremost amateur scientist, explains how you can measure the aerosol clouds from the January 2022 Hunga Tonga volcano eruption — the world's highest — that are still visible at sunset today.

Makers, hams, and citizen scientists share the combination of a technical culture and community. The amateur community is where the real magic is and no one can quite explain why they do what they do. Twitter doesn't have that kind of community and that's why I'm not on Twitter anymore. If you're a ham, I'd love to hear from you. 📻





MacGyver Challenge: S.O.S.!

CAN YOU MACGYVER AN OCEAN RESCUE SIGNAL IN TIME?

By Lee D. Zlotoff and Rhett Allain

We are all MacGyvers now! Make: is bringing Mac back to help you think — and make — your way out of emergencies and disasters. Watch for the next MacGyver challenge on the Make: website (makezine.com), Mastodon (@makemagazine), Twitter (@make), and Facebook (makemagazine) and enter your solutions for a chance to be featured in these pages and win Make: goodies!

THE SCENARIO

You and two people from your team at work have been burning the midnight oil for weeks to submit a project by the deadline — which you've met. And the project's been approved. So, to celebrate and enjoy some much-needed R&R, the three of you head out for a day of ocean fishing on your well-appointed motorboat. What's more, you've all agreed to leave your phones on shore to guarantee some time without screens. After a spectacular day with lots of freshly caught fish in the cooler, you discover that the engine won't start. And, for all its bells and whistles — like a motorized anchor winch — your boat has no radio. And you can all see the skies are quickly darkening and there's a storm headed your way.

THE CHALLENGE

Using whatever you can find from the boat and the list of items below, how can you come up with a way to signal for help before you and your mates become food for the fishes?

WHAT YOU'VE GOT

And it's *all* you've got:

- Any part of the boat
- Flotation devices
- Fire extinguisher
- Drinking water
- Fishing gear
- Anchor and chain
- Snorkeling gear (but no scuba)
- A 5-gallon container of gasoline plus whatever's in the boat's tank
- A basic tool kit, including a Swiss Army Knife
- Duct tape, of course
- An unopened box of 30-gallon black trash bags

TURN THE PAGE FOR SOLUTIONS!



LEE ZLOTOFF is an award-winning writer, producer, and director of film and TV, including *MacGyver* (1985–1992). His new production, *MacGyver: The Musical*, casts a different audience member as Mac at each performance. macgyver.com



RHETT ALLAIN teaches physics at Southeastern Louisiana University. He was technical consultant for the *MacGyver* reboot (2016–2021) and an advisor for *MythBusters*. He blogs about physics fun at rhettallain.com.

MacGyver Challenge: S.O.S.!

OUR SOLUTION

Create a radio transmitter. Impossible? Not so fast. We're going to build the first kind of radio: a *spark gap transmitter* (aka *wireless telegraph*). The idea is to produce electrical sparks that broadcast radio waves on a broad range of frequencies.

Of course, you need a battery to supply the electrical current. It won't have enough voltage for large sparks, so you'll boost it by building an inductor: basically a coil of wire, maybe wrapped around a ferromagnetic core, like iron. An inductor produces a voltage that's proportional to

the rate of change of current. So that means we need to turn the current on and off very quickly.

One trick is to use this same inductor as an electromagnet that pulls a wire off a contact to stop the magnet, which immediately makes the wire reconnect and turn on the current again, and so on (this is the idea of an electric buzzer). With that, you just need to take another wire to tap an electric contact — and remember your Morse code — to send a radio signal.

MOST PLAUSIBLE SOLUTION

Much like our solution, David Honess (via Mastodon) says to "make a very basic oscillator that works at radio frequencies" and then send an SOS, though he leaves off the details.

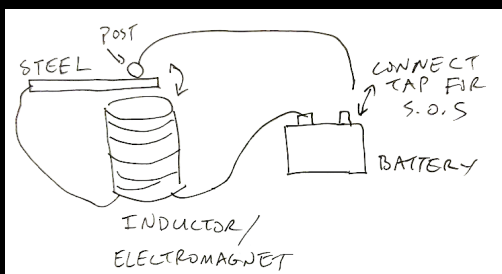
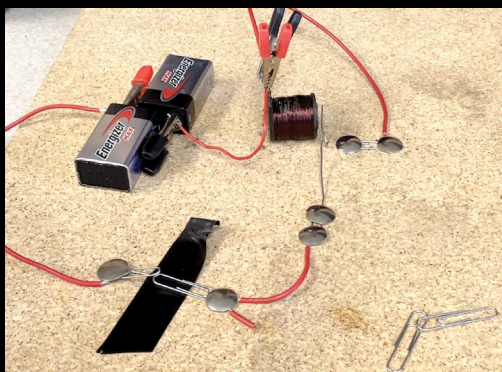
MOST CREATIVE SOLUTION

Mike Fish (on the *Make:* blog) and @AreScoops (Twitter) both thought to take the battery and two conductors in the water to create electrolysis, separating the H_2O into hydrogen (H_2) and oxygen (O_2). Collect the hydrogen gas with a trash bag to make an impromptu balloon to signal for help.

Very creative, but making enough hydrogen would take time. Another problem is the trash bags — great at holding trash, not so great at holding hydrogen (but should work in a pinch).

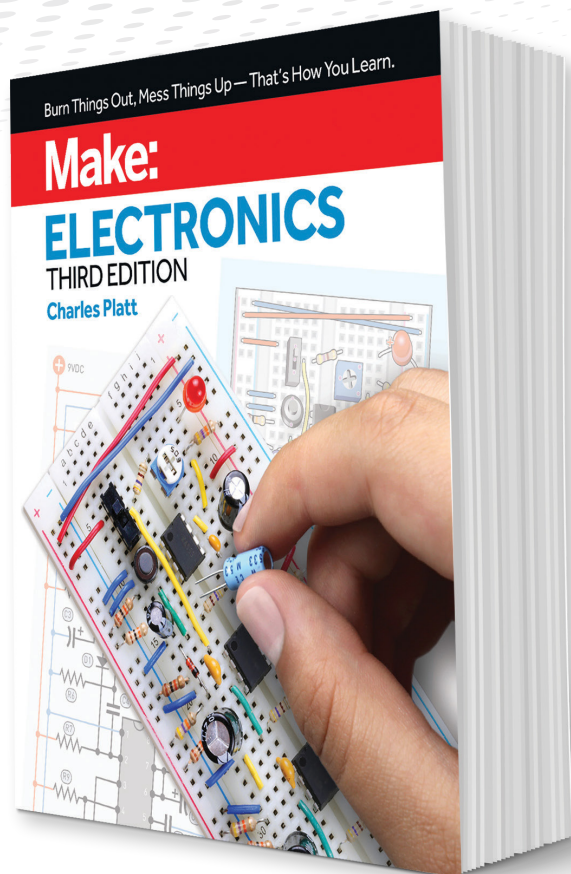
HONORABLE MENTION

Derek Fox (Facebook) would remove the engine's alternator and spin it manually by wrapping a cord around the shaft. With each pull, it creates a current. Connect to the boat lights for a signal. 🚩



Make: Books

LET CURIOSITY LEAD YOUR
LEARNING JOURNEY



Make: Electronics, Third Edition

by Charles Platt \$34.99

NEW COLOR ILLUSTRATIONS!

Starting with basic concepts, this friendly and comprehensible guide takes the reader step-by-step toward circuits of increasing complexity. The principle of Learning by Discovery, pioneered by Charles Platt, uses hands-on experiments to create a lasting and entertaining learning experience.

OTHER GOODIES TO GRAB:

Make: Calculus

by Joan Horvath and Rich Cameron
\$29.99

Robot Magic

by Mario Marchese
\$24.99

Making Simple Robots, Second Edition

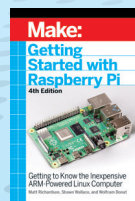
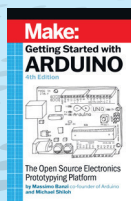
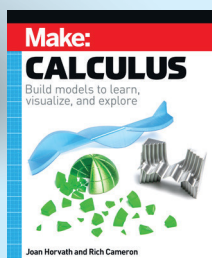
by Kathy Cecher
\$24.99

Getting Started with Arduino, Fourth Edition

by Massimo Banzi and Michael Shiloh
\$19.99

Getting Started with Raspberry Pi, Fourth Edition

by Shawn Wallace, Matt Richardson,
and Wolfram Donat
\$24.99



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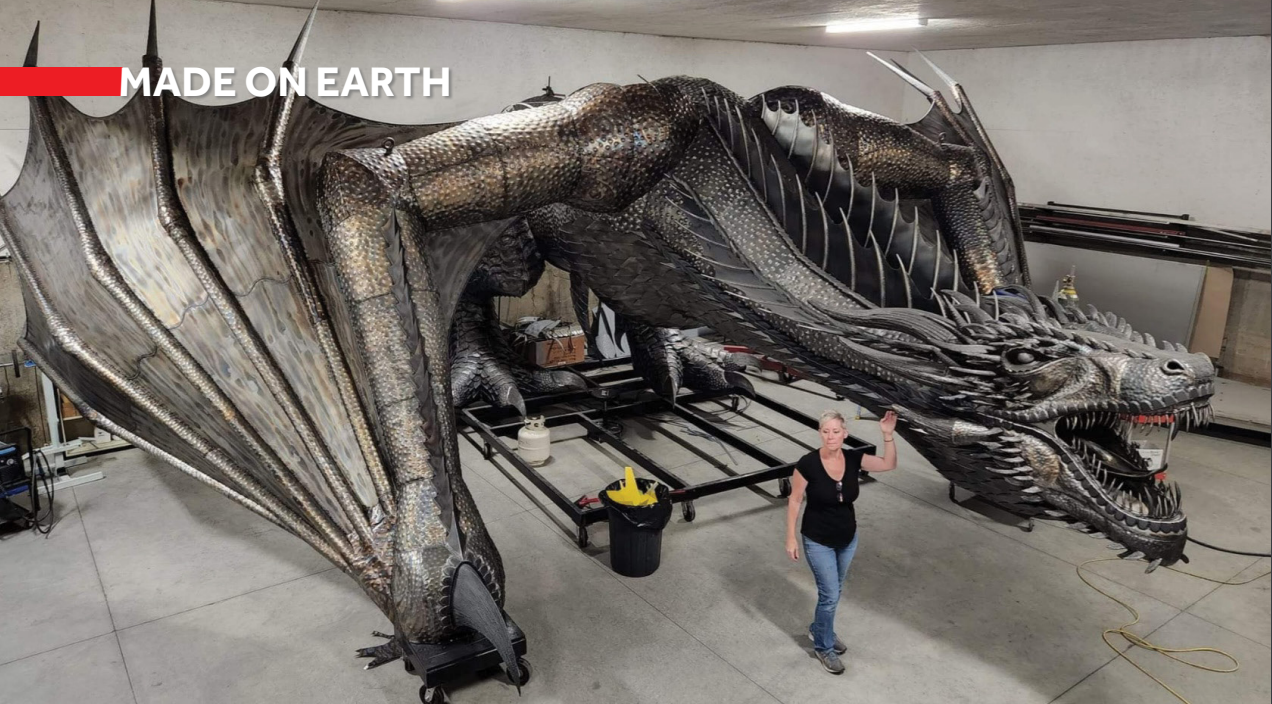
In the world of hobby electronics, the concept of making the circuit itself — the components, the wires, the underlying material — into an artwork is a well-respected endeavor. People have been making pretty circuits, or sneaking tiny designs etched into the functional engineering, since the dawn of electronics. Having such a rich history, it's even more impressive when something new blossoms out of that fertile soil.

Atdiy of the **Tymkrs** (pronounced "Toymakers") came up with this interesting new take on artistic PCB design, harnessing the somewhat newly approachable flexible PCB services out there. Her idea was to use the flexible materials to emulate the petals of a flower, while carrying the electricity to light up tiny LEDs mounted to it.

Just like some of the most sought-after plants in the world, this one went through a peculiar gestation period. Her initial concept designs were produced and sat in storage for years between attempts to make this project work. Constructing circuits with flexible PCBs takes a delicate touch, and Atdiy had to learn how to work with her flower to get it to bloom. Out of 20 attempts, only 13 petals survived.

In the end, her sculpture serves as a beacon of creativity, and reminds us that there are always new discoveries to be made, even in areas that we thought to be fairly well explored. —*Caleb Kraft*





A DANCE WITH DRAGONS

[YOUTU.BE/JXW27KKY-E4](https://youtu.be/JXW27KKY-E4)

Game of Thrones was an immensely popular TV show for much of its running. There were very few people who didn't gaze at the gorgeous dragons on screen in the later seasons and wonder what it would be like to stand in front of one of these beasts; to feel the blistering heat as they stretched out their necks and exhaled plumes of flames. Sculptor **Kevin Stone** doesn't have to imagine: he's brought this experience to life.

This 15,000lb stainless steel sculpture of Drogon, the biggest of the dragons from the show, stretches over 55 feet long and is 30 feet tall in his crouching position. If he were to spread his wings, he would be over 100 feet wide!

The real icing on this cake, however, is that when constructing the sculpture Stone also had a "poof," a propane-powered flame system, designed so that this dragon really can breathe fire. After over two years of work hammering, shaping, welding, and generally sculpting Drogon out of steel, Stone will have to say goodbye. Drogon is headed on to his final home, a private owner who is just waiting for the time that they can step outside their house and say "Dracarys" to unleash a dragon's fury. —Caleb Kraft



Kevin Stone