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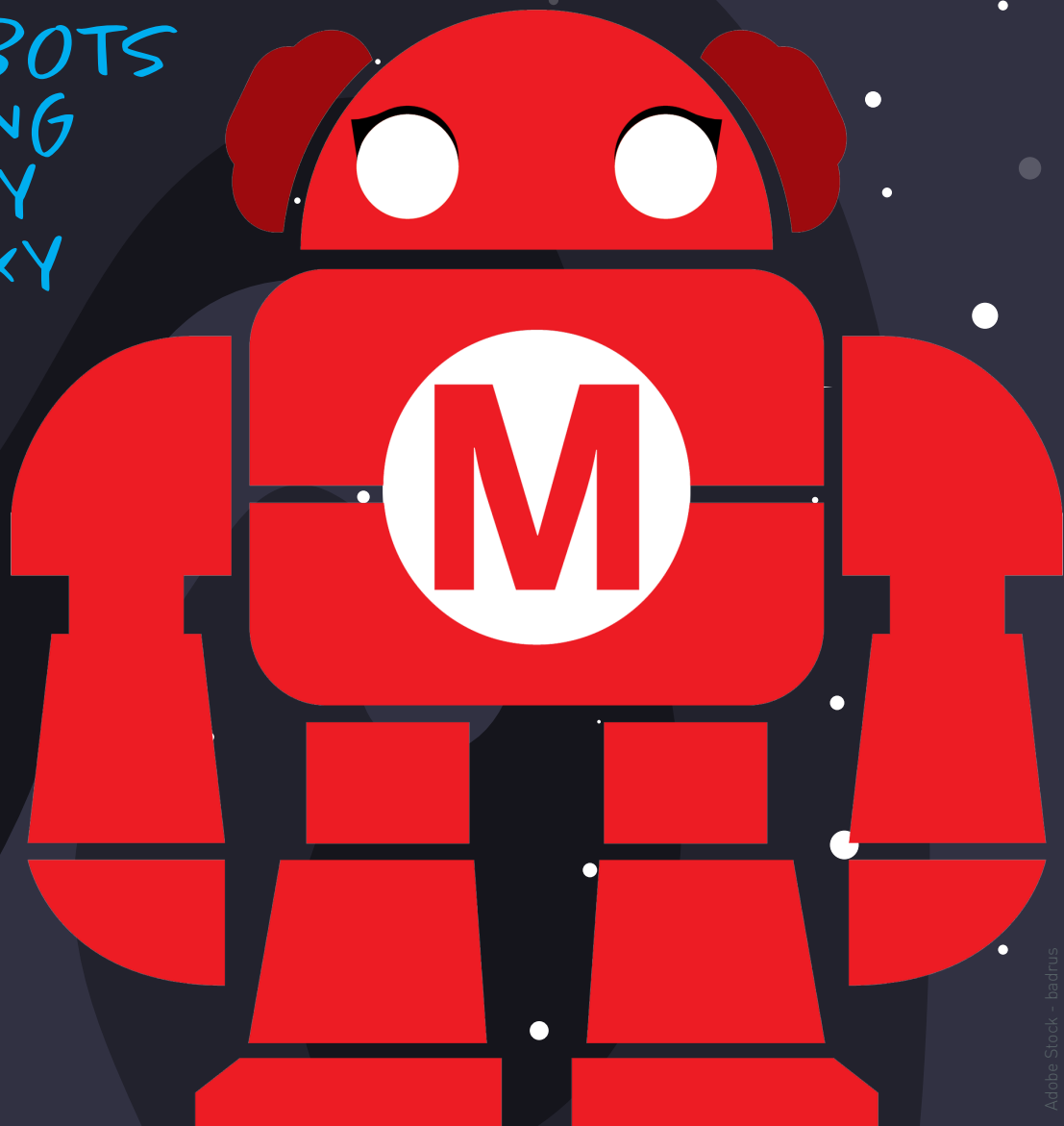
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STAR WARS

DIY DROID FACTORY

BUILDING BOTS
AND FINDING
COMMUNITY
IN A GALAXY
NOT SO
FAR AWAY





Written by James Graeber

Galaxy of Droidsmiths

Welcome to the expanded universe of Star Wars droid builders



JAMES GRAEBER is an engineer and winemaker in Folsom, California. He discovered the droid builders visiting Maker Faire Bay Area with family in 2016.



Chris Moody, James Graeber

Longtime *Make*: readers — and visitors to Maker Faires around the world — know how much we love R2-D2, that cheeky little astromech droid from *Star Wars*. We profiled the R2 Builders Group way back in our second issue in 2005 (makezine.com/article/craft/r2-diy), and showed how to build your own life-sized, remote controlled Artoo in 2016 (makezine.com/projects/building-your-first-r2).

Since then, the *Star Wars* universe has only grown, and the makers who create their own replicas and custom droids have grown with it. Let's check in with them, and learn what's going on in the expanded universe of droid building.

THE ASTROMECH BUILDERS (R2 BUILDERS)

This is where it all started, and it continues to grow. The famed R2 Builders Club forum at astromech.net is where makers come together to share their knowledge and resources for building R2-D2 and many other popular droids.

The forum hosts blueprints and 3D models created by club members who carefully reviewed movie footage and reverse-engineered the required dimensions, and in some cases were able to take measurements directly from screen-used droids. These

blueprints are then used to create detailed plans for all the droid parts.

Plans are designed to suit many different building styles — you can build a droid using hand-cut sheets of styrene plastic; or use a CNC, waterjet, or laser cutter to cut your own droid parts from styrene, wood, and aluminum; or grab 3D models that will allow you to print parts, or even an entire droid!



MEMORY WIPE

Raise your manipulator arm if you remember the "R2-DIY" cover of *Make*: Volume 02, featuring the R2 Builders Group, in May 2005!



The forum is also a great place to get help with your build. Builders work to keep their designs compatible with each other, and many will build and sell kits for specific parts, or even completed parts. And if you don't have access to the tools needed for a scratch build, you can get in on a "parts run" to get started.

SAME DROIDS, NEW WAYS TO BUILD

In recent years, builders have developed new ways to create their own astromechs. 3D printing was already a good way to make small, detailed parts (known as greeblies), but today people are printing their entire droid, and new communities have sprung up around the technique. The **MrBaddeley Printed Droid** group is where Michael Baddeley shares the 3D models he creates, including a fully printed R2-D2. Find it at facebook.com/groups/MrBaddeley or patreon.com/c/mrbaddeley/home.

If you believe droids should be made of metal, there are new options for you as well! Some builders have converted the club blueprints into files that can be uploaded to **online custom fabrication sites** like SendCutSend and OSH Cut, allowing makers to create their own parts from aluminum with minimal tools.

As the world of electronics advances, new components make their way into droids. Builders can now choose from traditional brushed scooter motors, or newer brushless motors like the **Q85**

and **Rev Neo**, which offer higher efficiency and more precise speed control. Foot drive systems such as the **MaxDrive** support both brushed and brushless options, and popular control softwares such as **SHADOW** have been updated to work with both as well.

Newer, inexpensive hardware like the audio **DFPlayer** from DFRobot and the **ESP32** processor reduce the cost and size of some of the key electronic components. Again, developers on astromech.net are collaborating on updates and sharing their code, allowing builders to use either the new components, or previous ones like the popular MP3 Trigger and Arduino Mega.

Astromechs also have a new voice! For years, most builders have used the same sound files, which cover a range of droid emotions. We now have the **Human-Cyborg Relations** hardware and software (humancyborgrelations.com), which generates unique vocalizations for R2 and other astromechs based on their original speech patterns and phonemes.

Our options to control these new features are increasing too. The **Kyber Control System** allows builders to add multiple buttons to any sBus-capable R/C receiver to activate sounds and animations. It was built with droids in mind, integrating with popular hardware and features, including **Pololu Maestro servo controllers** and the **MarcDuino animatronic controller**.



THE EXPANDED UNIVERSE

Whenever a new droid shows up on screen, makers everywhere start thinking, “How can I build that?” New clubs have formed around specific types of droids, where makers can share blueprints and 3D models, help each other, and show what they’re working on. Let’s take a Star Tour of these builder communities and meet some outstanding droidsmiths!

BB-8

When filming *The Force Awakens* in 2014, Lucasfilm used many different techniques for animating the spherical BB-8 droid (Figure A), including puppetry, greenscreens, and remote-controlled “trike” versions with extra stabilizing wheels. An actual free-rolling BB-8 wasn’t needed for filming, but was still the goal for Lucasfilm engineers. When they finally rolled out the first true BB-8 at Star Wars Celebration in 2015, they proved it could be done, and set the spheres in motion for the legions of fans who wanted to have their very own BB unit. Like R2 builders, the BB-8 builders have forums to share their plans, 3D models, and knowledge. Find them at bb8builders.club/forum and facebook.com/groups/BB8BuildersClub.

BB-8 BUILD TEAM PROFILE

Psy DeLacy, Chris Stroud, David Ferreira, Matt Hobbs, and Alex Coajou

What else do you do with your buddies, other than redesign a droid from the ground up? Bonded through the droid building community and their mutual love for BB-8, this team had all been building the little droid since they first saw him roll across the screen (Figure B).

Then in 2019 they decided to start anew — Chris and Dave were upgrading their custom drive system, so why not rework the entire droid to integrate new features, update existing ones, and “try a few things”?

The team made a wish list for both the frame and the drive, and got to work. Connectors were debated, tolerances and densities scrutinized, motors vetted, and prototypes printed. Quality-of-life improvements include a keyed configuration for easy frame assembly, pogo pins to connect panels, and easy access to the frame hardware. They also decided to optimize for SLS printing, which allowed for clever hardware integration in limited space, while retaining a strong frame.

After performance-testing a variety of motors and actuators, the drive system was tweaked and simplified. Custom controller boards were created for the drive and body panels, and a custom battery to fit nicely within the drive.

By Celebration Anaheim in 2022, BB-8 was ready to roll for the first time. Chris dove into the programming to refine the functionality, stability, and performance, dialing in settings and adding features throughout the summer. Even though BB-8 is a one-player droid, Chris made sure to add “free animation” wherever it made sense. These little things — like when BB-8 goes to turn, he will look slightly toward the direction he’s turning — not only lighten the mental load of the operator, but also give BB-8 a bit more life.

Since then, BB-8 has been to Celebration in London and Tokyo, and countless events around North America. The team is happy with BB-8’s performance. There’s always more they want to do, but there are also always new droids to build!



K-2SO

Introduced in *Rogue One*, with a backstory fleshed out in *Andor*, K-2SO (Figure C) is another droid with a lot of personality. You might think a 7-foot-tall bipedal robot is more suited to a billion-dollar company like Boston Dynamics, but that doesn't stop droid builders. Most of our K-2 builds are currently static, but not all of them! A full 3D printable model is available at Droid Division (droiddivision.com) and you can join the K-2SO Builders Club for details and knowledge sharing at [facebook.com/groups/243024372796193](https://www.facebook.com/groups/243024372796193).

K-2SO BUILDER PROFILE

Darren Moser (@drscifi)

When the *Rogue One* trailer dropped in 2016, Darren started his first technical notebook with a dream of bringing K-2SO to life as a puppet (Figure D) using 1" PVC pipe as the skeleton, with adjustable elbow "spider joints" that allow the arms, knees, hips, and ankles to pivot. He sculpted EVA foam with box cutter knives and a borrowed band saw to cover the pipe skeleton and give K2 form. The entire puppet was connected to a tactical vest, allowing Darren to walk around wearing it, his feet in dive fins bolted under K2's feet. A pulled-apart pan/tilt camera system supplied rudimentary head motion while a combination of wood, string,

and PVC pivots created fingers that at best twitched about. It was Version 1, but Darren was just getting started.

Over the next 8 years as Darren grew as a maker, improving his skills with foam, 3D printing/modeling, programming, and painting, K2 evolved through four more versions. By spring of 2025, *Andor* Season 2 was a few months away and Darren set himself one goal: bring his K-2SO puppet to an *Andor* event. Never had the upgrades happened so fast! Darren gave K2 new 3D-printed shoulder rings with greater detail, and new joint covers with mirrors to create the illusion that the round elbow or knee was hollow. An entire new head mechanism was developed by Travs Butler from Dave Moog's (Droid Division) 3D files, and a bike cable linkage system connected a custom puppet controller to the individual fingers allowing K2 to point, fist bump, and grasp light objects. Dual joysticks controlled the head motion and neck bob, while twin cameras allowed Darren to see what was in front of K2 and where he was looking.

At last Version 5 was complete, just in time for the Hollywood premiere of *Andor* Season 2 at the El Capitan Theatre. Darren suited up and with his friend Mark Edwards (dressed as Cassian Andor from *Rogue One*) walked out onto the red carpet to greet the fans, the crew, and the stars.

"It's important to find joy in both the workshop and the showcase," Darren says. "We cannot just live in one."



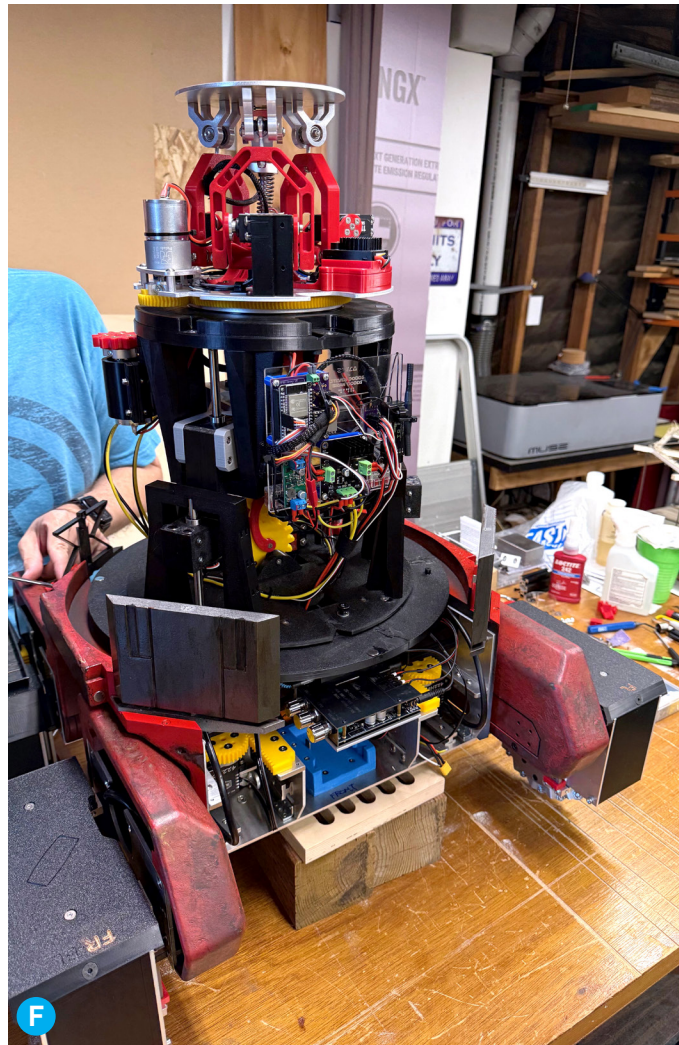
B2EMO

Of course we can't talk about droids from *Andor* without talking about B2EMO (Figure E). With feet that can expand and retract, a multi-segmented spinning body, a highly articulated head, and the ability to strafe sideways on omniwheels, this is obviously a challenging build, but given that Lucasfilm used all mechanical/practical effects for the filming of *Andor*, it's an achievable one. The most popular model comes from MrBaddeley Printed Droid, but like other droids, there is a community of builders innovating components and sharing plans, software, and 3D models. Find the B2EMO Droid Builders Group at facebook.com/groups/b2emo.

B2EMO BUILD TEAM PROFILE

Steve Dodds and Brian Dodds

B2EMO caught Steve Dodds' eye right away in *Andor* Season 1. This new droid was clearly a practical animatronic prop, not CGI, and full of character — like an old, loyal family dog who spends much of his day snoozing in his bed. After a Thanksgiving dinner conversation with his brother Brian, they started building in early December 2024 and had B2EMO presentable for WonderCon in March 2025. A week later, he was rolling around the California Science Center in LA for Yuri's Night on April 5.



The brothers' B2EMO is a highly customized build, based on Michael Baddeley's V2 files, with a modified version of David Ferreira's "Pro" head mechanism and a variation of Tim Hebel's prototype drive system (Figure F). His shell is 3D-printed ABS plastic, while the internals are a mix of aluminum and ABS. Brian custom-machined many of the aluminum components, including the adapter rings that house the brushless motors inside the 6" Mecanum wheels, giving B2 his ability to move effortlessly in any direction. He also designed and built many of B2's other assemblies and routed power and communications wires.

Meanwhile, Steve kept his printer running nearly 24/7 to produce the exterior skins. He spent months gluing, sanding, texturing, and distressing everything to achieve the screen-accurate damaged look. Paul Thompson contributed his expertise on the final paint and weathering touches, while Steve dove into the code to bring B2 to life — programming and installing the lights, collecting and editing sounds, and animating motions.

B2EMO includes all the movement features seen in *Andor*: including omnidirectional drive, and the ability to contract into a compact defensive posture (turtle mode). He can speak lines from the show and play other sounds, and has a customized R/C control system that allows one person to operate him — with practice.



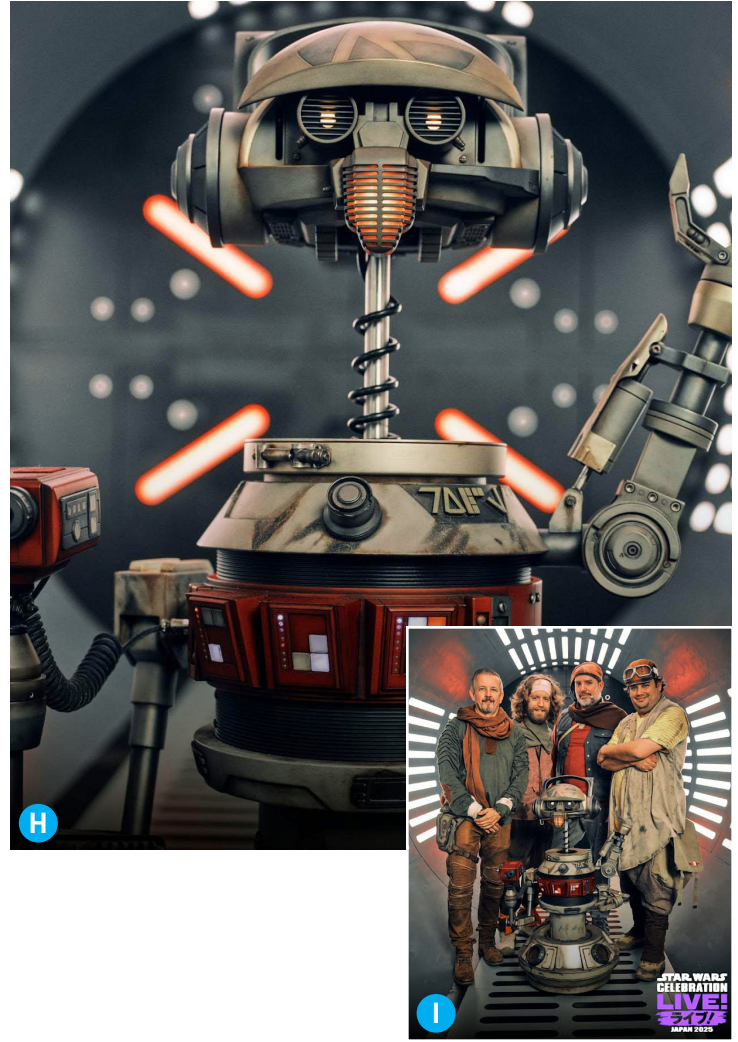
D-O

The Rise of Skywalker introduced yet another droid with a memorable personality: D-O (Figure **G**). The backstory of this self-balancing, one-wheel droid — cobbled together by a droidsmith using odds and ends from his workshop — has obvious appeal to the droid building community.

The first working D-O droid was revealed by Disney at Star Wars Celebration in April 2019, and the community didn't wait — they started building 3D models based on video of the stage event, and many fan-built D-O droids were completed even before the movie was released that December. Michael Baddeley created the first D-O replica, followed by Matt Denton. Denton, who worked on the official D-O for the movie, documented his construction process in a comprehensive four-part YouTube series. You can join the D-O Builders Club at [facebook.com/groups/2468594199841880](https://www.facebook.com/groups/2468594199841880).

RX SERIES DROIDS

Movies aren't the only inspiration for droid builders. The Disneyland attraction Star Tours introduced us to RX-24 or "Rex" as the animatronic captain of the StarSpeeder 3000, on his very first flight to Endor! Rex has since been re-purposed as R-3X and is helping to create the vibe as the DJ in Oga's Cantina at Galaxy's Edge. Fans have created plans, 3D models, drive systems, and speech



synthesis/modulation software for both RX-24 and DJ R-3X. There's even a "CantinaOS" in the works that allows R-3X to converse with you, in character, using ChatGPT! You can find the RX Series Droid Builders Club at [facebook.com/groups/616292118832957](https://www.facebook.com/groups/616292118832957).

RX BUILD TEAM PROFILE

David Ferreira, Chris Stroud, Matt Hobbs, Patrick Gray, and Trevor Zaharichuk

RX-91L, also known as Gil (Figure **H**), made his debut at Star Wars Celebration Anaheim in 2022. Brought to life by a team of friends (Figure **I**), this RX droid not only has a winning personality, but also has helped develop new tech being used by other droid builders. Because Gil has a lot of functionality — a drive system, three arms, and a head with multiple axes of rotation — operating him can be difficult. To overcome that, the team set up two different modes, one-player or two-player! They also utilized "free animation": rotate his head up and the visor will also rotate a tiny bit, or vice versa. Gil also has a voice, which the operator controls by speaking through a headset, and the vocalization drives the lights in his mouthpiece.

BDX DROIDS

In 2023 Disney Imagineers outdid themselves, unveiling the real-life BDX Droids (commonly referred to as the "Duckling Droids") (Figure

J). These small bipedal droids are usually seen in a pack of three, wandering around Galaxy's Edge with their trainers. Created in a collaboration between Disney, Nvidia, and Google DeepMind, they're a step beyond the animatronics we see elsewhere in the park, using AI for amazingly lifelike motion and emotion as they interact with guests. We also expect to see these droids in *The Mandalorian* and *Grogu* movie in 2026.

Want to build your own? Join the community that's working to develop the plans, models, and software. There are several initiatives in progress using different hardware solutions to re-create the BDX personality. Find the BD-X Duckling Droid Builders club at facebook.com/groups/1330064834544532.

MSE-6 (MOUSE) DROIDS

The MSE droid is as old as *Star Wars* itself, having debuted in 1977's Episode IV where it zipped around the Imperial ships, making deliveries and small repairs. Today's builders are using 3D printing, styrene, wood, and aluminum to faithfully re-create the original, as well as unique versions like "Mousezilla" that are strong enough to take a ride on, and even tow an astromech behind! It's a fun first droid to build; learn how at mousedroidbuilders.club or facebook.com/groups/MouseDroidBuildersClub.

MOUSE DROID BUILD TEAM PROFILE

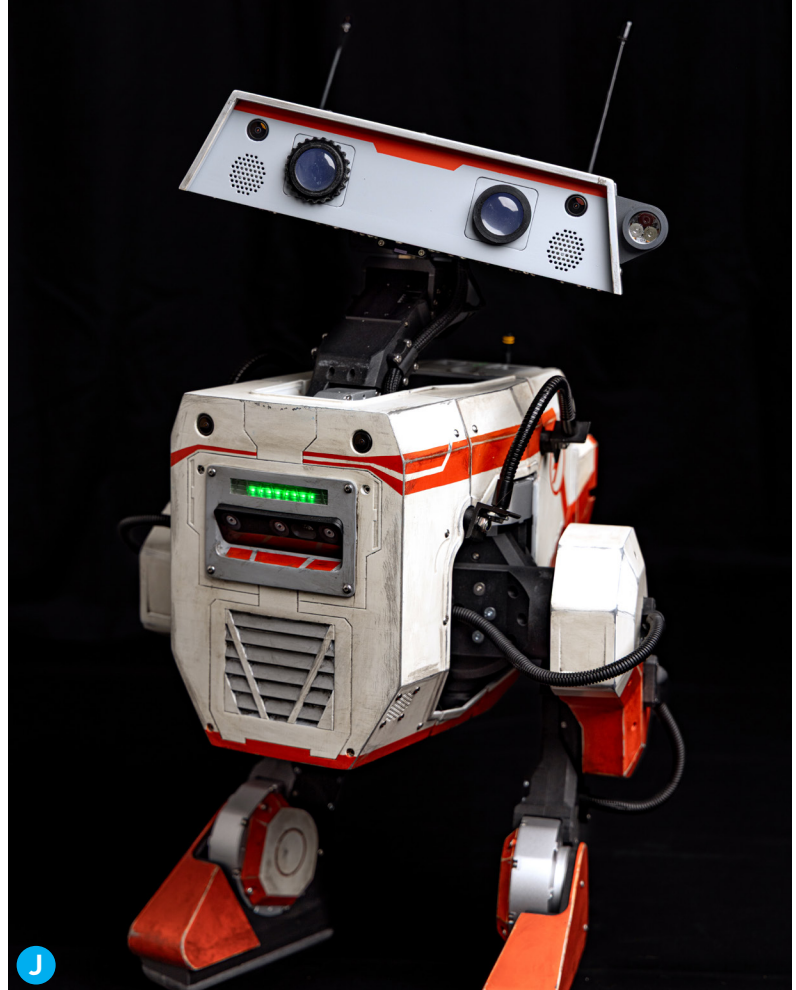
Romano and Connie Bassi

This MSE droid (Figures **K**, **L**, and **M**) was inspired by a 2008 episode of *Robot Chicken*. Externally, it's a screen-accurate outer shell of vacuum-formed styrene, mounted on a modified R/C car powered by a Sabertooth motor driver and steering servo. The side greeblies are real computer IC chips and capacitors mounted on breadboards.

But inside, Romano and Connie created a miniature cockpit using 3D files from Thingiverse, which they customized in Tinkercad. The cockpit houses two mice with 3D-printed frames. The driver's head moves side-to-side using a single servo; the passenger has three, for left-right and up-down head movement, and for leaning out a hidden side door, which is operated by a fourth servo.

They crafted the mice heads using needle felting, and sculpted the hands, feet, and tails from pink oven-bake clay. Uniforms were repurposed from 1:6 scale Imperial officer action figures. Armor and helmets were 3D printed using files from Thingiverse.

LEDs illuminate the cockpit, and servos are programmed using a Maestro controller, while sound effects — including clips from *Star Wars: A New Hope* and cute mouse squeaks — are triggered via R/C transmitter switches.



Chris Moody, Wes Ellis, Romano and Connie Bassi



C-SERIES ASTROMECH (CHOPPER)

C-series droids were considered obsolete during the Galactic Empire, but a few remained in use, most notably C1-10P, aka Chopper (Figure **N**).

Originally featured in the animated series *Star Wars: Rebels*, Chopper made the leap to live action in *Rogue One* and then *Ahsoka*. There are differences between the two versions, and builders have embraced both looks. Find the Chopper Builders group on astromech.net and at facebook.com/groups/150848812068222.

CHOPPER BUILDER PROFILE

Jaime Acevedo

Big fans of *Star Wars Rebels*, Jaime and his wife were inspired to build Chopper due to his prickly personality: he's not a typical droid subservient to humans. Jaime 3D printed Chopper using the files from MrBaddeley Printed Droid. To control his complex animation and sounds, Jaime developed a custom phone app and game controller that wirelessly connects to an ESP32 in the droid (Figure **O**). For stealth mode, a custom-built controller fits in his palm, with buttons for Chopper's most common actions (Figure **P**).

GNK-SERIES POWER DROID (GONK)

The Gonk droid can be found all over the galaxy, providing power where it's needed. Gonk droids are some of the easiest to create, as most builders start with two plastic storage bins stacked on top of each other, then use their creativity to add greebles such as lights, vents, holoprojectors, and often a functional charging port! The Gonk Droid Builders Group can be found at facebook.com/groups/413080335552627/.

GONK BUILDER PROFILE

Mike Longo

When *Star Wars* came out in 1977, Mike Longo was 12. His favorite droid was R2-D2, but he was fascinated by the funky Gonk droid in the Jawas' sandcrawler. Years later he came upon an oddly shaped plastic tote, and his build began (Figure **Q**). Mike used a 3D printer to make the feet and greeblies, and his son Nick wired the LED lights on the face. And to make it a real power droid, he added a portable charger with USB sockets.



N



O



P



Q

Jaime Acevedo, Mike Longo

TREADWELL DROIDS

WED Treadwell droids pop up all across the galaxy, tending moisture farms, repairing the Millennium Falcon, grilling up Krayt Dragon steaks. After playing a minor role in *A New Hope*, Treadwells have appeared in *The Empire Strikes Back*, *Attack of the Clones*, *The Mandalorian*, and *The Book of Boba Fett*. Paul Thompson and Ross Saggio are working on detailed build plans; find the Treadwell Builder's Club at facebook.com/groups/treadwellbuilders.

TREADWELL BUILDER PROFILE

Paul Thompson

Paul was 9 when he saw *Star Wars* and was completely blown away. His parents bought him *The Star Wars Storybook*, and inside was a small photo of Luke standing beside a Treadwell droid, gazing at a battle in the sky. Paul knew one day he'd build that droid.

In 2009 when he started, there wasn't much information available. His build (Figure **R**) has evolved with the help of other droid sleuths. Turns out Treadwell's "eyes" are the internal lenses from a Paterson Trident 35mm slide viewer. The gripper claw? A repurposed pickle fork. Tracks? A 3" race car blower belt turned inside out. Once he identified these, he could extrapolate dimensions for the whole droid.



SCRUBBER DROIDS

First seen in *The Phantom Menace*, the Scrubber droid cleans up around hangars and workshops. Early builders discovered it was actually an 8-gallon storage tote inverted and attached to wheels. Many use an R/C car as the platform, and as these totes are fairly rugged, one of the most common uses of scrubber droids has become ...

racing! Find the Scrubber builders group at facebook.com/groups/818123339392885, and check the Mouse forums for similar ideas.

Houston builder **Jesse Maricelli** built this amazing Scrubber (Figures **S** and **T**), complete with an old iPhone as a terminal display, after seeing a race at his local club. The mayhem that ensued from ludicrously fast droids tumbling down the street, flinging parts as they disintegrated, was enough for Jesse to say, "Yeah, I want one." 🚫



Paul Thompson, Jesse Maricelli

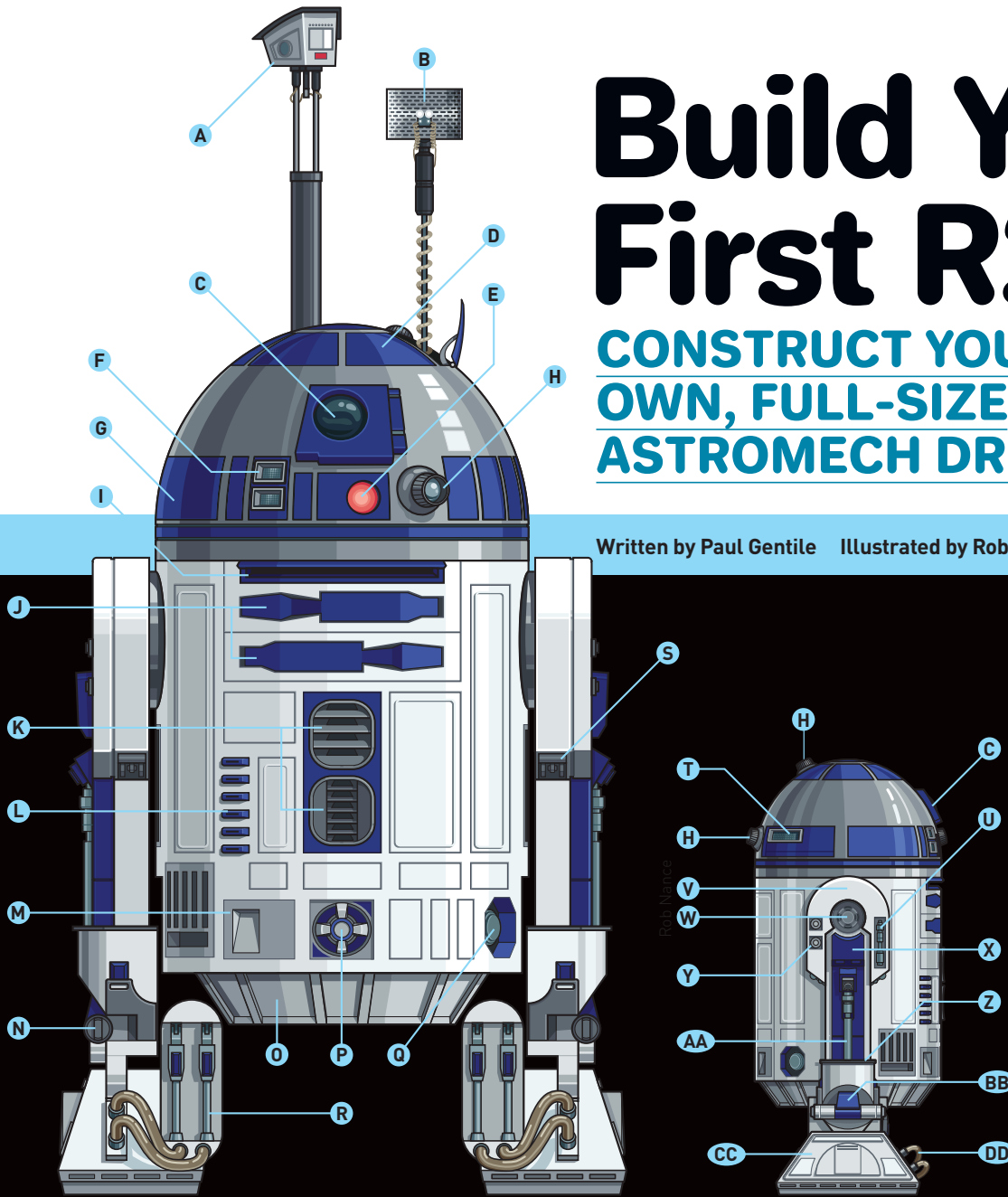


See more of these droid builds and builders in the extended version of this article at makezine.com/go/droidsmiths.

Build Your First R2-D2

CONSTRUCT YOUR VERY OWN, FULL-SIZE ASTROMECH DROID

Written by Paul Gentile | Illustrated by Rob Nance



- A Periscope
- B Life Form Scanner
- C Radar Eye
- D Pie Panels
- E Processor State Indicators (PSI)
- F Front Logic Displays
- G Dome Panels
- H Holoprojectors
- I Large Data Port
- J Utility Arms

- K Front Vents
- L Coin Slots
- M Coin Return
- N Ankle Cylinder
- O Skirt
- P Power Coupler
- Q Octagon Port
- R Battery Box
- S Under Shoulder Detail
- T Rear Logic Display

- U Shoulder Hydraulics
- V Shoulder Horseshoes
- W Shoulder Hub
- X Booster Cover
- Y Shoulder Buttons
- Z Ankle Bracelet
- AA Leg Strut
- BB Ankle Cylinder Wedge
- CC Drive Units (Feet)
- DD Foot Hoses

Time Required:
6 Months-3 Years
Cost:
\$500-\$10,000



PAUL GENTILE is a Maker and self-described professional geek. He and his wife and two sons have a passion

for making, scouting, video games, and technology. Paul co-founded Soldering Sunday (solderingsunday.com) to help young Makers learn electronics, and he's an officer of FUBAR Labs, New Jersey's first Makerspace.

ASTROMECH ANATOMY ACADEMY

A fully operational R2 unit can have hundreds of parts, but these are the key external details (or "greebles") you need to know to craft your own movie-accurate droid buddy. Some of these part names are official, from Lucasfilm/Disney's *Star Wars* universe; others are R2 builders' own pet coinage.

If you've been to a Maker Faire you've probably come across one or more life-size R2-D2s roaming about or partying with the DJ. These robots and other *Star Wars* "astromech" droids are built by people like myself who are part of the R2 Builders Club. Some of us are crazy for robotics, some just want a screen-accurate replica of their favorite *Star Wars* droid. For many of us, it's both — we love that we can build a real robot that's an iconic character.

When people encounter R2-D2 they go through stages of surprise, happiness, and then curiosity. "Did you buy it? Did you build it? Is it a kit? How long did it take? What can it do? Can I build one?"

Yes, you can. R2-D2 is not for sale, and there's no complete kit available. However, anyone can build an R2-D2.

THE R2 BUILDER'S PATH

The R2 Builders Club (astromech.net) maintains an official set of blueprints, CAD files, and 3D files for printing, and our members make and share parts. Don't worry if you don't have a particular skill — you can learn it. That's the Maker spirit. Club members are always willing to share knowledge and techniques. If we can do it, so can you.

In this article I'll walk you through a typical R2-D2 build — a simple and relatively affordable 3-leg, radio control setup, with dome lights and Bluetooth audio. You can add functionality later.

The R2 Builders Club was started in 1999 by Dave Everett as a Yahoo Group for "those interested in building a replica R2." Today we have thousands of members, with a Builders Council to moderate our forums, oversee our official R2 specifications, and approve part suppliers. Anyone is welcome to join, it's free, and it should be the first step on your journey to building your very own droid.

WHY BUILD AN R2?

Let's discuss a few things to help you avoid the Dark Side. Why build a full-size R2-D2?

» **You can't buy one.** R2-D2 and its imagery are the property of Lucasfilm and Disney, and they haven't granted anyone a license to sell full-scale operating replicas. There are sellers on the internet offering a "full size R2" or parts. Stay away. The forums are full of members who found these weren't quality products.

» **You have Lucasfilm's blessing.** The club has a mutual understanding with Lucasfilm and Disney that we don't exploit our droid building. We don't sell droids or droid kits to the general public. Over the years, we've had the opportunity to measure original R2 units from the Lucasfilm archives for our official blueprints.

» **Because it's fun!** Figuring out how things work and solving challenges is an adventure. When you build your droid, it truly is yours and is infused with your personality.

BEFORE YOU BUILD

Building an astromech droid is a big project, but if you break it down into its parts it's easily achievable. First, ask yourself these questions:

» **Which droid will you build?** R2-D2 is popular but there's a universe of astromechs to choose from. Do you want a droid that's screen accurate to a particular movie?

» **What functionality will you include?** Will your droid be static, radio controlled, or have some autonomy? Will its panels open? Perhaps to reveal accessories like a Periscope, Life Form Scanner, or even a lightsaber launcher? Will it be a 2-leg, 3-leg, or, most challenging, a "2-3-2" with a retractable center leg?

» **What materials will you use?** Underlying all these decisions are

Materials

R2 builds vary widely — here's what goes into our beginner's build. For more sources and part numbers, visit makezine.com/go/building-your-first-r2.

CUSTOM PARTS, THROUGH R2 BUILDERS CLUB:

- » **3D-Printed R2 dome** from files at MrBaddeley Printed Droid group.
- » **Styrene R2 body CNC kit** from Frank Pirz of Jackson, New Jersey, r2d2.media-conversions.net. Includes body frame and skirt, utility arm box, shoulders (2), legs (2), foot covers (2), battery boxes (2), center leg, center foot, and center foot shell.
- » **Styrene body skins (2-part)** Buy from Frank Pirz (see above) or cut your own, following the blueprints by Dave Everett at astromech.net/forums/downloads.php.
- » **Plastic external details** aka "greebles" — R2's vents, radar eye, etc. I used 3D-printed parts from other builders. Or 3D print your own from the STL files at astromech.net/droidwiki.
- » **Teeces Lighting System** for R2's dome. Get a kit with preprogrammed Arduino from Nate Lesan, Gardner, Kansas, at astromech.net. Or order PCBs from oshpark.com and solder them yourself (see youtube.com/murphydigital).
- » **Slip-ring and adapter kit (optional)** powers the dome from the body; from Glyn Harper, U.K., makezine.com/go/harper.

OFF-THE-SHELF PARTS:

- » **Lazy Susan bearing, 17-3/8" diameter** Rockler part #12451
- » **Delrin bearings, 5/16" (200)** aka acetal bearings
- » **Styrene sheet, white, 3mm, 2' x 4'** for making minor parts
- » **Weld-On cements for plastic: #3 (1 pint) and #16 (2 pints)**
- » **Polymer braided water supply hoses, 30" (2)**
- » **Floral craft rings, 18" (2)**
- » **Neodymium magnets, 3/8" disc, 1/16" thick (20)**
- » **Epoxy putty** such as Bondo
- » **Miscellaneous hardware**

Electronics

- » **R/C transmitter and receiver**
- » **LiPo battery packs (3)** 5,000mAh, 4S 30C, 14.8V
- » **Battery charger**
- » **Battery cable, 2-wire, 25'**
- » **Servo cable, 3-wire, 25'**
- » **Servo connectors, male/female pairs (24)**
- » **Battery connectors, XT60 type, male/female pairs (10)**
- » **Gearmotor, 30:1 ratio**
- » **Motor controller, 5.5V–30V, 15A** Pololu #1381 or 1376
- » **Wheel, 80mm x 10mm**
- » **Mounting hub for 6mm shaft**
- » **Bluetooth speaker**

Drive System

- » **Razor scooter motors, chain drive, 100W 24V (2)**
- » **Motor controllers, 5.5V–30V, 25A (2)** Pololu #1381 or 1383
- » **Drive chain, #25 (1/4"), 60"**
- » **Chain connection links, spring clip type (8)**
- » **Sprockets: 9-tooth with hub (2), 22-tooth with hub (2), and 22-tooth plate (4)**
- » **Steel shafts:**
- » **1/2" dia., 3 1/4" long (2) and 1/4" dia., 4" long (1)**
- » **Ball bearings, flanged, 1/4" ID, 1/2" OD (4)**
- » **Shaft collars, 1/4" ID (4)**
- » **Rubber wheels, 5" x 1 1/4" with 1/2" Delrin bore (4)**
- » **Swivel caster with rubber wheel**
- » **Delrin rod, 3/8" dia., 6" length**
- » **Compression springs, 1/4" OD, 9/16" long (4)**

Paint and Finishing

- » **Spray primer, white (20 cans)**
- » **Spray paint: white satin enamel (10 cans), metallic cobalt blue (5 cans), purple gloss (5 cans), silver metallic enamel (5 cans)**
- » **Rub & Buff Wax Metallic Finish, silver**
- » **Craft paint, bronze metallic**
- » **Foil tape**

money and time. The biggest driver of both will be the materials you build with.

CONSTRUCTION MATERIALS

» **Aluminum** When *Make*: profiled the club a decade ago (see *Volume 02, "R2-DIY"*), an all-aluminum droid might cost \$20,000 and weigh over 300lbs. Since then, builders have contributed new “diet” aluminum parts that are cheaper, lighter, and stronger. Today an aluminum droid can weigh less than 200lbs and be built for half that cost. Still, it’s the premium option.

» **Styrene plastic** is affordable and lightweight: A styrene droid can weigh well under 100lbs. **Dave Everett’s styrene plans** allow a patient builder to hand-cut flat styrene stock and build a complete droid with very simple tools, for as little as \$500. CNC-cut styrene makes the job quicker.

» **Wood** is strong, light, and affordable — it’s generally used for the frame and legs and then covered with styrene. Many builders have used the **Senna Wood Frame plans** to build their R2.

CHOOSING A DOME

R4 and R5 series astromechs have a **conical head** that’s easily made from flat styrene. R2-D2, however, requires a **true dome** that’s not easy to duplicate. In the past we’d wait for a club supplier to produce a “run” of domes; in the meantime members used BBQ grills, squirrel baffles, and lampshades. Today R2 domes are available in aluminum, cast composites, or vacuum-formed ABS styrene, which we’ll use in this build.

PRE-MANUFACTURED PARTS

Builders have stepped up to provide pre-manufactured components in aluminum, cast resin, 3D printed plastics, and CNC-cut styrene. Frank Pirz recently engineered a new generation of CNC styrene parts that are stronger and lighter by design. Club members can buy these (r2d2.media-conversions.net) or cut their own — just contact Frank through the club forums (username: mediaconvert) to get the AutoCAD drawings.

For this build, we’re using Frank’s CNC parts for the droid body, with a combination of 3D printed and cast-resin “greebles.” Let’s get started!

BUILDING YOUR FIRST R2-D2

Here’s a quick flyover of a lengthy build; for more details, visit the project page at makezine.com/go/building-your-first-r2.

BODY CONSTRUCTION

1. CUT THE DOME PANELS FREE

The outer dome is laser-cut — just trim the excess, and cut the panels free from their retaining tabs (Figures **A** and **B**).

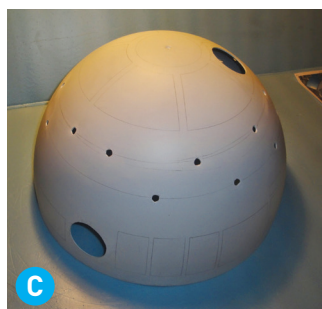
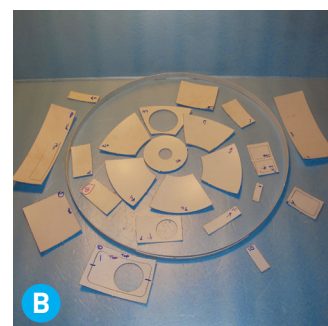
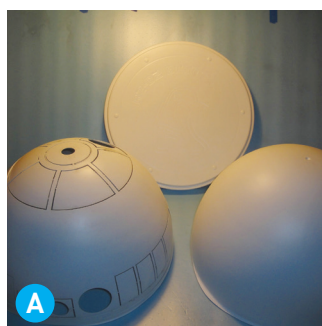
TIP: Before you cut anything, label everything — many parts look similar once they’re all over the workbench.

2. TRIM THE DOME SUPPORT RINGS

The dome base needs internal support, and a pair of floral craft rings work perfectly. Trim to fit on top of the dome ring. You’ll glue them later.

Tools

- » Eye protection
- » Gloves, nitrile or latex
- » Weld-On applicator bottles
- » Utility brushes for glue
- » Utility knife, hobby knife
- » Straightedge, steel
- » Files, rough and smooth
- » Sandpaper, various grits
- » Screwdrivers
- » Allen wrenches
- » Hand drill or drill press
- » Step drill bit, 1/4"–3/4"
- » Tap and drill set
- » High-speed rotary tool
- » Bandsaw, coping saw, hacksaw
- » 3D printer (optional)
- » Routing table or CNC cutter (optional)



3. CUT HOLES FOR DOME COMPONENTS

Align the outer and inner domes, then mark and cut holes for the 3 holoprojectors (the front one is what we see R2 use for the “Help me, Obi-Wan” hologram), the front PSI, rear PSI, front logic displays, rear logic display, and the “magic panel.” (This particular dome panel defies engineering — it looks like it’s made of metal, but it lights up in some scenes and it opens in others.) Test-fit your logic frames.

4. GLUE THE DOMES TOGETHER

Drill glue holes around the inner dome as shown in Figure **C**. Align the inner and outer domes, then flow Weld-On #3 cement between the layers, through the glue holes. Tape in place to dry.

5. PREP THE DOME BEARINGS

R2 builders discovered that Rockler’s Lazy Susan bearing happens to be a perfect fit between R2’s dome and body, enabling his head to spin 360°. Unfortunately it’s loaded with grease, hard to turn, and noisy. Clean it and replace the steel ball bearings with acetal (Delrin) ones, and it works beautifully.

Drill matching holes in the Rockler, the body frame, and the dome ring. Now generously epoxy the dome ring and floral rings into the dome.

6. CUT OUT INNER DOME PANELS

Eventually you'll want to make the dome panels operable. Cut the inner dome now to allow for that (Figure D). For the "pie panels" on top, the inner lip should measure 20mm on 3 sides and 10mm at the bottom, where the hinge will go. After cutting, gently sand the edges.

7. TEST-MOUNT THE RADAR EYE

R2's "radar eye" is the focal feature of his "face." If you compare movie to movie, that radar eye moves around quite a bit! Almost all builders will end up placing it by eye — pun intended. If it looks good to you, that's where it goes.

If desired, make a hole now in the dome underneath the radar lens, so later you can place sensors or a camera.

8. BUILD THE BODY FRAME AND SKIRT

Following Frank Pirz's instructions, the styrene "egg-crate" frame and skirt go together fast — slot A into slot B. Mark the parts before assembly (Figure E) — your little Makers can help. Flow Weld-On #3 between joints to tack them in place, then follow up with Weld-On #16 for strength (Figure F). The frame might seem flimsy but the skins will lock it together.

Attach the skirt to the bottom of the frame. The skirt will be visible later, so fill any gaps with model putty or Bondo, and sand smooth (Figure G).

9. TEST-FIT THE DOME

Test-mount the Rockler bearing's outer ring to the frame. On its inner ring, add upward guide bolts to match the holes in your dome ring. Use nuts to adjust the gap between frame and dome, so it spins evenly. R2 is coming to life!

10. ATTACH THE SKINS

The styrene skins are also a 2-layer process. Wrap R2's frame with the first layer, check the fit, and adjust. Tack the skin in place with Weld-On #3 and follow with Weld-On #16. Secure with straps, painter's tape, or strong magnets, and let everything fully cure. If you want the body doors to open, cut them out now.

Repeat with the second layer.

TIP: Don't cut doors out before gluing the skin — it'll make the skin flimsy and difficult to position. Some builders prefer glues to solvents here — the skins are thin, and too much solvent can cause ripples that need to be fixed later.

11. TEST-FIT ALL BODY COMPONENTS

Trial-fit your "greebles" and adjust if needed. For example, R2's two utility arms tend to rub the skin as they open; to fix this, just sand the backside of the arms at an angle.

Don't glue any components in place yet.

12. BUILD SHOULDERS, LEGS, AND FEET

Like the body, the legs go together fast. Tack in place, then bond, then fill any gaps with a plastic filler (Figure H). The shoulders are round at the top (we call those the horseshoes) and have mounting bolts for



Paul Gentile

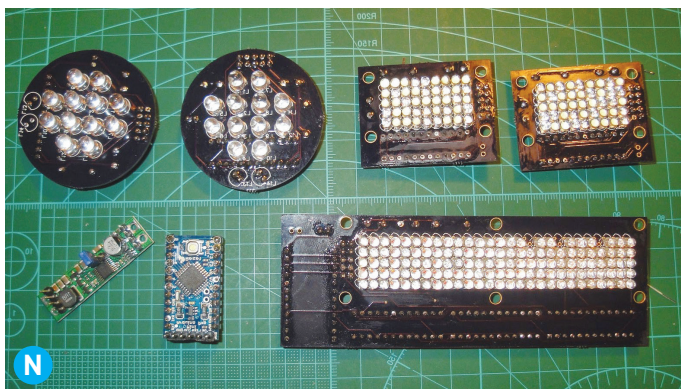
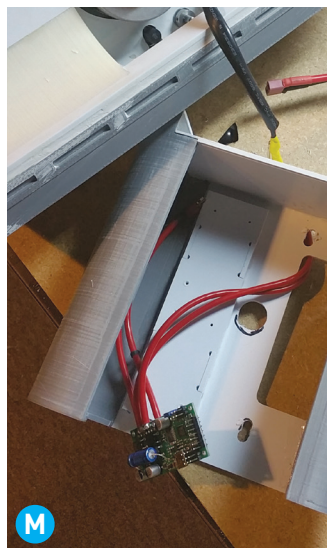
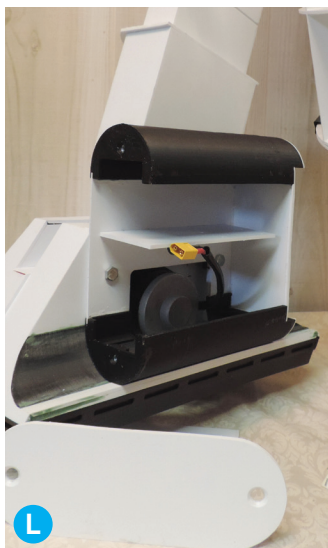
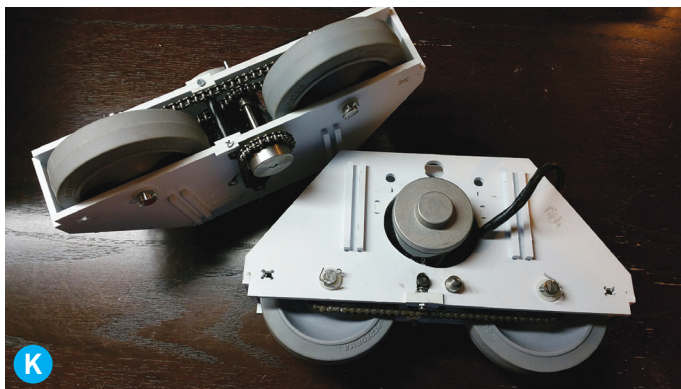
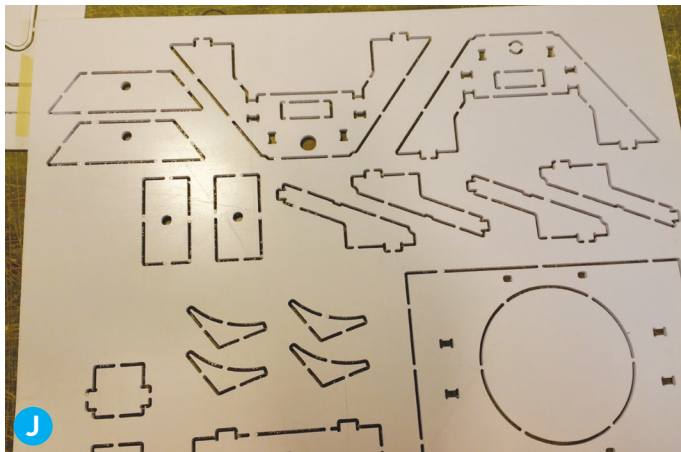
the body on one end, and for the legs on the other. Frank's styrene legs incorporate the ankles and are extremely strong.

We're building a 3-legged R2, where his center foot is extended for easy cruising. The left and right legs are set at an angle of 36° by the shoulder mounting plates in the frame (Figure I).

13. BUILD THE DRIVE SYSTEM

R2 will be driven by two Razor 100W 24V scooter motors, one in each foot. The drive system is probably the most challenging part of the build, but with a little patience you can do it in a simple workshop. I used the tools at my local Makerspace, FUBAR Labs in New Jersey.

The design calls for 2 wheels in each foot, driven by a chain. You'll need to fabricate short axles, attach the sprockets



to the wheels, cut the chain to length, and then assemble it all (Figures **J** and **K**). It's a good rainy weekend project. For every part of the drive system, I made at least one spare, just in case.

For more detail on the drive systems see makezine.com/go/r2drive.

14. FOOT COVERS AND BATTERY BOXES

Frank's design uses styrene for the flat sections and 3D-printed parts for the curved pieces (Figure **L**). Often we think of 3D printing as a singular design choice, but in this case it's combined with other materials in a very practical design. Removable panels, held in place with magnets, allow access to batteries and the mechanicals in the foot.

15. BUILD THE CENTER FOOT

The center ankle attaches to the skirt, and the center foot has a swivel caster that lets R2 move any direction and turn in a very tight radius.

ELECTRONICS

For our R2 we're keeping it simple: radio control for movement, Bluetooth audio, a Teeces lighting system, and Pololu motor to turn the dome.

1. CONNECT THE DRIVE MOTORS

Connect your scooter motors to two Pololu 25A motor controllers, one in each battery box. You're using two 5,000mAh 14.8V LiPo batteries, again one in each battery box. This should give you several hours of run time. With this setup, 12 volts is plenty of power (Figure **M**).

2. MOUNT THE DOME MOTOR

For the dome motivator, we're using a 30:1 metal gearmotor from Pololu, with their 15A motor controller and 80mm wheel with high-traction sticky tire. This wheel will ride on the inside of the Rockler bearing to spin the dome, using a spring mount to maintain tension.

3. CONNECT THE R/C SYSTEM

All 3 motor controllers can be connected to a typical R/C receiver. Drive and steering are on my right stick, dome control on my left.

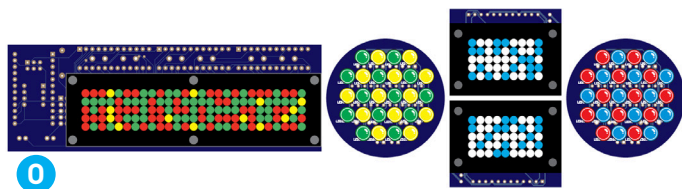
Since R2 can weigh in at 100+ pounds and a loose droid is never a good thing around people, I suggest using a 2.4GHz system with a failsafe that returns all controllers to neutral if signal is lost.

» **Next Level:** An alternative to R/C is the ServoShock system [servoshock.com] which pairs a Sony PS3 game controller via Bluetooth (or USB) to a receiver module that can connect to 10 servos, has 17 digital outputs, and automatically returns to neutral if signal is lost. And it's got an optional Arduino shield you can leverage for additional functionality.

4. BUILD THE DOME ELECTRONICS

R2's dome electronics as seen in the movies include 2 big round PSI lights, front and rear logic displays, and 3 holoprojectors. The easiest way to illuminate these is with the Teeces V3 Dome Lighting System [joymonkey.com/run], available through the club. It's an older system, but an easy DIY kit that includes an Arduino Pro Mini to run the lights (Figures **N** and **O**). (Soldering the Teeces kit together is what led me to FUBAR Labs and the whole Maker Movement — so I am a little

Paul Gentile



partial to this kit!)

Once the kit is built, mount the logic lights to your logic frames. The PSI mounts are a homebrew solution from the club using 1½” PVC pipe fittings from the local home superstore.

Inside R2’s body, you need to power the dome motivator and your R/C receiver. Add another 5,000mAH 14.8V LiPo battery, connect it to the motor controller (ESC) and use the ESC’s 5V out to power your receiver (Figure P).

TIP: Use R2’s doors to access the electronics so you don’t have to remove his dome all the time!

For the lights, you could put a smaller battery inside the dome, but I prefer to route power from inside R2’s body, using a 24-wire slip ring with an adapter from fellow R2 builder Michael Erwin. This adapter has a DB25 connector on each end so you can remove the dome easily. And it can handle 2 amps per channel; again, you don’t need it now, but it will be there when you’re ready for it.

» **Next Level:** Add servos to open panels and move the holoprojectors (you can see my holo servos in Figure O), or accessories like the life form scanner or periscope that rise out of R2’s dome. You’ve prepped your dome for these, but you can tackle them later. (There are 6 more movies due out — you have some time!)

5. ADD SIMPLE BLUETOOTH SOUND

R2’s chirps and beeps strike a chord in people — they’ll ask you if R2 can make specific sounds they remember. Of course the club has a whole library of R2 sounds. Just pair a Bluetooth speaker with your smartphone, and download a soundboard app that you like. Add your R2 sounds, and place your speaker inside R2. My little speaker cost \$35 and is very loud, even in a crowd.

» **Next Level:** Now I use a Bluetooth receiver and local audio amp with twin 100W speakers!

FINISHING AND ASSEMBLY

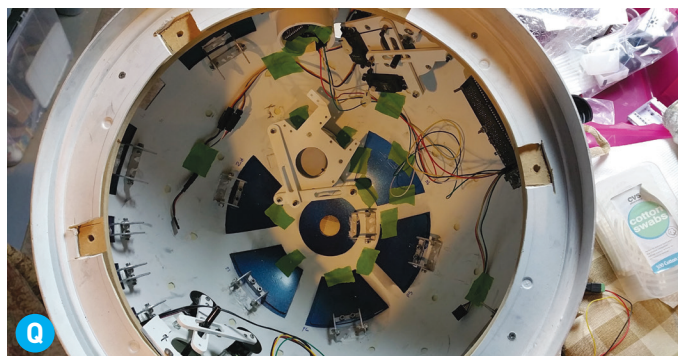
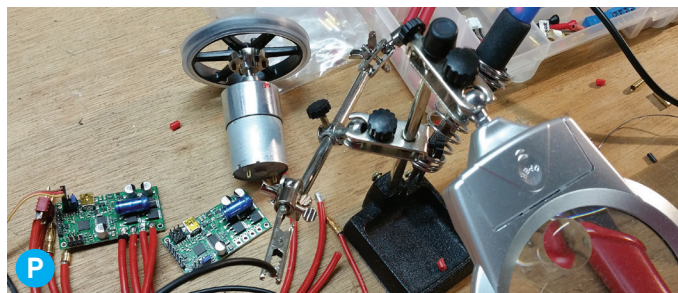
1. TEST-ASSEMBLE

Assemble the major components of your droid. Test all your electronics and the settings of your motor controllers. When it’s all to your liking, take it all apart again. It’s time to paint.

2. PAINT EVERYTHING

Which parts should be which color? Check the reference photos in the Club’s wiki and you’ll see that R2-D2 has changed his looks over the years. Paint R2 to the scheme you’re happy with. I’ve never had a kid run up to R2, throw his arms around him, and say, “R2, your holoprojector is the wrong color.”

For the “aluminum”-colored parts I used Eastwood “Almost Chrome” spray paint. I went with a satin white, and for R2’s signature “blurple” color, aka “Hypo Blue,” I alternated between metallic blue



and, while that was still wet, a quick dusting coat of gloss purple (Figure R). (For more painting tips, check the project page online.) For R2’s shoulder joints, I used aluminum foil tape for a sharp, bright look. Foot hoses are made from braided faucet hose, with a bronze metallic paint.

The last detailing choice is weathering. I love the weathered R2s, but I want the pristine, ready-for-the-big-ceremony R2. (I might need to build a second droid!)

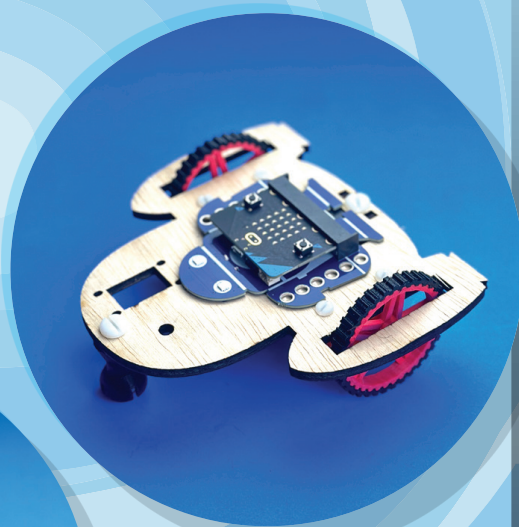
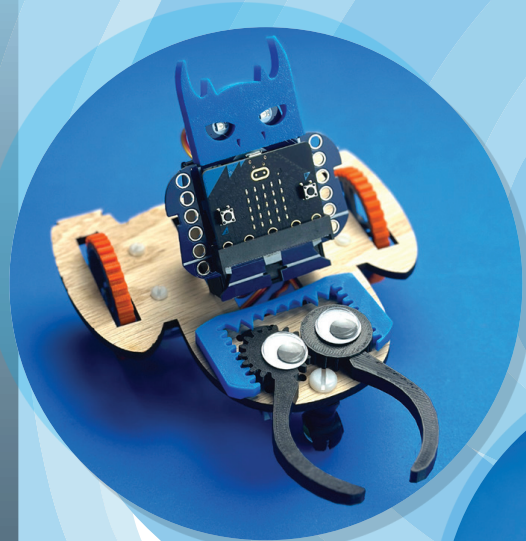
How do builders get a painted dome to look even more like milled aluminum? Rub and Buff, a wax paste with metal in it. Find it at a craft shop. It takes a lot of elbow grease, but it’s worth it.

3. ASSEMBLE YOUR DROID

Welcome to the fleet! You’ve joined an elite few who have a showable, fully operational droid. We have thousands of members, but there are less than 500 operational droids, and less than 200 screen-showable droids worldwide.

That wasn’t bad at all, was it?! What do most builders do when they complete their droid? Start a second one. In the meantime there’s plenty of opportunity to show off your R2 at Maker Faire, attend charity events with the 501st Legion, take him to libraries, and brighten up people’s day. You’ll inspire other Makers, and maybe make some brand-new Makers too. 🎯

Get lots more photos, build tips, part numbers and sources, and share your R2 build at makezine.com/go/building-your-first-r2.



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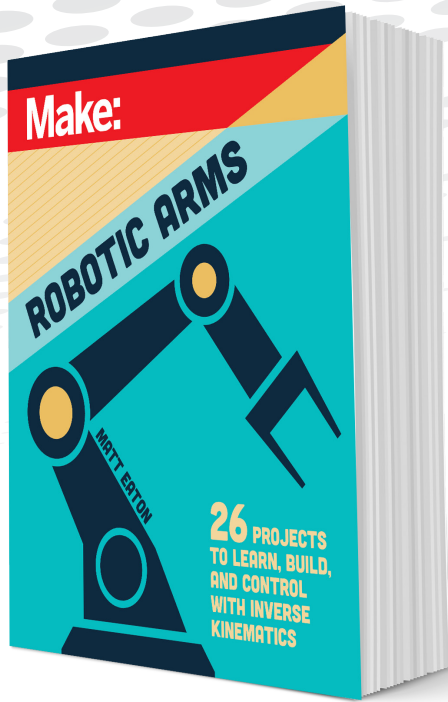
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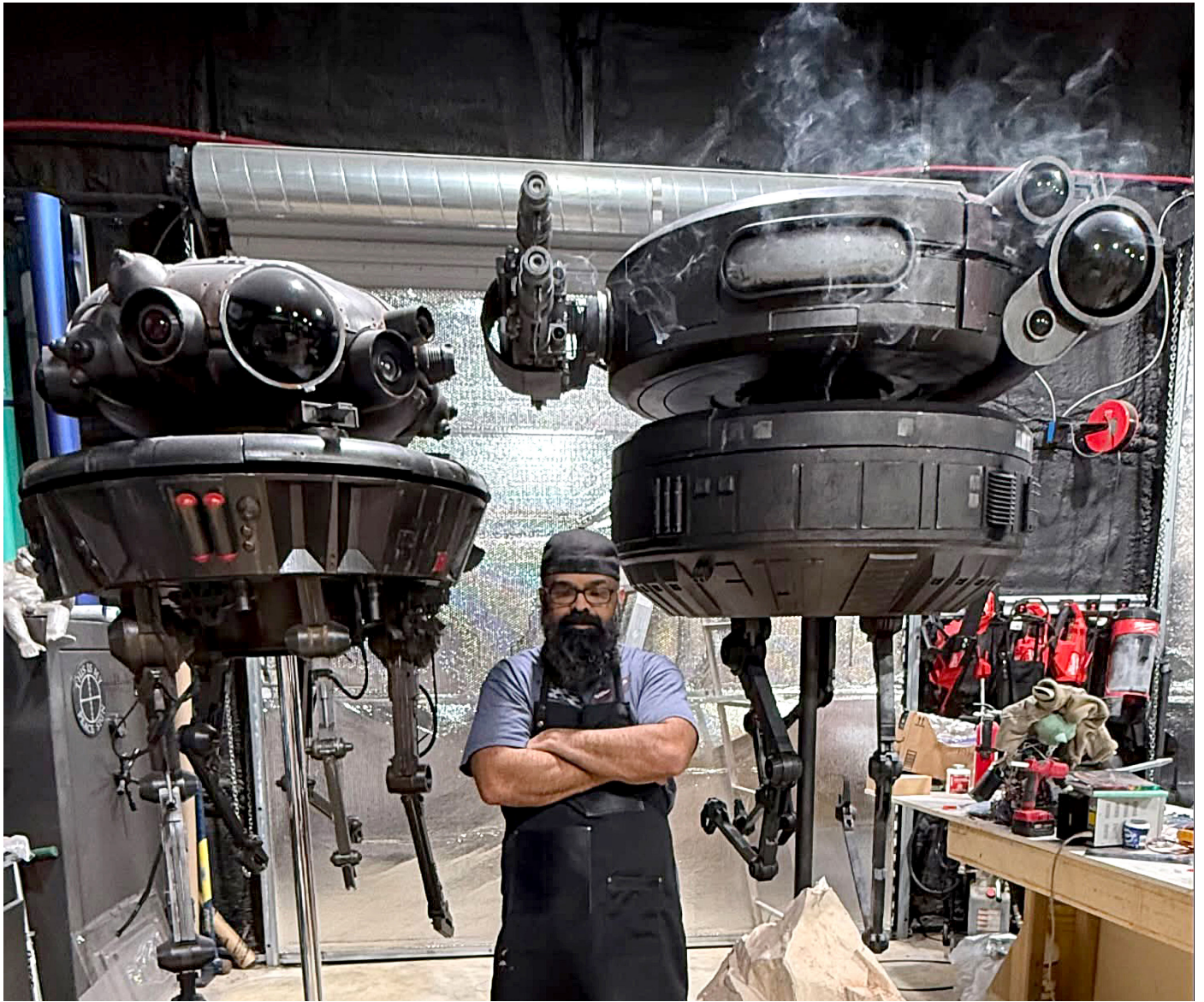
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ON THE GO





From Dreams to Droids

MY JOURNEY TO THE WORLD'S FIRST VIPER PROBE DROID

Written by Jose Velazquez



JOSE VELAZQUEZ is a creative engineer in Hazel Green, Alabama, who transitioned from auto body painting to building droids, collaborating with Disney, and founding PMW Robots (pmwrobots.com). He hopes his passion for innovation inspires others to pursue their dreams in engineering and design.

Meagan and Jose Velazquez

Auto painter, soldier, droidsmith? All of the above. My path from painting cars to Patriot missiles to building world-class droids has been driven by hard work, curiosity, and the unwavering belief that anything is possible if I set my mind to it.

DISCOVERING A PASSION FOR CREATION

I was born in the Bronx, New York City in 1986, and grew up in Orlando, Florida. As a high school sophomore, I discovered a love for painting cars through an auto body program guided by my teacher Gary Williams, a mentor and father figure who inspired me to dream big. After graduation I landed my first job as head painter in a local body shop. It was there I discovered I had red/green color vision deficiency, and I had to quickly adapt to seeing colors differently than others.

Even though I enjoyed my job, I felt something was missing. Encouraged by my high school sweetheart, Meagan, I took another step toward my goals by joining the US Army. I became a Patriot Fire Control Enhanced Operator/Maintainer, operating the Patriot missile system (Figure A). During a six month deployment to the UAE in 2014, a new love emerged as I was introduced to the *Star Wars* series for the first time. Watching the movies in both chronological and episode order, I became fascinated by the vast world created in these films.

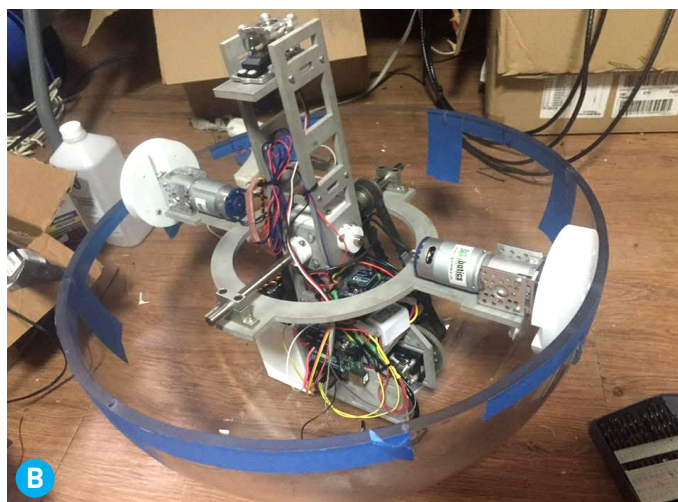
After returning to the States, I rewatched the *Star Wars* series with my now-wife, Meagan, and we discovered the online communities of droid builders. I then attended Warrant Officer Candidate School and was sworn in as a chief warrant officer in 2014. While serving my last tour in South Korea, I decided to challenge myself by building my first animatronic rolling **BB-8 droid**. Without access to all the machine tools needed, I collaborated with an Air Force machine shop, where I provided 3D-printed parts for airmen to practice on, and in exchange I would receive a CNC milled part. After two years of research and experimentation, I completed my first fully rolling animatronic remote-controlled droid (Figures B and C).

Unfortunately, after just 10 years of service, a shoulder surgery left me unable to meet Army physical fitness requirements, leading to my medical retirement in 2018. The career change was initially devastating but turned into a blessing. I was hired as a contractor by my Army mentor to work as a systems engineering analyst for communication on the Patriot missile system. Settling into a more stable life allowed me to focus on full recovery — and my hobby of droid building.

One month into retirement, Disney Imagineers discovered my movie-accurate **pit droid** on the Replica Props Forum (therpf.com/forums) and invited me to collaborate on *Star Wars: Galaxy's Edge*. I designed and cast all the pit droids for both Disney World and Disneyland (Figure D). This project turned my hobby into a real passion and led me to establish my droid building business, Prototyping and Manufacturing Works (PMW) Inc. (pmwrobots.com).

FULL-SCALE IMPERIAL PROBE DROID

Now I was eager to challenge myself and push my skills higher by tackling something bigger: a large-scale droid. My journey led me to Dave Moog, a talented 3D designer from the U.K., and his company, Droid Division, which offers static 3D models for printing. Although intrigued by the possibilities, I wasn't interested in creating a static model. I wanted something dynamic and mobile.



Chris Moody, James Graeber

Meagan and Jose Velazquez



After some research I connected with another builder, Michael McMaster, who had crafted the **Imperial probe droid** seen in the original trilogy and Season 3 of *The Mandalorian*. I decided this would be my next big project, with the ambitious goal of completing it by MegaCon Orlando 2024, about eight months away. I set about designing a new base for the droid that was not only structurally stable but also mobile, easy to assemble and disassemble, and safe to navigate through crowded conventions.

My research led me to modify adult mobility scooters, given their ability to support over 600 pounds. This seemed like a solid foundation for the all-steel structure I envisioned, though I was unsure of the final weight. I also decided to deviate from McMaster's cantilever design and instead opted for a "straight pole" design for easier transportation, weight management, and assembly and disassembly (Figures **E** and **F**).

I successfully completed the original probe droid for MegaCon 2024, achieving all my functionality goals. The droid featured DC actuators for the legs, refrigerant air thrusters, a spinning head, lights, articulating antennas, and full mobility — making it only the second fully articulating/mobile probe droid in the world.

THE VIPER PROBE DROID: A MONUMENTAL CHALLENGE

Fueled by my newfound confidence, I embraced the challenge of creating the **Viper probe droid**, which is featured in *Solo: A Star Wars Story* as a strictly CGI creation. I was eager to bring this droid to life in the real world and push my skills to the limit. In October 2024, I committed to building the life-sized droid for MegaCon

Orlando in February 2025 — just three months away.

I quickly recognized that this project would require a collaborative effort. I started by designing the head and body using CAD, while reaching out to friends for assistance. I enlisted Michael Baddeley from the UK to help design the guns and legs. Stephane Beaulieu contributed by coding the Arduino control boards for the body lights, sounds, and the foggers and LEDs in the guns; the droid was also equipped with air thrusters, RGBW lights, head rotation, car audio speakers and amplifier, and mobility on its base. To create the front lens, I brought in Tim O'Sullivan, who crafted a mold (puck) and vacuum-formed it using 0.04" PETG plastic.

OVERCOMING CHALLENGES WITH CREATIVITY

Constructing the Viper probe droid presented significant challenges, particularly concerning time management and structural safety. Juggling my job, family commitments, and the tight deadline demanded many late nights, with my wife and kids frequently bringing food to the shop and offering their unwavering encouragement.

I immediately dove into CAD, utilizing every reference image I could find to design the droid with as much detail as possible while ensuring it remained functional. I collaborated with Baddeley via Autodesk Fusion 360; I focused on designing and scaling the body and head, while he took charge of the guns and legs, scaling them according to my designs. Once he gave me the thumbs-up on a completed section, we would discuss any observations or changes needed, and I would print test parts. This often revealed issues with tolerances or fit, prompting more meetings and messages.

Meagan and Jose Velazquez

Just one week after taking on this challenge, I began printing the outer shell of the Viper head and body (Figure G). My focus for the design was on weight, assembly, and safety. After printing the body and head, I reinforced the interiors with automotive fiberglass matting and resin. This approach allowed me to prioritize aesthetics in my 3D printing while relying on the fiberglass for structural integrity and weight reduction.

Despite my efforts, the head was still heavy, so the first version of the spin mechanism was inadequate. Back to the drawing board. With time running short, I searched for existing solutions that could rotate and support 100–200 pounds. I discovered a turntable designed for 3D scanning people and large objects. It had a weight limit of 500 pounds, was the perfect size, and operated on a manageable power requirement of only 12 volts. This experience underscored the importance of adaptability and creative problem-solving versus starting over from scratch (Figure H). As Theodore Roosevelt said: "Do what you can, with what you have, where you are."

I still had to design a mount for the turntable, adjust its height, and create a mounting solution for the head. Fortunately, I could accurately 3D-scan the turntable and adjust the Fusion files. After finalizing the designs, I used my CNC plasma cutter to cut and weld the mounts for both the body and head onto the turntable. It worked — but it left me only a month to print all the legs and finish the electronics and assembly.

The first and only test assembly was completed January 25, less than a week before we headed to Orlando for the Viper's debut! After many long nights overcoming frustrating obstacles, I finally saw the end of this project. Overall, it involved over 2,093 hours of printing time, 62kg of PETG filament, numerous printer repairs, and a lot of troubleshooting. Beyond 3D printing, the project required six gallons of resin reinforcement, laser-cut wood, CNC metal work, welding, and CAD.



INSPIRING FUTURE BUILDERS

When asked why I build such amazing things, my answer is simple: for the smiles and inspiration it brings to fans and makers alike. Whether it's seeing someone relive their childhood dream or encouraging a young mind to start building, these moments are priceless.

My journey shows that with passion, hard work, and a little creativity, amazing things are possible. It's never too late to find what you love and make it part of your life. Whether you're a young dreamer or a seasoned creator, there's no limit to what you can achieve if you keep challenging yourself and learning along the way.



Imperial Probe Droid Builders Group:
facebook.com/groups/503363040384828



Meagan and Jose Velazquez

Dreaming of Droids



FROM HONDURAS TO LA, A LIFE OF MADCAP ROBOTICS

Written by Walter Martinez Marconi

WALTER MARTINEZ MARCONI is an engineer/artist/educator/actor/IT manager in Lakewood, California. See his work at socialrobots.com.

Back in 1977, growing up in Honduras, I was 5 years old when my mother took me to see *Star Wars*. I

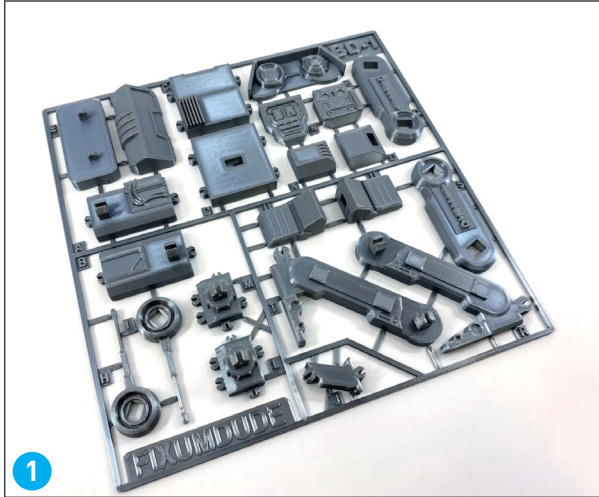
clearly remember telling her that I would build those robots when I grew up. When I was in high school, my father was working in the U.S. and I asked him to send me a RadioShack Tandy TRS-80 computer I saw in a magazine. I did not know English, yet all my notes were English because that is how I learned BASIC computer programming and electronics. My lab was on the roof of my house like a Frankenstein lab — I had chemistry sets, electronics, and dead bugs and lizards that I hoped to bring back to life! I almost burned our house and got electrocuted a few times!

I came to Los Angeles right after high school and studied computer engineering and electronics. I'm currently an IT manager for CSU Long Beach, where I lectured for 23 years, teaching robotics, managing senior projects, and participating in *BattleBots*. I would go on to build robots for TV and film, including a movie starring John Boyega where I had to use a cutting tool close to his neck. I was nervous; I did not want to be known as the guy who killed Finn!

My passion for *Star Wars* reignited in 2019 when I met builders showing off semi-completed droids and saw I could do it myself. It took me two years to complete my R2-D2. My latest adventure is background acting, including a new movie with a little green creature coming up in May. 🎬



- 1 Trooper doll from *Rogue One*. It's like an emotional support stormtrooper — haha!
- 2 WEN drill press, although I am searching for a better one
- 3 Buckets of infrared and sonar sensors, motors, servos, etc.
- 4 R2-D2 dome mechanism in progress
- 5 Hakko FX-888 soldering iron; generic hot air rework station
- 6 MSE-LB, a custom color 1/1 scale R/C Mouse Droid
- 7 R4-LB, a fully animatronic 1/1 scale Astromech droid that took two years to build!
- 8 Custom lightsaber for my A'Sharad Hett *Star Wars* costume
- 9 Servo tester
- 10 ES-SE droid legs and other parts on the floor — standard in my garage!
- 11 Bust form for sewing costumes
- 12 Filament dryer
- 13 FLSun delta 3D printer, and a small pretzel given to me by a kid while I was dressed as a Jawa; she did not get scared!
- 14 3D-printed heads for my Astromechs: R2, R9, R4, R5, and ZK
- 15 ROS1-based robot platform
- 16 Elide Fire Ball extinguisher in case 3D printer goes crazy and catches on fire
- 17 24" USCutter wireless vinyl cutter
- 18 Prototype head for Astromechs
- 19 Red toolbox from when students and I made battle robots.



Kit Cards

Written by Caleb Kraft

Modern model method: 3D print the parts on an old-school “sprue” then snap them off and build

TIME REQUIRED:

1–2 Hours Print, 1–2 Hours Build

DIFFICULTY:

Easy

COST:

\$5–\$10

MATERIALS

- » 3D printing filament
- » Model glue
- » Model paints (optional)

TOOLS

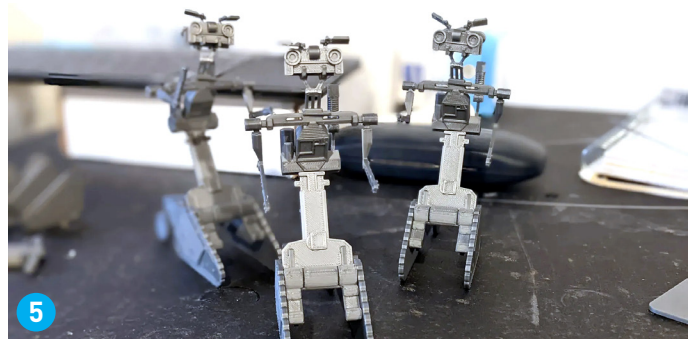
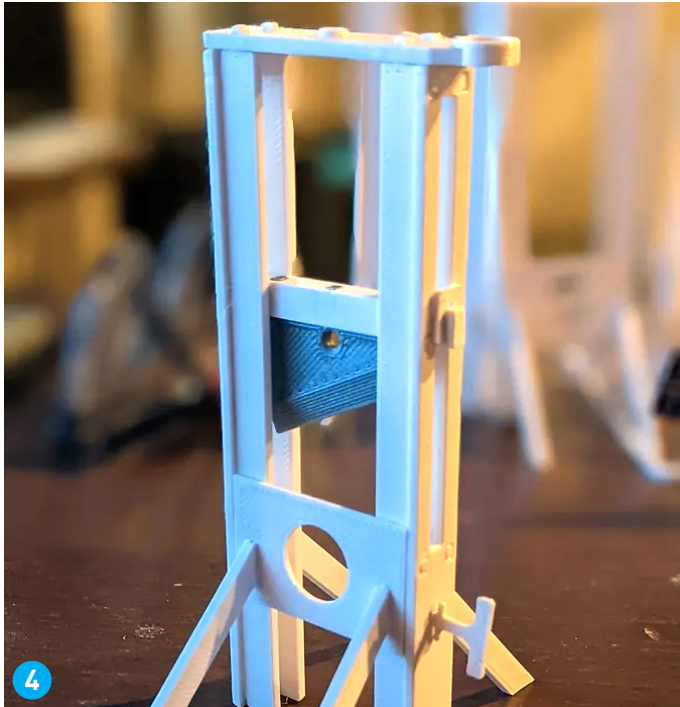
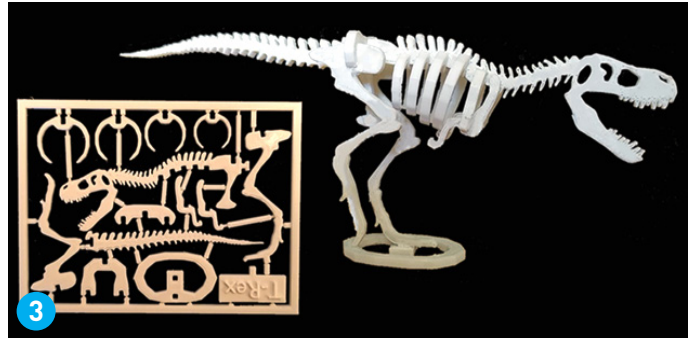
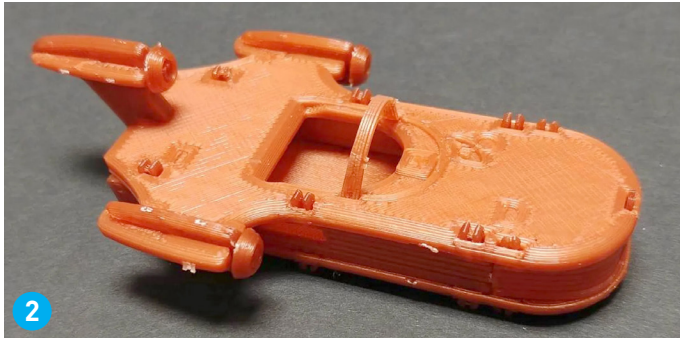
- » 3D printer
- » Hobby knife

Model building carries positive memories for many makers.

Snapping those parts off that weird frame, cleaning them up, carefully assembling and then finally admiring the finished model. The experience could be so cathartic. An interesting trend in 3D printing has captured some of that nostalgia and repackaged it as a new method of making things.

Kit cards are 3D-printed models that come on a sprue — the plastic frame that used to be the result of injection molding — so that you can cut the pieces free and assemble your model. These little cards are a clever way of giving someone a 3D printed experience in a tidy, portable package, so that they too can enjoy the catharsis of building their model.

Here are six kit cards for you to try out.



Loyal Moses, Michael Grugel, Marco Melzi d'Eril, Thomas Quick, Yuval Dascalu

1 STAR WARS BD-1 DROID

by Michael Grugel

printables.com/model/188568

Little buddy bot BD-1 may not be the best-known droid in the *Star Wars* universe but this kit card is very impressive in the quality of the finished model.

2 STAR WARS LANDSPEEDER

by Michael Grugel

printables.com/model/80917

Another stunning piece of work by Grugel, aka Fixumdude, this speeder shows how you can cleverly clip pieces together to get nice shapes with real depth. It doesn't even require glue! He's got lots more kit cards at printables.com/social/98664.

3 T-REX

by Marco Melzi d'Eril

www.thingiverse.com/thing:4902649

Going back to the basics, this *Tyrannosaurus rex* model is very reminiscent of a model many of us had as kids. Mine was glow-in-the-dark and if I use the right filament, this one can be too!

4 DIY MINI GUILLOTINE

by Thomas Quick

printables.com/model/127813

Frankly, I'm not sure what office doesn't need a guillotine.

5 JOHNNY 5 (NOVA ROBOTICS S.A.I.N.T)

by Thomas Quick

printables.com/model/135284

Johnny 5 from the *Short Circuit* movies looks fantastic in this kit. The fact that the neck and eyebrows were designed to be poseable is fantastic and adds so much life to the model.

6 FIDGET KIT BUSINESS CARD

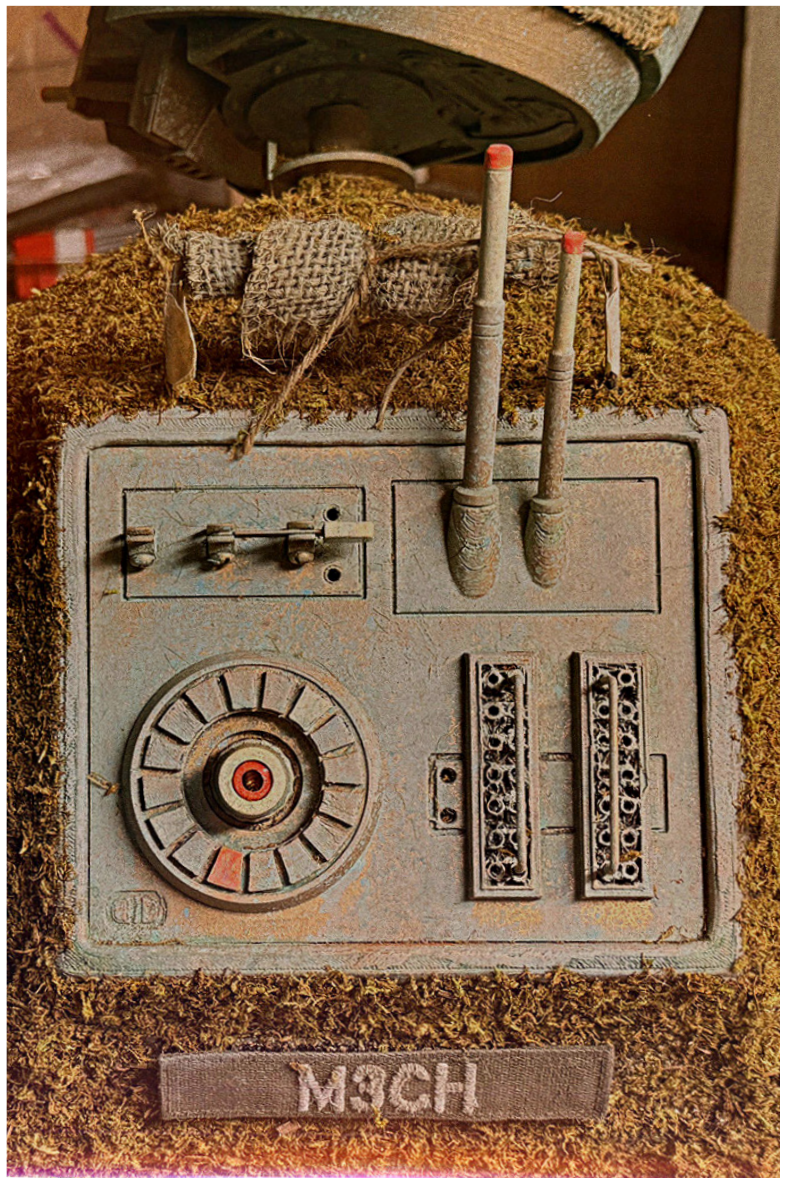
by Yuval Dascalu

www.thingiverse.com/thing:1956539

This clever little business card fits together to have functional gears. Customize it in CAD with your own text! 🛠️



CALEB KRAFT is a former senior editor of *Make:* and has been 3D printing since 2013.



Tomasz Opasiński

OTHERWORLDLY DROIDS [instagram.com/opasinski](https://www.instagram.com/opasinski)

Most grownups seem to lose their playfulness as they age. Thankfully, **Tomasz Opasiński's** imagination hasn't stopped expanding. Opasiński builds *Star Wars*-inspired droids with touches of originality that are built, and reveal themselves, in layers.

His first was M3CH, a towering 7-foot-tall K-2SO-type droid as seen in *Rogue One* ("mech" means "moss" in his native Polish). Inspired by a friend's replica terra-cotta warrior, he wanted something that would dominate the space in his studio. "I don't have this instinct of doing micro models like that and painting them. I don't have patience for it," Opasiński said. But other fans have built standard-colored K2 droids before, and as an artist, his had to be original.

He took inspiration from the woods around his Los Angeles home and invented a friendly backstory. What if the robot was abandoned in the forest, shed its evil ways, and became a benevolent guardian to creatures around it? The final sculpture is covered in moss and scraps of fabric where parts would've been replaced. But adding

moss turned out to be a bigger challenge than expected: "This stuff chips off so easily that it's not even funny. I will never do any robots covered in moss anymore."

M3CH was built with 3D-printed parts, but Opasiński doesn't own a 3D printer. Each fused-filament and resin piece was ordered online. To supplement custom shapes, he also sourced components from Apex, the surplus store in LA where production crews go to get great greeblies. Hence, there's a mix of printed and found elements making up the robot and surrounding environment. There's also no shortage of Easter eggs, including a hidden Homer Simpson piloting M3CH in his head.

The build took 9 months to finish and got a great reaction online. Opasiński ended up meeting some ex-ILM modelers and got to see their work close up, inspiring him to create more robots with their own stories. He'll keep building droids not only to command attention, but to reclaim that spirit of childhood wonder. —Sam Freeman





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