THE GREAT CREATE

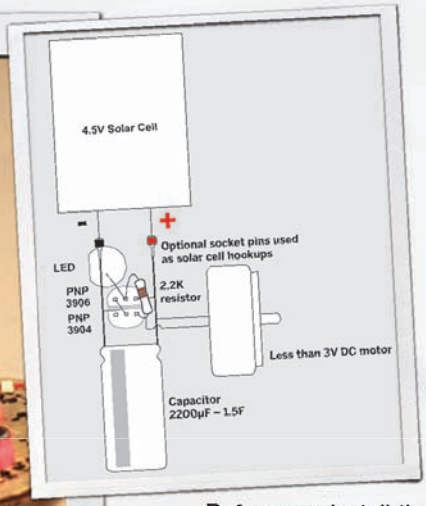
RadioShack®

A CELEBRATION OF AMAZING CREATIONS AND THE PARTS THAT MADE THEM POSSIBLE.

CREATE SOLAR CHARIOTS THAT RACE WITH THE SUN

Use a simple circuit, DC motors, and solar cells to build autonomous racers.

BEAM (biology, electronics, aesthetics, mechanics) is a type of robotic design that makes use of simple components and bits of techno-junk to create cool robo-critters, many of them inspired by nature. Clever circuit designs, analog parts, and minimal components make it a perfect type of robot-building for beginners and kids.



Our Solar Chariots ready for action. The Roller (left) moves straight, like a dragster. The Symet Chariot (right) spins and moves like a top when the circuit fires.

One of the basic BEAM circuits is called the Solar Engine, a simple means of collecting a solar cell's output and using it to power a motor. The Solar Engine can be used to drive all sorts of BEAMbots. In this project we'll use it as the muscle to power a little solar race car and a top-like spinner.

Let's Get Started:

The list below includes enough parts to make two solar engines. To assemble each one, follow the diagram and wire together all components as shown. Note that the flat sides of the transistors face each other. (You can use heat-shrink tubing to hold them together.)

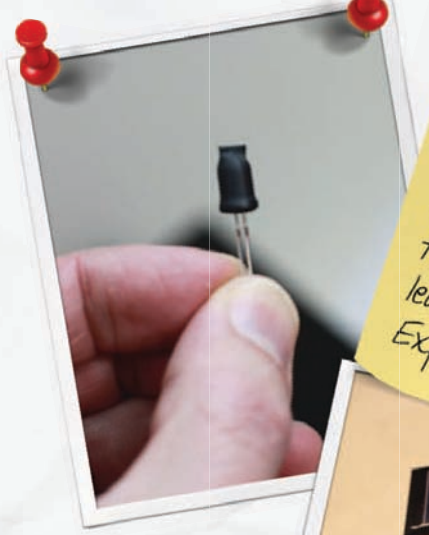
This type of solar engine is called a FLED-type, for "flashing LED." The LED is not used as a light, but as a trigger to dump the charge from our capacitors. When the charge is high enough to flash the LED, it becomes a conductor and allows the current to flow through the circuit and turn the motor. When the charge is dissipated, the resistance goes back up and the charging phase begins again.

Before you install the LED, cover it with heat-shrink tubing and use a heat source to fix it onto the dome of the light (see photo).

For both the Solar Roller and Symet, you'll want to attach three 4700µF capacitors (in parallel) where one is shown in the diagram.

Once the circuit is built, the real creative fun comes in with laser cutting (or using another cutting method) the structural components and wheels for your vehicles. We have downloadable templates available on the Make: Projects page at makeprojects.com/project/b/1939.

When you're done assembling the parts from the template,



Once you have the circuit working, try using higher-value capacitors (such as "supercaps"). Try different bodies for the Roller. See if you can increase your circuit firing time/distance traveled. BEAM is all about learning through trial and error. Experiment!

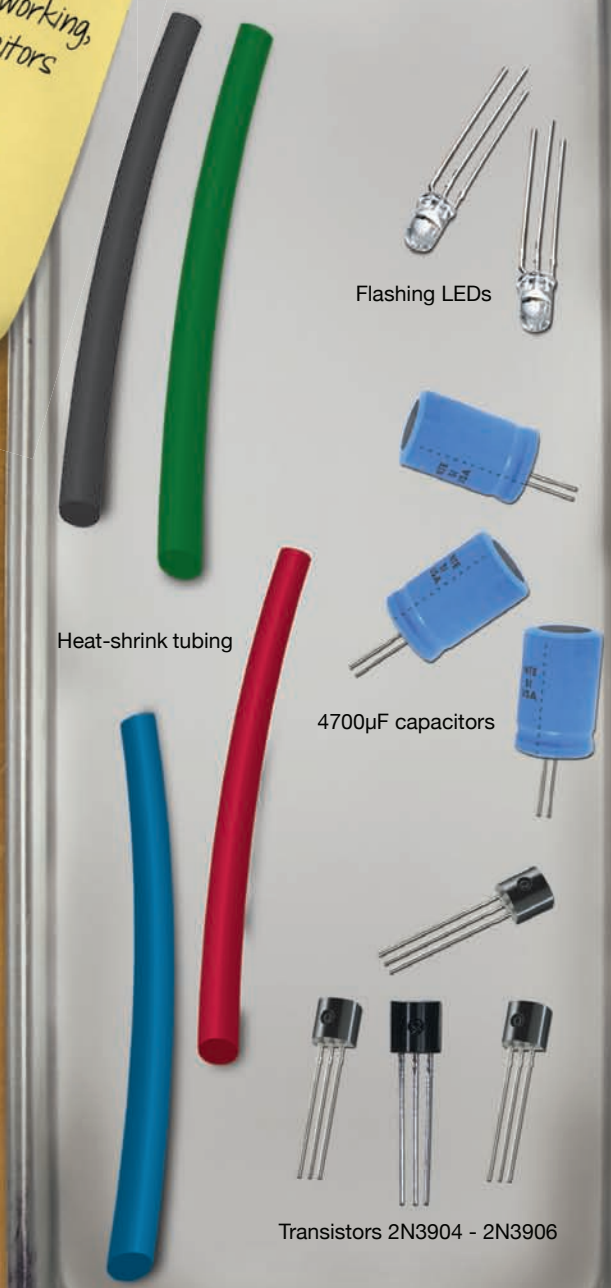
you can attach the circuit to your motor and the solar cell to your circuit. (Again, see the project online for details.) Now take your racers into the sunlight and start your engines! The Symet will spin and move when it releases its charge, and the Roller will race forward like a solar-power dragster. For maximum racing fun, build two Symets or two Rollers and race against your friends.

By Gareth Branwyn, MAKE Editorial Director, and Zach and Kim DeBord

PARTS

- ☐ (2) Transistor 2N3904 ("3904") NPN #276-2016
- ☐ (2) Transistor 2N3906 PNP #276-1604
- ☐ (2) Flashing LEDs #276-036
- ☐ (2) 1/4W 2.2K resistor #271-1325
- ☐ (6) 4700uF capacitors #55047495
- ☐ (2) 4.5V solar cell
- ☐ (2) DC motors (salvaged from portable cassette player)
- ☐ (4) Socket pins
- ☐ Heat-shrink tubing
- ☐ Hex nuts
- ☐ Machine screws
- ☐ 1/8" telescoping metal tube

SOLAR CHARIOTS INCLUDE THESE RadioShack® PARTS



To submit your own creation, explore other great creations, and get the hard-to-find parts you need, visit RadioShack.com/DIY.

SCAN THIS QR CODE TO LEARN MORE ABOUT THIS PROJECT

A SUMMER OF MAKING

BY DALE DOUGHERTY

Dale Doughtery with the Project Make class (see page 100 for more about the program).

When I recently visited a middle school in Santa Rosa, Calif., I saw no students. None. I learned it was the week for standardized testing. The library and playground were empty.

The school was designed for 1,100 students and now serves only 300; 85% of them are low income. If parents can afford it, they apply for a transfer to a better school. These are the children left behind.

Previously, I met with the school board and superintendent to talk about ways to introduce making into schools. An assistant superintendent suggested that this middle school was a good place to start, and that we could make a difference by starting with a maker-themed summer camp, working with the local Boys & Girls Club.

For all kids, time spent outside of school is as important, if not more so, than time inside school. Some kids have perfect summers filled with engaging activities and family trips. They even get to spend weeks at incredible summer camps. Other kids aren't so lucky and don't have enough to do. Experts believe that summer is a period when disadvantaged kids give up some of the gains made during the school year. They start the next year behind.

Back at the deserted school, the principal gave us a tour to find a space for the summer camp. She showed us a few uninspiring classrooms with no windows; a science lab that doubled as a Spanish classroom; a music room no longer in use, even though old instruments were in view. We found a room that read "Wood Shop" on the door, but I stepped inside to find exercise equipment for phys ed class. The next room said "Metal Shop" and was mostly empty, except for a storage area with some old machines still hanging around.

I knew right away this would be a perfect space for kids. The Boys & Girls Club director asked if we could paint the room. "You can do anything you want," the principal said. Excellent, I thought, a project for the kids. She encouraged us to create a makerspace that could be used not just this summer, but during the school year too. "These kids need it," she explained. "They need to play. They need opportunities to create."

As we talked about the program, I warned everyone that it could be messy — we didn't necessarily know everything but I was pretty sure the kids would have a lot of fun. I recalled the silk-screening project in our lab and suggested that the summer camp could start off by inviting the kids to make their own camp T-shirts.

"I'm so happy you care about this school and its kids," the principal said. It was her birthday, and she said she would consider the summer camp a birthday present.

When I returned to our office, I saw galleys of this "Best Summer Ever" issue, our first devoted to kids. I realized we had already done a lot of the hard work of selecting great projects for kids. The timing was perfect, I thought. We'll use it as a guide for the summer camp.

Later the same day, I was on a call with this issue's cover girl, Super Awesome Sylvia, and her dad. I told her about the summer camp and asked if she'd visit and do some fun projects with the kids. They'll have seen her on the cover, so I'm sure it would mean a lot to them to meet her. Sylvia's father said she was beaming. So was I.

This special issue provides all you need for a summer of making in your own community. Just add kids, even some who aren't yours. It's going to be a bit messy but lots of fun. Send me some pictures or a video (page 86). Extra credit for 3D.

Dale Dougherty is founder and publisher of MAKE.

Gregory Hayes

HOW WE MADE THIS ISSUE 3D

MAKING THE DIFFERENT FLAVORS OF OUR "SCHOOL'S OUT" 3D IMAGES. BY PAUL SPINRAD

Barry Rothstein at our 3D photo shoot for this special issue.

When the MAKE staff was first exploring a 3D issue, we planned to do the whole thing using *2D-to-3D image conversion*, with the help of industry leader 3DX (see right). But our Maker-in-Chief Sherry Huss had the brilliant idea to also reach out to the vibrant maker community and immediately thought of Maker Faire alumnus Barry Rothstein (pictured). Barry happily agreed to come to our headquarters in Sebastopol, Calif., and he led us in a fun 3D photo shoot surrounded by a bunch of cool projects, tons of kids, a few dogs, and only a little poison oak — it was the only downer of the weekend!

Using a rig of his own making, Barry shot these images with his twin Sony DSC-R1 cameras synchronized with a LANC Shepherd trigger controller. He produced most of the photos as *traditional 3D images*, where the depth appears behind the picture plane. But the inset photos of the marshmallow shooters (page 21), frozen banana pops (page 33), TV-B-Gone (page 57), rockets (page 65), Ella's 3D-printed head (page 73), and Kryptonite Kandy (page 81) are all *phantograms*, where the subject appears closer than the picture plane, rather than behind it.

When Barry was getting started with 3D, he used a modern replica stereoscope and shot his photos using the "cha cha cha" method (aka the "stereo shuffle," described on page 14). Later he learned how to make phantograms. To align the stereo pairs more accurately and improve 3D quality, he built a tripod-mountable slider bar for his camera out of sliding aluminum door parts, which he used to produce his first book, *Phantograms from Nature*.

Creating phantograms is easy — look for a PDF tutorial on Barry's website (3ddigitalphoto.com). Before snapping your picture, you place a rectangular frame, just like a wooden picture frame, around your subject. Once you've got your shots, you do some simple Photoshop work to crop them and then run them through StereoPhoto Maker or other anaglyph software.

If you make your own phantograms, submit them on Barry's website, and he'll post them up for the world of 3D enthusiasts to enjoy.

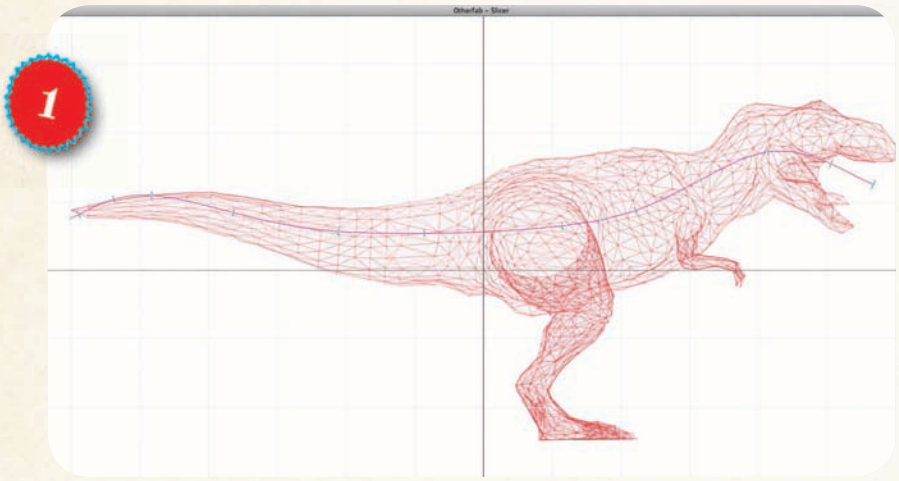
3DX
EXPERIENCE YOUR BRAND

MAKE produced the image on this cover a different way. Photo Editor Gregory Hayes took a 2D photo of Super Awesome Sylvia, and we sent it to 3DX (go3dx.com), a company that performs 2D-to-3D image conversions for print and movies. Using proprietary software that interprets the depth cues from a 2D image, they construct a simulation of the original 3D scene. If you've been to the movie theater lately, you've probably seen one of their cool posters!

MAKE Executive Editor Paul Spinrad can move his eyeballs apart to view stereo pairs without a stereoscope (but not while keeping them in focus).

MAKING BIG THINGS IN 3D

GOT CARDBOARD? BUILD BIG 3D OBJECTS FROM 2D "SLICES." BY SAUL GRIFFITH WITH SAM CALISCH



3D printing is exciting and has the maker world all aflutter. It is wonderful, but it's still not a technology that can produce big models quickly, from robust materials, at a low cost.

At my company, Otherlab, we've been working with Autodesk on several very lightweight, very fun software tools to quickly break down 3D models into physical parts and assembly instructions. The result: you can quickly build your model at any scale, from a great variety of materials. It's a brain-twisting jigsaw puzzle with the ultimate payoff: your geometry, made real big, in real stuff.

For example, imagine you need a dinosaur to complete your Halloween costume — a *Tyrannosaurus rex* that's actually rideable (for a very lucky 3-year-old). How are you going to make a truly awe-inspiring dino before your fast-approaching party?

Autodesk and Otherlab teamed up to create 123D Make (123dapp.com/make), a "decomposition" application for building cool stuff out of 2D shapes, or "slices." These instructions will work for any 3D model, but my 3-year-old loves *T. rex*.

In this article I'll show how you can use these clever algorithms, automatically generated instructions, and low-cost materials to make just about anything, and then make it big.

1. FIND, MIX, OR MAKE A 3D MESH

There are great free 3D models all over the web, and they're multiplying fast. Try TurboSquid (turbosquid.com) or Google 3D Warehouse (sketchup.google.com/3dwarehouse) for a start. Download your model as an STL file.

For bonus points, modify your mesh using MeshMixer (meshmixer.com, see page 76 for more about it) or create your own mesh with AutoCAD or Rhino.

The wealth of models available is great, but they often have small errors, invisible to the eye, that throw off the math required to slice and dice them. Don't worry if your mesh isn't "watertight" — 123D Make has some very slick tools that automatically fix holes, self-intersections, and other errors. It's Eulerian magic!

Sam Calisch

2. SLICE IT

Create a free account at 123dapp.com and then open the 123D Make web app. Choose your construction technique: Stacked Cardboard Slices. (You could also choose the Folded Paper Panels technique to make an origami-like model.)

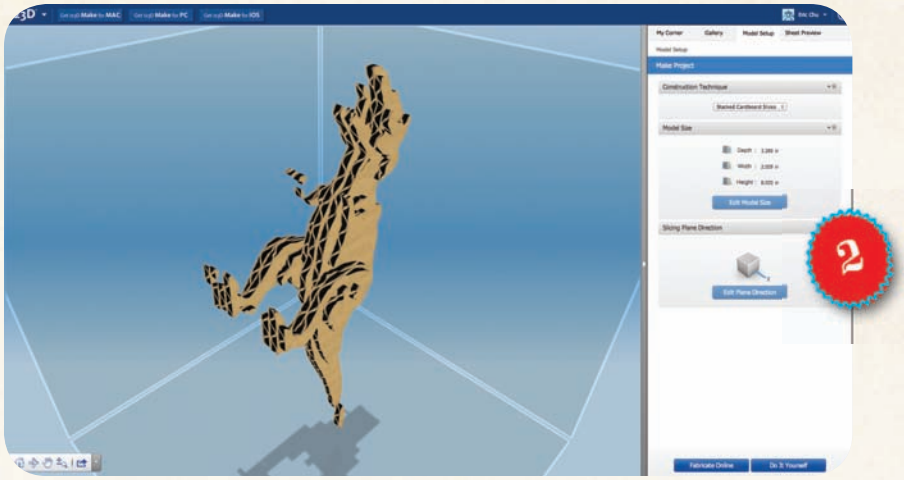
Now upload your model as an STL file. 123D Make will automatically heal any errors in the mesh, and then turn your model into horizontal cardboard slices!

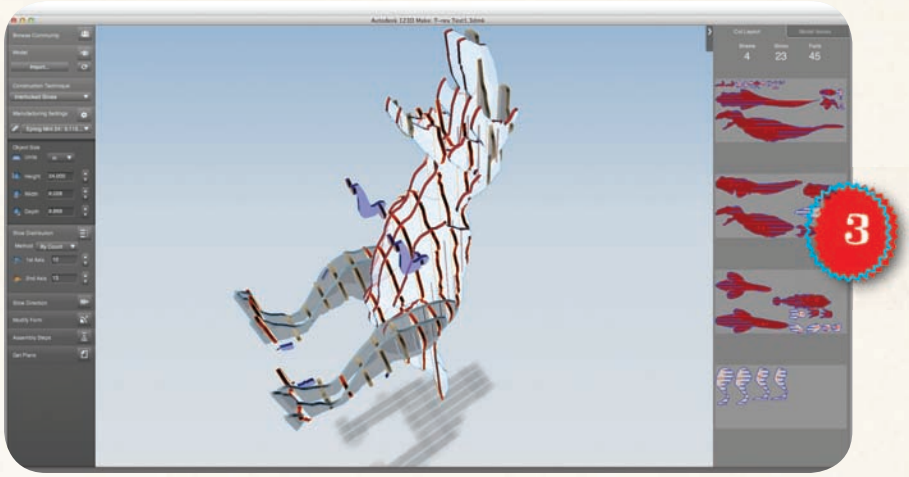
Click on the Model Setup tab and you can change the size of your model. The web app currently allows you to design a 12"-tall model, which is a lot bigger than most 3D printers (see Step 3 to go even bigger).

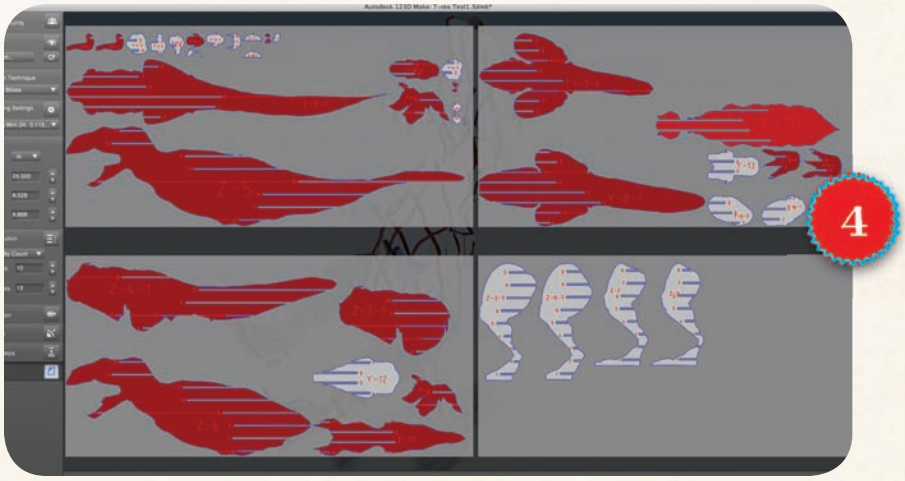
You can also choose to slice your model using planes that are parallel across one of the 3 radial axes:

» x axis (vertical slices, side to side)
» y axis (vertical slices, front to back)
» z axis (horizontal slices).

These planes may vary depending on the model you use. For a stronger *T. rex*, click on Edit Plane Direction, and select the plane that makes vertical slices, lengthwise (nose to tail), as shown here.







3. MAKE IT EVEN BIGGER (OPTIONAL)

Remember, we're going big here. To make a model taller than 12", you'll need to download the desktop version of 123D Make (free for Mac or PC), which can scale your model up to any size!

Another nice feature of the desktop version: instead of just slicing on the x, y, or z plane, you can position your slices along an arbitrary path (the backbone itself), creating a cool "skeletal" structure. Or choose the Interlocked Slices technique to make a "waffled" model, as shown here.

4. CUT OUT YOUR SLICES

After slicing up your dino, you'll have a set of output shapes or slices. You can see these under the Sheet Preview tab. Now you need to cut them out. Here are 3 ways:

» If you're lucky enough to have access to a laser cutter, they're almost as easy to use as an inkjet printer. Change the Sheet Size to something the laser cutter can handle, and then click Do It Yourself to download the patterns for all your slices. These EPS files can be sent directly to a laser cutter by Adobe Illustrator, Corel Draw, or almost any program that can read and print EPS files.

» If you don't have a laser cutter handy, you can click Fabricate Online, and Autodesk will laser-cut your cardboard parts and mail them to you for about $10. Or you can send your files to a service like Ponoko (ponoko.com) to cut them out and

mail them to you.

» For the patient maker, a printer, tape, and an X-Acto knife will get the job done. Set the Sheet Size to something your printer can handle, and then click Do It Yourself to download the patterns for your slices. Print them full-size on paper, tape them to cardboard, and cut the shapes out carefully.

5. ASSEMBLE YOUR MODEL

This is the fun part. These sliced models have all the brain-twisting fun of a puzzle — in 3D. Stack and glue them in numerical order, or if you used more complicated slicing paths, slide the notches together. Watch your model take substance.

6. SKIN IT IN PAPIER-MÂCHÉ

Using your sliced model as a support structure, it's easy to make a skin with papier-mâché. Start with a few cups of warm water and mix in all-purpose flour a cup at a time until the mixture is thick enough to hang on your fingers.

Tear long strips of newspaper, dip them, and wipe off the flour-water mixture, leaving them covered with a thin layer. Apply the strips in a cross-hatched pattern, but avoid building up too many layers at once.

After several layers, the papier-mâché should be strong and tough.

To help coats dry faster, apply strips of dry newspaper with heavy pressure in particularly wet areas.

For the last coat, mix some wood glue into your mixture for a smoother finish.

7. APPLY PAINT AND PERSONALITY

Papier-mâché takes paint well. Get creative and give your *T. rex* some style. If you want to get crazy, you can get some amazing effects with sanding and painting (see ultimatepapermache.com). Don't stop at painting — add feathers, claws, horns, and laser-beam eyes.

8. MAKE ONE EVEN TOUGHER AND BIGGER

Cardboard is cheap and easy to cut, but other materials can make bigger, stronger stuff. Lasers can cut wood, acrylic, steel, matte board, and tons of other materials, but don't be afraid to tackle this project with a good old-fashioned router or band saw (with adult supervision).

This technique is great for school plays, parade floats, human-sized chess sets, or any other time small just won't do.

Saul Griffith is chief troublemaker at Otherlab (otherlab.com). Sam Calisch, also of Otherlab, makes math make things.

Sam Calisch

12 & UP

RED LEFT, BLUE RIGHT

MAKE 3D MOVIES AND PHOTOS ON A SHOESTRING. BY STEVE WHITE

Want to make your own low-budget *Avatar*?

3D video camcorders and displays are getting cheaper, but they're still fairly expensive, and the only sub-$100 cameras that take 3D still photos all use roll film. So I thought it would be fun to mix the old with the new and see how cheaply I could build a digital camera rig for creating old-school red-blue 3D stills and video.

My design goals included real-time preview ability, focus and parallax control, and perhaps most importantly, compatibility with my daughter's *Barbie and the Magic of Pegasus* 3D glasses.

Good old red-blue anaglyphic 3D works on ordinary screens, can be printed using any color printer, and requires only super-cheap glasses for viewing. You can't do all that with the polarization-based 3D that movies use today. And there's free, easy-to-use software that lets you create anaglyphic 3D from stills and video captured with ordinary digital cameras. Looking at 3D is fun, and it's even more fun when you've shot it yourself.

THE STEREO SHUFFLE

The easiest way to start making your own 3D photos is the *stereo shuffle*, described by Bill Coderre in MAKE Volume 06 (page 143).

Take your digital camera outside and find a scene with a fun variety of distances to focus on. The closest objects should be at least 5 feet away, and perfectly still. Also, make sure that everything in the scene will be in sharp focus. Sunny conditions will help your depth of field.

Ready? Hold the camera to your eye, and lean very slightly to the left. Snap a picture. Lean very slightly to the right, and snap another picture. That's your basic *stereo shuffle* right there.

Avoid scenes where there's a lot movement, because you capture the 2 images at slightly different times. And as with all images that are destined for red-blue anaglyphic, whether stills or video, avoid subjects that are red or pink, or have vertical stripes. (Zebra stripes make perceiving depth with binocular vision more difficult, a feature which helps protect zebras from predators, especially when they're clustered together and running.)

Another fun source of 3D stereo pairs is any 2D movie that you can watch on your computer screen. Grab 2 frames from any horizontal tracking shot, and use them to create a 3D scene.

TWIN CAMERA STILL PHOTOS

To take high-quality 3D photos, you need 2 camera lenses capturing the image at the same time, either on a special 3D camera (the non-film ones are expensive) or on 2 regular cameras that you synchronize.

For high-end still cameras, you can find twin camera controller plans and products at the Ledametrix Digital Stereo Photography website (ledametrix.com).

ANAGLYPH PHOTO SOFTWARE

You can use free software to create a red-blue anaglyph out of 2 images, such as StereoPhoto Maker (stereo.jpn.org/eng/stphmkr), which is Windows-only, and Anabuilder (AnaBuilder.free.fr/welcomeEN.html), which runs cross-platform. These programs remove red tones from the right image, remove green and blue (cyan) tones from the left image, and combine them into a 3D image that you view with red-cyan 3D glasses. Parts of the image that appear dark to the left eye and light to the right will look cyan, and areas that look light to the left eye and dark to the right will look reddish.

StereoPhoto Maker aligns the left and right photos into a combined stereo anaglyph automatically and can generate them in batches.

With AnaBuilder, you need to align

Gregory Hayes

MATERIALS & TOOLS

LOGITECH 960-000043 QUICKCAM DELUXE WEBCAMS (2) I bought these refurbished for $15 each. This is a good webcam for this project due to its small size and focusable lens.

RIGHT ANGLE BRACKETS, 2" (2)

MENDING PLATE, 6", METAL with 4 mounting holes

TURNBUCKLE, 3/16" x 5½", 2½" TAKE-UP

HOT SHOE MOUNT/TILT ATTACHMENT FOR CAMERA such as the ePhoto Adjustable Swivel Hot Shoe Mount FT9712H, available from Amazon

MINI TRIPOD such as the GorillaPod Magnetic, #MKJB01 from Maker Shed (makershed.com)

MACHINE SCREWS, ¼-20, ½" LONG (2 FLAT-HEAD AND 2 ROUND-HEAD)

NUTS, ¼-20 (5)

WASHERS, ¼-20 (4)

ACORN NUT, ¼-20

CONTACT CEMENT

LAPTOP COMPUTER WITH 2 FREE USB PORTS, WINDOWS-BASED

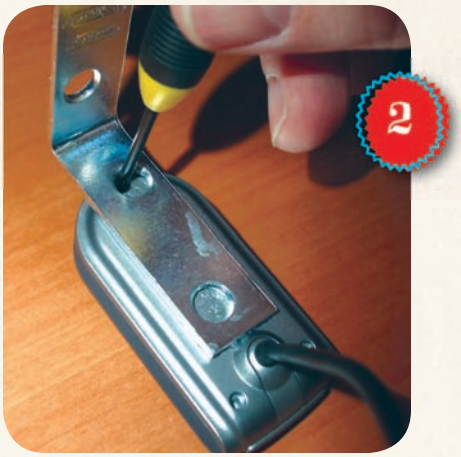
3D CAPTURE SOFTWARE such as Stereoscopic Multiplexer and Player (3dtv.at) or Onuprova 3D Camera (redcyan3d.codeplex.com), depending on whether you're making video or stills

3D GLASSES, RED-BLUE ANAGLYPHIC like the ones bound into this magazine

USB EXTENSION CABLES (2) (OPTIONAL) The webcam cables are a bit short.

SCREWDRIVERS, PHILLIPS HEAD (2) one small, one large

Steve White



each image pair manually. Using the arrow controls, you move, stretch, and rotate the left image against the right, so that all objects align horizontally, and the closest point on the nearest object has its 2 views superimposed. This puts it at "window depth," which is easier to view. You can experiment with "eye poking" 3D, such as phantagrams, later.

HARDWARE AND SOFTWARE FOR 3D STILLS AND VIDEO

For video and lower-resolution stills, an easier hardware setup is a Windows laptop with 2 USB webcams plugged in. You can shoot and produce 3D video using Peter Wimmer's Stereoscopic Multiplexer and Stereoscopic Player software (free trial version at 3dtv.at; register for full functionality and to remove watermarks), or you can capture and produce 3D stills using the free Onuprova 3D Camera software (redcyan3d.codeplex.com).

With a webcam-laptop setup, you need to keep the 2 webcams securely positioned and lined up precisely. Here's how I put together a fun and easy 3D capture rig for around $35. As a first-time maker, I'm proud to introduce the Frankencam3D.

BUILD THE FRANKENCAM3D

1. To remove the clamp on each webcam, unscrew the 3 screws in back. Lift away the back cover and gently unplug the USB cable's connector from the circuit board. Remove the 2 screws that hold the cable clip and slide it away to separate it and the cable from the back cover. Pop the clip off the back cover by pressing the cover against a flat surface.

2. Mount the brackets to the back covers with contact cement, aligning them by positioning the upper edge of the metal where the bevel for the cable starts. The cover's straight sides make a nice guide for vertical alignment, and a hole in each bracket allows access to the lower mounting screw. (I returned the screw to its hole before this step to make reassembly easier.)

Replace the USB cables on both camera covers, plug the cables into the circuit boards, and screw the covers back onto the cameras.

3. Mount the camera brackets to the mending plate using the plate's first and third holes (shown on page 16). This approximates the distance between your eyes, for a realistic 3D effect. Then link the back ends of the camera brackets with the turnbuckle, using the flat-head screws.

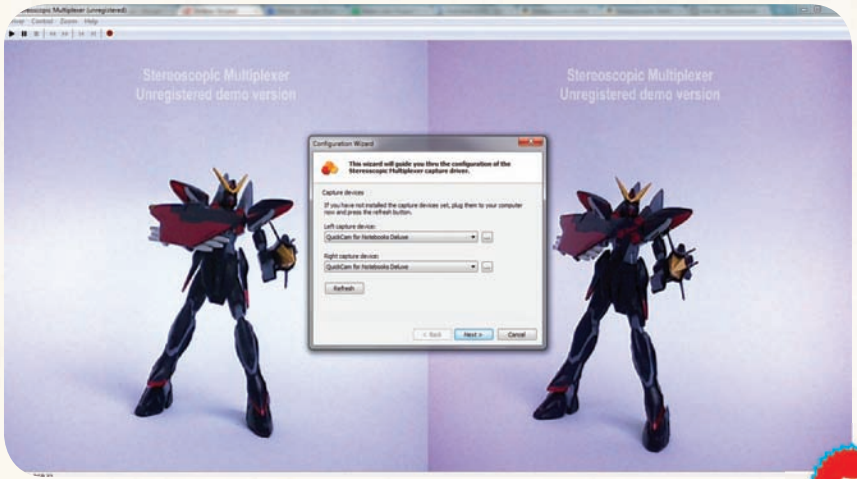
4. Unscrew the top and bottom parts of the hot shoe mount so that you're left with only the pivot joint. Screw this joint onto the tripod, screw a nut on top, then fit the camera rig over the nut and secure it with the acorn nut. Finally, hook up the USB cables to your laptop. That's it — the rig is ready to go.

The Logitech cameras include a velcro wrap on the USB cables, which you can use to neatly manage the rig's wires. The turnbuckle in back lets you experiment with the rig's parallax control, fine-tuning the cameras' angles to achieve more precise 3D effects.

MAKING 3D MOVIES

5. To capture and produce 3D video with Stereoscopic Multiplexer, first select the 2 USB cameras in the configuration wizard under the Driver menu. The software will display the live webcam feeds side-by side; make sure the order is correct (left and right), then turn the camera lenses to manually focus each one.

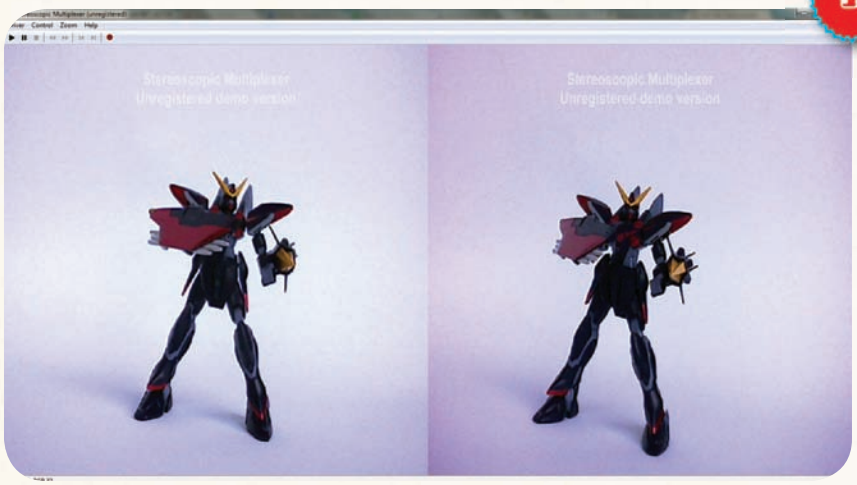
Close Stereoscopic Multiplexer.



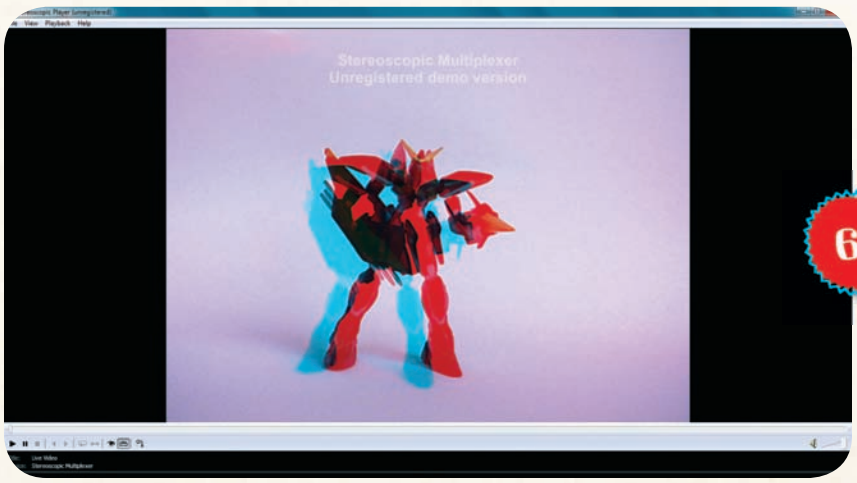
6. Open Stereoscopic Player and select File → Live Playback/Stereoscopic Multiplexer to display your live stereo image. Under Settings, choose the Optimized Anaglyph Red-Cyan playback option, and test the image with your 3D glasses. Now you can compose your shot, readjust the focus if needed, and experiment with the parallax to see what works best.

When you're satisfied with the image, close Player and relaunch Multiplexer. Now you can record video clips by clicking the Record and Stop buttons. You can view your clips back in Stereoscopic Player, in a number of 3D video formats.

Onuprova 3D Camera works basically the same way, and also has a shutter button for capturing 3D stills.



That's it. You're now officially a 3D photographer or moviemaker! Many factors will impact your results, including distance from the lens, severity of parallax, focus, and lighting. So start experimenting, and by all means, find ways to improve your rig.



Steve White (stevewhiteproductions.blogspot.com) is a filmmaker, writer, and twin dad living in Asheville, N.C. He produced and directed the feature film *Immortal* and wrote *VisionFactory: Adventures in Corporate Screenwriting*. He's currently working on a new book *One and a Half Stars on Netflix*, and the screenplay *KITTEH!*

SCAVENGE YOUR NEIGHBORHOOD!

LOOK AROUND! YOUR NEIGHBORHOOD CAN BE A TREASURE TROVE OF GREAT MATERIALS AND TOOLS FOR MAKING.

CURBSIDE FREEBIES

Even though some of it can be tricky to snag when you're out on your bike, you'll want to find a way to carry the occasional piece of lumber or discarded electronics back to your home base.

CONSTRUCTION SITE

No need to hop the fence after hours — the site foreman will gladly unload unwanted lumber, foam board, and other random bits and pieces. Just ask nicely.

GARAGE SALE

Need a hammer and some nails? How about someone's stash of practically new craft supplies? Just remember to haggle — these sellers are trying to get rid of their old junk, and they want you to take it away!

THRIFT SHOP

Grab your coin jar and spend your pennies on how-to books, tools, and cheap electronic gadgetry. You'll find aisles and aisles of value.

SURPLUS STORE

Where else are you gonna find a box of turbo-encabulators with pre-fabulated amulite, surmounted by a malleable logarithmic casing whose two spurving bearings are in a direct line with the pentametric fan? Only at Colonel Scratchy's Military and Scientific Junk Emporium!

DUMPSTER

One man's trash is another man's treasure. Get permission from the owner before diving in for cardboard boxes and wooden pallets, and always keep a sharp eye out for rats and rusty nails. Yuck!