

WELCOME

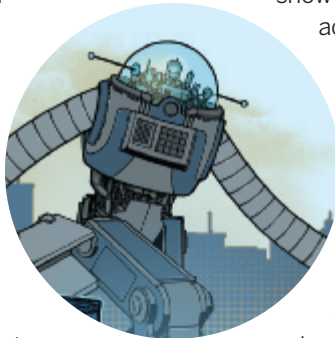
Join the Robot Uprising!

By Gareth Branwyn

This is MAKE's third issue featuring robots, after Volume 06 in 2006 and Volume 27 in 2011. So, what's changed in robots in that span of time from a maker's perspective?

Those issues focused on the playful side of DIY robotics: robots as toys or pets, robots that entertain. But bot builders are also getting serious. Like many makers, they're evolving from hobbyist to professional. As hardware becomes ever more sophisticated and less expensive, as maker communities grow (both online and off) and offer better advice and collaboration, and as crowdfunding boosts good ideas from prototype to product, all forms of maker innovation are benefiting.

In the robotic realm, there's no better example than our cover story. In this first-person account by David Lang we meet Eric Stackpole, who, joined by David and hundreds of collaborators, created an open source underwater exploration vehicle, the OpenROV. Typically ROVs are incredibly expensive, but this humble project is a game changer. The creators had no prior experience building underwater robots, but were able to leverage online expertise, local makerspace tools, and off-the-shelf parts. After an impressive Kickstarter campaign, they now even offer a kit. Their inspiring story caught the attention



of Google and NASA. The venerable National Geographic Society has even approached them to talk about using similar rovers in their Explorers Program.

Humanoid robots are normally prohibitively expensive, too. Even the DARwIn-OP, an open source robot created as an affordable mini humanoid, costs upwards of \$12,000. By 3D-printing his own parts and sourcing cheaper components, robot builder Michael Overstreet built a DARwIn-OP clone for half that price. His 1.5-foot-tall robot is a state-of-the-art humanoid that's as capable as commercial robots costing three times more.

There's never been a better time to delve into robotics, whether you're a tinkerer or a more serious explorer. With the powerful tools and expertise now available, the next great leap in robot evolution is just as likely to come from your garage as a research lab. Beginners will love our Arduino-based CoffeeBot. We even

show you how to make a mini linear actuator out of a lip balm tube. So what are you waiting for? The robots aren't going to build themselves. Yet.

The ingenuity in this issue doesn't stop with robots. You'll find a clever door-top "safe" for stashing valuables, a surprisingly good-sounding cigar box speaker built with the lowly LM386 audio amp chip, and a hand-cranked Geiger counter. *Très* steam-punk! And do you think the output of your hobby-grade 3D printer is the best you can do? Think again. Matt Griffin, who helped us mastermind our popular *MAKE Ultimate Guide to 3D Printing*, shows you finishing techniques to take your 3D prints to a whole new level.

You'd be forgiven for wondering: Who the heck comes up with this stuff? Makers — clever, creative people exploring the limits of their imaginations and skill sets, and just having fun making and sharing things. I don't know about you, but in some small, weird way, that lip-balm actuator gives me hope for the future. ■

Gareth Branwyn is MAKE's editorial director.

Nate Van Dyke



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TORMACH MAKER PROFILE - ROAMBOARD

Engineer and maker Rob Green uses the Tormach PCNC 770 to manufacture steering knuckles and steering mounts for the innovative RoamBoard, a four wheeled articulated skateboard that brings surfing and snowboarding to the streets.

"As an engineer, I love to create stuff. About ten years ago, two of my three boys were old enough to be into unicycles and skateboards and doing tricks on bicycles. So I asked them, 'Hey what do you guys think about building an electric skateboard?'"



With the help of his oldest son, Green began prototyping and then manufacturing the board about three years ago. When it came time to move some of the manufacturing in-house Green chose the Tormach PCNC 770, and now has plans to move all RoamBoard manufacturing in-house.



Read the full story at: www.tormach.com/roamboard



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3D shootout, upcycling visions, pure Pyrex, and unholy smoking.



» Excellent job on your MAKE Ultimate Guide to 3D Printing (makezine.com/3dprinting). I'm thinking about buying or building a 3D printer with my grandson, so I read the issue looking for insight into what makes a good one.

One article advises to put the printer on a solid table; another talks about moving the extruder off the hot end to reduce mass. Both indicate that a lack of stiffness is a big problem in the design of a 3D printer. Combine this with drives that have substantial backlash and bearing systems that are relatively loose, and it's easy to see why only one printer reproduced the hole in the bird's beak.

This reminded me of a packaging machine I worked on years ago. It had a reciprocating carriage, and when we mounted a barcode printer on the machine, the printing smeared badly due to vibration. I set up a dial indicator with its probe touching the printer housing, and we found that one part of the mount deflected far more than the rest. We reinforced that part and the printer worked perfectly.

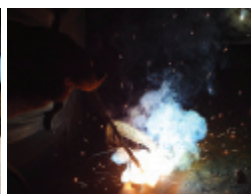
I suspect a little time with a dial indicator would be a real eye-opener for these 3D printer builders. MAKE could do technical reviews too, on the pros and cons of construction methods and how they affect the outcome.

—Gary H. Lucas, *Hightstown, N.J.*

» Your 3D printer “shootout” really helped set the standard and challenged us to do better for our users. We loved that you got together such a great team of testers, and that they were able to generate so much useful input in such a short time. We're working hard to do better at the “Christmas morning test.” The “torture test” prints have also challenged the community: expect to see many more printers achieving top results on that one!

Community standards are fundamental — there is so much interest, and so many wonderful new printers, that developing a common language and set of metrics will really be important for users now and in the future. We have several thoughts on how to develop even more accurate and objective testing procedures. We really hope you will consider making this a regular issue. We believe your continued active role will be crucial to ensuring a collaborative and open 3D printing community in the future.

—Espen Sivertsen and the
Type A Machines team, San Francisco



» I really enjoyed Chris Hackett's “DIY Welding Rod” project (Volume 33), but I noticed the NaOH (and HCl) chemistry was done in a Pyrex measuring cup. When World Kitchens bought the rights to make Pyrex cookware in the United States, they switched the recipe from borosilicate (true Pyrex) to tempered

soda-lime glass (like car window glass). Tempered glass is strong and heat resistant, but scratches will significantly weaken it, and when it breaks it shatters into little cubes. People have cooked with it for years and most have no problems, but I suggest splurging on real Pyrex labware to heat acids and bases at home.

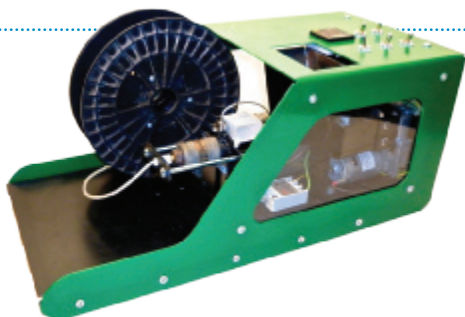
—Josh Feldman, Lawrence, Kan.

» I enjoyed your DIY meat smoker project (“Nellie Bly Smoker,” Volume 32). I realize it uses an electric element as a heat source, but if readers do experiment with adding charcoal as you suggest, regular charcoal briquettes should never be used, as they contain anthracite coal and will impart a less-than-desirable flavor. Natural lump charcoal made from hickory, mesquite, etc., will keep the smoke flavor pure and temperature consistent.

—Brent Benson, Corona, Calif.

PROJECTS EDITOR KEITH HAMMOND REPLIES:

Brent, you’re right, we should’ve cautioned against fossil-fuel-fortified briquettes; veteran BBQers consider them sacrilege. When testing the Nellie Bly Smoker, I experimented with natural mesquite lump charcoal to raise the temperature on a big batch of beef brisket. It worked. And tasted great.



» The 3D printing movement and Tyler McNaney’s Filabot (makezine.com/go/filabot) are so exciting. I imagine legions of young people becoming fabulous recyclers, walking down the street, picking up discarded plastic items, thinking: “This is exactly what I need to make _____!”

I imagine oceans without islands of plastic.

I imagine manufacturers and the packaging industry stamping a number on every piece of molded plastic, so it can be easily reworked.

I imagine companies like 3M creating labels that can be easily peeled from plastic packaging, without solvents, so that every square inch of the plastic can be recycled or reformed. Let’s all work on this together!

—Jacqueline Brook, Putney, Vt.

» Reading the “Little Big Lamp” project in Volume 32, I was surprised to see pulse-width modulation (PWM) used to reduce the voltage across a string of LEDs from 12V to 10V. This approach, with ULN2003 grounding a string of three LEDs, allows adjustment of the average current and voltage but leaves peak current and voltage uncontrolled. During the pulse the LEDs will be subjected to full power supply voltage (minus 1V collector-emitter saturation voltage of the Darlington array). LED forward voltage of 3.67V (11V/3) most likely exceeds the maximum ratings of available devices. Forward current will also be excessive as a result. As a result, both longevity and power dissipation will suffer.

I would suggest that the right way to build an adjustable-brightness LED lamp is to use an adjustable switch-mode current source.

—Dmitry Teytelman, San Jose, Calif.

AUTHOR CHARLES PLATT REPLIES: The LEDs I recommended were rated 3.3V “typical” but their acceptable maximum is 3.6V. While the 12V DC power supply is at the upper limit after passing through the Darlington array, I felt it was acceptable, especially as many AC adapters deliver less than their rated voltage under load. The LEDs are still available from eBay’s TopBright LED Store, although the typical forward voltage has been increased to 3.4V (same maximum as before).

I think an adjustable switched-mode current source would be more expensive, so I feel PWM is an acceptable way to run these LEDs, as the heat which is a major factor in stressing the LEDs will diminish in ratio with the duty cycle.

MAKE AMENDS

In Volume 33’s project “Panjolele: The Cake Pan Ukelele,” we advised readers to draw a chord and its perpendicular three times to find the center of a circle. It’s only necessary to draw two such perpendiculars; their intersection will mark the center. Thanks to reader Michael Nachtigal of Wesley Chapel, Fla., for the fix!

A Meeting of the Minds

By Ryan P. C. Lawson, Esq.
Small Business Advocate

As a maker, you have some great ideas. You probably have some solid skills, too. You might be a welder, an electronics whiz, or a woodworker. Odds are, though, you're not all of these things. If you want to turn your ideas into a successful business, at some point you'll probably need help. For example, you may need someone to make CAD drawings of your finished product for replication or to apply for a patent. No matter what the work is, if you have someone helping you, they're performing a service. Alongside that service should be some sort of service contract.

A service contract doesn't have to be in writing. You and Bob could shake hands and agree that you'll buy Bob dinner if he quickly welds two pieces of metal together for you. If it's anything more complex than that, though, you'll want to get things in writing.

Most lawyers will tell you that you want a written contract as insurance in case anything goes wrong. A contract serves as proof of what you agreed to, and can be used as evidence in court.

But a contract can be used for something much more important: setting expectations between two people about the services to be performed. When service contracts fail, it usually stems from a lack of alignment between the people involved. Writing a good contract eliminates ambiguities and makes sure you and the other person have the same expectations from the beginning.

Think of hiring a painter. A simple contract might say, "John agrees to paint my living

room for \$200." While that is a written contract, it doesn't address who is going to buy the paint. John might think you are, and you might think that a painter comes with the paint. To solve this, you can say, "John will paint my living room for \$200 with paint and brushes that I supply." Now you both agree on who will shoulder the cost of the supplies. When writing a contract for services, think about who is supplying materials and tools.

Another critical area to consider is time. Do you care when the service gets done? If you pay someone to mow your lawn weekly, what day they mow may not be important. But if you pay someone to mill parts for you, you might need them by the end of the month. In that case, your contract should specify a time.

Of course, if you set deadlines, you have to think about consequences if they're missed. I need someone to solder a circuit board by the end of the month. If it comes in a week late, maybe I only pay half price. Or maybe I get a 2% discount for each day it's late. If you have measurements of either time or quality that you agree to in a contract, you can also specify consequences if they're not met.

A service contract should specify how someone is being paid. The two usual ways are a fixed fee for a job (or a portion of a job, such as \$5 per part) or an hourly rate for work performed. If it's hourly, make sure you both understand what's included in billable hours. Are meetings to discuss the project billable? What about time spent to correct for errors in workmanship? Make sure you both agree.

If you're being charged per job, it's critical to define what the job is. In my living room example, does it include painting the ceiling, or just the walls? Is it one coat or two? Is trim work extra? Define the work up front to make sure you're both happy with the outcome.

There are other terms you may want to include — look online for sample contracts. Crafting a well-written contract is a lot easier than you might think, and can help to avoid disagreements later. ■

Ryan Lawson is a Michigan lawyer. His practice focuses on technology licensing and advising small businesses.