Make: PROJECTS

A HANDS-ON INTRODUCTION TO AFFORDABLE 3D PRINTING

Getting Started with MakerBot

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Anna Kaziunas France
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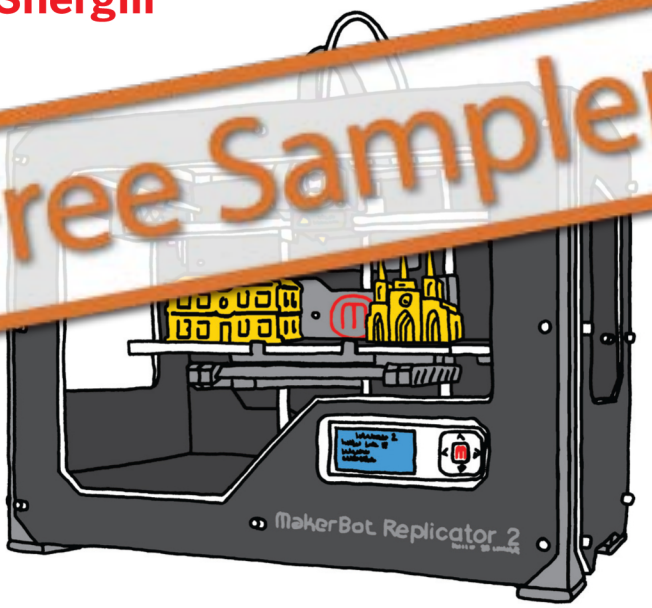

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by Bre Pettis, Anna Kaziunas France, and Jay Shergill

Printed in the United States of America.

Published by O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

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Editor: Brian Jepson
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Interior Designer: Ron Bilodeau and Edie Freedman
Illustrator: Marc de Vinck

December 2012: First Edition

Revision History for the First Edition:

2012-12-07 First release

See *http://oreilly.com/catalog/errata.csp?isbn=9781449338657* for release details.

ISBN: 978-1-449-33865-7

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1/Introduction

In which the reader shall learn about the implications and responsibilities that come with being the Operator and Caretaker for a MakerBot and shall be introduced to robots of great power and promise.

How Does a MakerBot Work?

All MakerBot prints start with a digital design—a 3D model of your object. Software takes that model and slices it up into layers a fraction of a millimeter thick. When it's time to print, a MakerBot works by laying down layers of plastic. Each layer is precisely drawn by the machine using molten plastic. It cools immediately, and in the process of cooling down transforms from a molten liquid into a solid model! Figure 1-1 shows the original MakerBot Replicator.

MakerBots print in thermoplastics—either ABS (the same stuff Legos are made of) or PLA (a biodegradable substance made from starchy foodstuffs). A thermoplastic is a material that softens and becomes pliable above a certain temperature and then returns to its solid form as it cools. The thermoplastic printing material—also called filament—starts out on a reel like spaghetti or very thick fishing line. When you're printing, a very precise motor drives that raw filament through an extruder, a very tiny nozzle that gets hot enough to melt it. What comes out the other end is molten plastic that looks like super fine angel hair spaghetti, which quickly cools and turns into whatever it is you're printing.

As it prints, the MakerBot draws a "picture" in two dimensions with this small bead of plastic. When it's done drawing each two-dimensional layer, it moves up a fraction of a millimeter and draws another picture right on top of the first one. Just like that, your object gets built, one layer of plastic at a time, until it gets presented to you as a solid finished object.

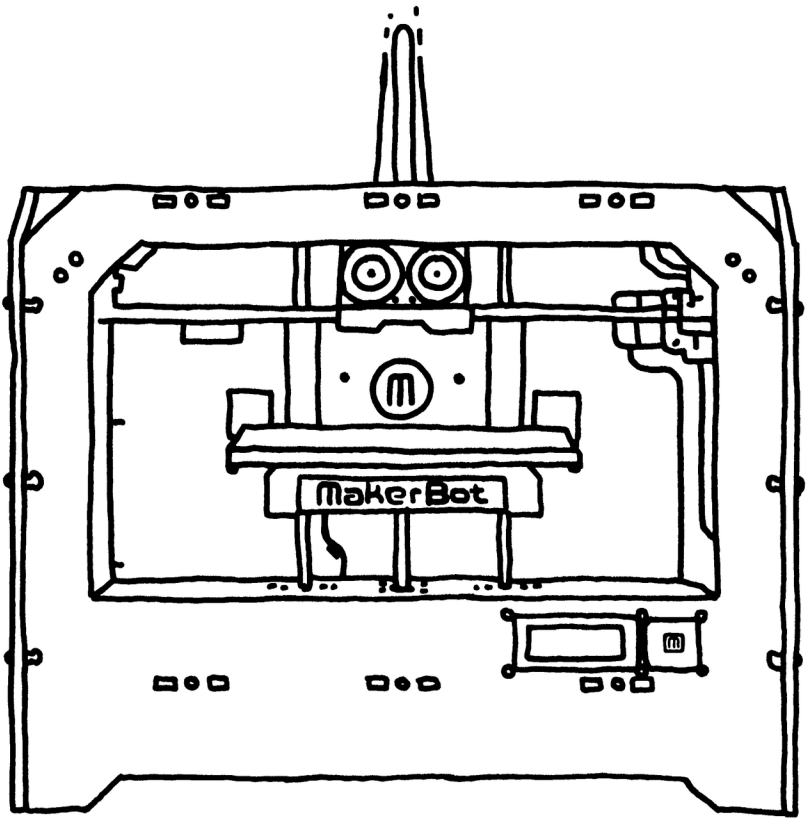

Figure 1-1. *Diagram of a MakerBot*

The MakerBot Cupcake CNC, Thing-O-Matic, and Replicator Series

MakerBot Industries has just announced its fourth generation desktop 3D printer, the MakerBot Replicator 2. This printer is a PLA-only printer and can make things that are 11.2 x 6 x 6.1 inches in size. That's big enough to make a good sized shoe!

MakerBot launched their company with the Cupcake CNC in 2009 which made things that were about 4x4x4 inches and then in 2010 they launched the MakerBot Thing-O-Matic which could make things approximately 5x5x5 inches. In 2012, the MakerBot Replicator was released with the option of having two nozzles so you can make things in two colors. It can make things that are about 6x6x9 inches or roughly the size of a loaf of bread.

MakerBot Plastics: ABS and PLA

ABS (Acrylonitrile Butadiene Styrene) is the same thermoplastic that Legos are made of. It starts to soften around 105° C. It's the "classic" plastic. If you look around your house, you'll find lots of products made from ABS, including kids' toys, sports equipment, and even things like Big Wheels. Most of the interior of cars is made from ABS these days, too. ABS is a wonderful material and when it's in its goo-like state it flows easily through the extruder's nozzle, which makes it perfect for injection molding and 3D printing.

PLA stands for polylactic acid and is made from plant starches, usually corn in the USA and potatoes in Europe. Because it's made from biological materials rather than petroleum, it can decompose in a suitable compost bin or facility, which makes it a more environmentally friendly plastic. It also smells like waffles when you make things with it. PLA melts at a slightly higher temperature than ABS, around 150° C.

The MakerBot Replicator 2 is designed to print in PLA only, but older models (the original Replicator, Thing-O-Matic, and Cupcake CNC) can handle ABS well.

What Can a MakerBot Make?

With a MakerBot, you can make anything. While there is a limitation on the size of things that you can make, if you want to make something bigger than the build volume, you can make it in multiple parts and glue them together.

> I find there to be a number of parallels between using a MakerBot desktop 3D printer and one of my other hobbies, origami. A few years ago, Robert Lang, an engineer and modern origami designer, presented a complete algorithm that solves for an origami base that can have any number of desired flaps of any length, that could be then folded into anything from a single square of paper. In essence, Mr. Lang's research has demonstrated that a sophisticated origami folder could fold absolutely anything from just one single sufficiently large square of paper.
>
> A MakerBot provides an operator with an extra dimension beyond a simple two-dimensional sheet of paper, while removing the skill requirement from the equation. You can make a complicated plastic structure with a MakerBot just as quickly and easily as you can a solid cube—using the same volume of plastic.
>
> It stands to reason that if anything is possible in a single sheet of square paper, at least that much is possible with a machine that can build things in three dimensions.
>
> — MakerBlock

How Did MakerBot begin?

In 2007 Bre Pettis and Zach Smith helped organize the NYC Resistor hackerspace in Brooklyn, NY to create a place for hackers, makers, and like-minded tinkerers. Armed with a great space and a shopful of tools, it wasn't long before the two friends got involved with the open-source RepRap project.

A RepRap is a self-replicating machine. The RepRap Project is an open source community project intended to spread the idea of home manufacturing to the masses. It was among the first home 3D printers. It's a machine that's designed from as many off-the-shelf parts as possible. And it's also designed to make parts to make more of itself. This may boggle the mind and conjure images from Terminator movies, but the fact is, these robots are cute and thankfully, they don't have artificial intelligence.

It took a lot of trial and error to get their RepRap to work for even a few minutes. They thought they could design a machine that is more reliable and wouldn't just be focused on making parts for more 3D printers, but that could make anything.

In January of 2009 Adam Mayer, a programmer and another member of NYC Resistor got involved in the project. The trio quit their jobs, acquired the domain name "makerbot.com" and Makerbot was born. They started prototyping a machine using mainly off the shelf parts and the tools they had at hand, including NYC Resistor's 35 watt laser cutter.

In those early months, they worked at NYC Resistor and often stayed up for days at a time, creating prototype after prototype. After many late ramen- and caffeine-fueled nights, their first machine, the "Cupcake CNC" came to life. They wanted to launch at SXSW, and got the first prototype actually working at 8am on March 9, 2009 just two hours before their flight. With their "trusty" prototype, they printed dodecahedron-shaped shotglasses at various bars around Austin for as many geeks as possible. It wasn't long before the orders for CupCake kits started rolling in.

2/The House That MakerBot Built

In which this universal tool grants new eyes to see your world, the power to make almost anything, and the ability to solve problems that couldn't be solved before.

When you have a Makerbot, you start looking at things—and if you want them, you think about making them with your MakerBot instead of buying them. When things break, you could start stressing out about where you'll find a replacement part, but when you have a MakerBot, you start thinking about how you can make your own part to fix it.

In our consumer-focused, disposable world, a MakerBot is a revitalizing force for all your broken things. Having a MakerBot allows you to make things instead of buying them—and in a consumer-focused world, that's a super power worthy of a superhero!

Besides fixing things and creating them from scratch, you can invent new things and develop alternative solutions to problems. With the cost of filament so low, the cost of failure is low and that means that it's not going to cost you very much to try out an idea; if it doesn't work, you can adjust the design and try it again and again. This ability to iterate is a powerful force in the universe and it makes you unstoppable. So many people try something and if it doesn't work, they give up. With the ability to iterate and make things over and over again, you can become an unstoppable force of iteration and invention—and you'll try and try again.

While the replicating possibilities for a MakerBot are infinite, the most common kinds of uses seem to fall into just a few categories:

MakerBots can be used to create a permanent drop-in replacement for broken, missing, or worn out parts

These kinds of fixes actually save things from filling up landfills. Often, just being able to create a part in your home saves more time and money than would be consumed by driving to the hardware store to purchase it. Being able to create a direct replacement part allows for a permanent fix that might otherwise be "MacGyvered" to into working condition with duct tape, zip ties, or super glue. While duct tape, zip ties, and super glue will forever be perfectly acceptable ways to fix things, they are all temporary and potentially unsightly hacks. For example, if the knob on your stove breaks, it may prove impossible to get a replacement, but it's easy to MakerBot a new knob and keep your stove instead of having to throw it out because you can't buy a knob. (You probably wouldn't do that; you'd get some duct tape or attach a pair of vise grips to the metal rod, but you get the idea.)

MakerBots can be used to customize or add functionality to existing objects

Some designers have thought of ways to use their MakerBots to repurpose disposable products into newly functional objects. For example, consider the bottle watering cap (*http://www.thingiverse.com/thing:9535*). With it, you can turn a disposable bottle into a watering can. The hockey stick pen cap (*http://www.thingiverse.com/thing:13052*) lets you turn an ordinary writing instrument into a miniature piece of sports equipment.

The "Nickel for Scale" project (*http://nickelforscale.com/*) lets you take a photo of something you want to attach a replicatable object to (with a nickel in the photo for scale), and adjusts the size so it will fit.

Inventing Your Own Things

This is where the infinite possibilities begin. We'll talk about this in the next section.

Make a Better Mousetrap: Inventing Things with a MakerBot

MakerBots can be used to invent things! By creating something entirely new to the universe that has never existed outside your imagination, you'll get the rush of being an inventor.

When you have a MakerBot you can make things in minutes that may take other people weeks to make. Need a bottle opener but the store is closed? No problem, download the model from Thingiverse and print it out. You can modify it to have your name on it, change the shape to look cooler to you, or think up some other way to improve it or customize it. Nobody with a MakerBot will ever have to buy a bottle opener again!

No, Really, Make a Better Mousetrap

Building a better mousetrap is a classic story of innovation. Cathal Garvey had a problem: he had a mouse living with him in his home in Ireland. He'd just gotten 5 fresh pounds of ABS plastic for his MakerBot and he wanted to find a way to catch the mouse without killing it. He made a blog post (*http://blog.makerbot.com/2010/03/01/cathal-garveys-mousetrap-design-challenge/*) that quickly made its way around the Internet with a request to follow the age old tradition of building a better mousetrap. His criteria was that the mousetrap had to be a "live" trap so that the mouse wouldn't be killed.

Within a day, there were 9 designs on Thingiverse tagged "mousetrap" and within a few weeks, more were added. Whose freshly invented mousetrap would meet the challenge?

Thingiverse user 2RobotGuy came up with a solution that used the power of gravity to spring the trap and keep the mouse in a bent tube that looked like a bent toilet paper tube with caps on the ends (see *http://blog.makerbot.com/2010/03/24/youtube-tilt-n-trap-first-working-3d-printed-mousetrap/2/*), shown in Figure 2-1. In captivity, he shows undeniable video footage of catching a mouse in his trap: *http://youtu.be/7E8CZd66ILI*.

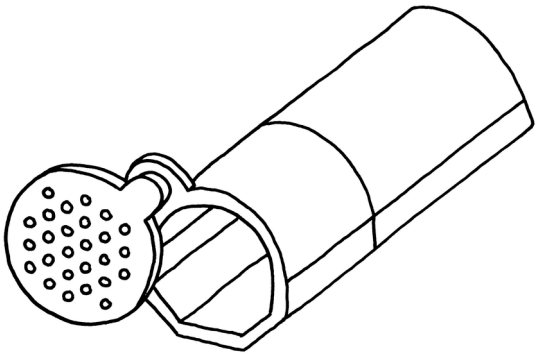

Figure 2-1. *Mouse vs. MakerBot*

With This Thing, I Thee...

Sometimes you need something special (Figure 2-2) for a special someone and there isn't time to go shopping, buy something, or have something made for you.

This happened to Thingiverse user Fynflood (see *http://www.makerbot.com/blog/2009/10/06/makerbot-love/*). It was Friday and Fynflood was leaving with his sweetheart to go to Iceland the next day and he had just realized that Iceland would be the perfect time and place to propose. With just hours to spare, he went to Hive 76, his local hackerspace, where they had just set up a MakerBot. At Hive 76, Fynflood got some help to model a ring and he made it. In Iceland, he gave her the box and she opened it up, saw the ring and said "yes!"

And that's not all. There are more stories—from *http://www.makerbot.com/blog/2011/08/08/makerbotted-engagement-rings/*.

Astera Schneeweisz was ready to propose to her sweetheart. Here's her story:

> I talked Marius into remotely making two rings for me just in time to propose to Joernchen on July 15th. Well... he said *yes!* `\o/` And he's wearing the ring all day, though he actually never liked rings at all. ABS is just awesome for engagement rings!

Robert Carlsen also made the leap:

> Kara doesn't wear much jewelry and we don't support the diamond trade. I still wanted to give her a personal, meaningful symbol of the engagement.
>
> I had heard of other folks making rings (even an engagement ring) on Thingiverse – I'm not pretending to be incredibly original with this. However, I did design Kara's ring with CAD software (open source of course – QCad / OpenSCAD) and replicated it on my MakerBot Cupcake #2943. I wasn't sure of her ring size, so I made several sizes of the band in black ABS plastic. The "stone" was made separately in orange ABS and glued into the setting. I also made a threaded box available on Thingiverse and scaled to just fit the ring.
>
> For the actual proposal, Kara had never seen the Pacific Ocean, but had grown up spending summers in Ocean City, NJ. We've also spent a lot of time at the shore together. After dating for a decade, standing ankle deep in the ocean with Haystack Rock in the background, it felt right to propose at that moment – she accepted and I presented her the box with the ring – which she loves....and here we are `:-)`

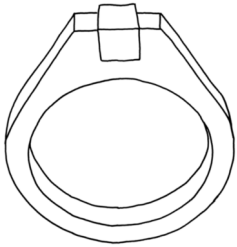

Figure 2-2. *A printed ring*

MakerBot in the Bathroom

Sometimes buying a replacement part just isn't good enough. The store may not pick up the phone, have what you need in stock, or maybe not even have enough of just one item. In many cases, the cost of just driving to the store for parts might be more expensive than the parts themselves. That's where this story begins; with a man in desperate need of a shower.

At *http://www.thingiverse.com/thing:3465*, Marty writes:

> It's a story that can happen to anyone. You move to a new town and leave your shower curtain behind. 'No problem,' you think, 'I'll just pick up a new liner at the pharmacy down the street.' So, you trek to the local pharmacy and find the shower curtain liner you were looking for, only to discover that they are out of rings, hooks, or anything made for holding up a shower curtain! Facing down defeat and the very real possibility that you will have to take a dirty, inefficient bath, you come to a stunning realization: You're a MakerBot owner. You live for these moments.

Marty quickly drafted a design (Figure 2-3) in OpenSCAD and replicated enough shower curtain rings to ensure a trouble free shower experience.

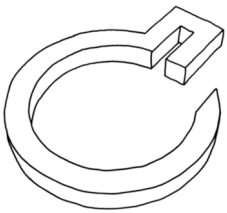

Figure 2-3. *Marty's curtain rings*

At MakerBot, we couldn't be happier to help you make the world a cleaner place. If you happen to be moving to a new place, you may be surprised at the things already available on Thingiverse for improving your new home.

MakerBot in the Kitchen

Once you have a MakerBot, you may find yourself looking at the world through "MakerBot goggles." Everything you look at gets analyzed for overhangs to see if will fit inside the build envelope of the MakerBot, could be replicated in parts, or how it could be made more awesome. From then on, you can add it to your mental file under "never have to buy one of those again!"

> Sometimes it's not even possible to obtain a replacement part. You can't find replacement latches for the single-pane windows in my 1970s home. No one makes them, no one carries them. Before owning a MakerBot, my options were to live without latches, cobble together something ugly, or just replace the entire window. Not surprisingly, the options of "living with it," "an ugly fix," or "replacing the whole thing" are rarely conducive to marital bliss. Fortunately for me, the best option of "making a new part" dovetailed quite nicely with my desire to buy a MakerBot.
>
> The first few days of owning a MakerBot involved me asking for lists of things I could fix, running around the house measuring things, designing parts, and then replicating and installing them as quickly as I could. The most fun part of this process was being able to measure and design parts as my MakerBot hummed in the background replicating little household fixes.
>
> — MakerBlock

Thingiverse user Zaggo needed to fix a light in his kitchen. The light was under his cabinets and over his counter and was attached with a bracket that had broken. He was able to design a new part in 15 minutes, replicate it in 20 minutes, and had his light fixed in just under an hour (*http://www.thingiverse.com/thing:995*). His bracket is shown in Figure 2-4.

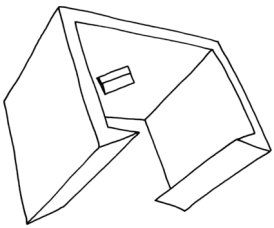

Figure 2-4. *Zaggo's light bracket*

Here's how PolygonPusher found a way to hang pots and pans:

> In this project I build a set of shelves for hanging pots and pans in my kitchen. For that, I needed 27 hooks. In my local hardware store I did not find any suitable hooks so I decided to design and make my own! :-) This also saved me some money since a simple hook in the store costs $4 a piece, making the total $108!" (*http://www.thingiverse.com/thing:11882*)

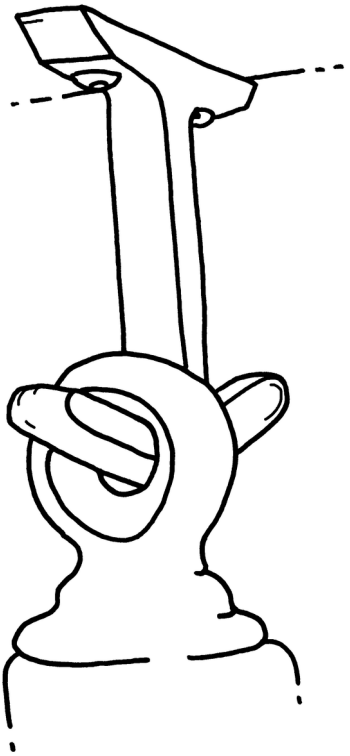

Figure 2-5. *PolygonPusher's hooks*

Close the Door/Open the Door

We spend so much time in our homes that it is just a shame when we have to put up with something that's broken. A broken mini-blind pull might seem like a small thing until you realize that you're interacting with it several times a day. For a MakerBot Operator, gone are the days when one almost imperceptibly small part will render a toy, tool, furniture, or even a vehicle useless. While there is a sense of joy and pride for any do-it-yourself-er (DIYer) when they fix something, being able to design (or upgrade!) a replacement and replicate a part means you can have a cosmetically pleasing and sturdy repair.

SideLong needed to keep the door frame to his home from shifting around, so he turned to his MakerBot to make something (*http://www.thingiverse.com/thing:10722*) to keep the door from getting jammed:

> My house is built on shifting sand and is continually oscillating between Brunswick and Coburg (in Melbourne, Aust) with the direction of travel depending on the weather. This means that my front door frame has a disconcerting habit of moving and getting stuck; really stuck! It's very frustrating to get home and find that I can't get in, because the door has moved and the lock tongue is jammed into the frame. So before I managed to destroy all the screwdrivers/bike levers in the house I designed this small thing, which I call the Door UnJam (Figure 2-6), to do exactly that.

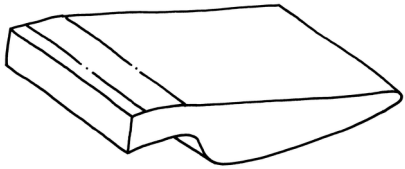

Figure 2-6. *SideLong's Door UnJam*

Tetnum and his fellow dorm residents had a common problem: none of the doorstops they purchase worked to keep doors open:

> In the dorms we have industrial carpet on the floors and all commercial doorstops people have or bought slid, were too short or failed. So I turned to Thingiverse and printed every door stop available were either

> destroyed by the door closers or did not work. So I designed a "saw-like" door stop that was taller and did not have any large openings to get crushed. Instead, it has columns to direct the force to the carpet and grip tighter. I also incorporated the school's logo into the door stop.
>
> My MakerBot Cupcake has been running nonstop to make enough for my floor. The doorstops have been in use for 4 weeks and are all holding up." (*http://www.thingiverse.com/thing:11566*)

This doorstop is a must-have dorm essential for any incoming college freshman. It's thin and can be stowed away anywhere in a small dorm room, useful for keeping the door open or from letting it swing open accidentally, and personalized for their college. In a dorm room where space is at an absolute premium, it makes sense to have a desktop 3D printer where you can create objects on demand, rather than have to stock up on things in advance. Rock on Tetnum!

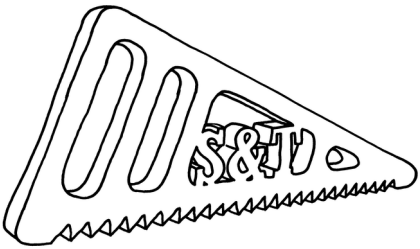

Figure 2-7. *Tetnum's Doorstop*

Project Shellter

Hermit crabs don't make their own shells. They scavenge their homes: in the wild their main source of homes is from deceased snails. When the snail dies, the hermit crab moves into the shell. MakerBot Industries, in partnership with Miles Lightwood, AKA TeamTeamUSA, created Project Shellter, a worldwide crowdsourced project to make replicated shells for pet hermit crabs.

The idea behind Project Shellter is that a community—MakerBot Operators and members of Thingiverse—can reach out across species lines and offer their digital design skills and 3D printing capabilities and give hermit crabs another option: custom replicated shells (see Figure 2-8).

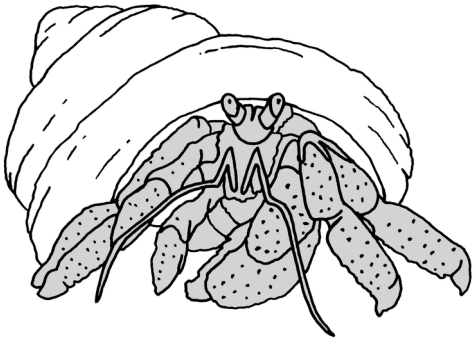

Figure 2-8. *Project Shellter*

To test the shell switching process of examination, switching, and adoption, MakerBot Industries partnered with hermit crab researcher Dr. Katherine V. Bulinski. They set up a crab habitat to test the hermit crab shell switching behavior and to see if the crabs would take to the replicated shells.

MakerBot requested that Thingiverse users design and post a shell that hermit crabs could try out. As the shells are created, they were replicated at the Botcave and placed in the crabitats.

As of spring of 2012, three hermit crabs have moved into MakerBotted shells, but this is just the beginning. Will they prefer one color over another? If you

have hermit crabs and a MakerBot and want to contribute to this crowd-sourced science project, you're invited to participate in the project! Read more at *http://www.makerbot.com/blog/2011/10/18/project-shellter-can-the-makerbot-community-save-hermit-crabs/*

Your MakerBot-Enabled Closeup

Photographers are some of the most avid MakerBotters. Being into photography almost assures that you're a gear hound and collect equipment to give yourself more options in the studio or in the field. From replacement lens caps to smartphone holders to tripod mounts, your MakerBot can replicate almost any accessory you, or a photographer you care about, desires.

In addition, a MakerBot can help you solve many common camera related problems. If you need to mount your camera to something else, you can replicate a connector plate. If you lost or broke a small (possibly expensive) plastic part, MakerBot a new one. If you need a hard to find part or you have a problem for which there is no current commercial solution, put on your inventor's hat and create the photographic tools of your imagination.

What may stand as the most famous example of a MakerBot-enabled invention is the POPA (formerly known as Red Pop), a holder and camera-like button for the iPhone: *http://everythingbeep.com/products/popa*. One of the earliest versions of this device was prototyped on a MakerBot before it went into full production. However, a MakerBot isn't just for creating prototypes. It can actually be used for small scale custom manufacturing. Brendan Dawes, one of the folks behind the POPA has a blog where he documents all of the things that he replicates on his MakerBot: *http://everythingimakewithmymakerbot.com*.

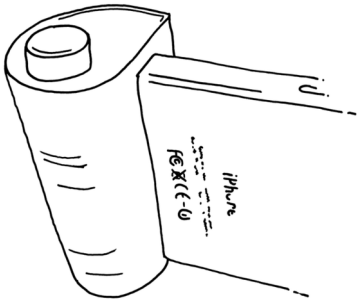

Figure 2-9. *POPA*

If you're a photography enthusiast, you've probably experienced many times when you have needed to mount your camera a specific item for a specific purpose. How often did you find yourself wishing that you could find your lost tripod mount? In this situation, a MakerBot is your best friend. There are currently dozens of tripod things posted on Thingiverse with more being added every day. That lost tripod insert, plate, or quick release can be replaced quickly, cheaply and easily.

Sometimes the standard tripod solution is not the right tool for desktop photography. jman needed a way to hold a camera in a stable position for photographing small items. His desktop tripod was not working well, so he designed a gantry solution derived from a traveling crane (*http://www.thingiverse.com/thing:11648*), shown in Figure 2-10. The camera can be held at a wide variety of orientations and heights, and then easily locked in place by tightening the knobs at either end and the it collapses down flat for easy storage.

Perhaps you need a simple mount for your point and shoot camera for self-portraits? Thingiverse user juniortan created a highly portable monopod (Figure 2-11) with a 360 degree swivel ball joint that can be mounted onto the tip of most drink bottles: *http://www.thingiverse.com/thing:2631*.

Replacing Lost, Broken or Unique Plastic Camera Parts

Your Makerbot is handy for solving almost any camera related part issue. MakerBot excels at reproducing lost or broken parts for camera mounted accessories, lens hoods and lens caps.

Many cameras have a "hot shoe" mount where a flash unit can be attached. Usually, these cameras will have a small, easy to lose piece of plastic that slides into the hot shoe connector to protect the electrical connections and keep them from getting dirty. Both antijon and TheCase have created downloadable hot shoe covers or you can easily create your own and then, print and replace using a MakerBot.

Another camera item that is easily lost is the lens cap. But thanks to madebydan, caps for Nikon lenses can be easily replaced! (see *http://www.thingiverse.com/thing:3328*) Another solution for the lost lens cap is to make sure that it never gets lost in the first place. The parametric Camera Lens Cap Holder by kitlaan at *http://www.thingiverse.com/thing:9860* attaches to your camera strap and makes it easier to keep track of your lens cap.

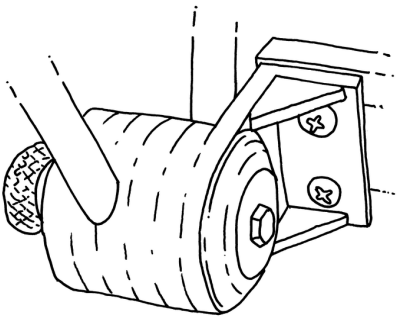

Figure 2-10. *jman's camera gantry*

Figure 2-11. *juniortan's monopod*

When you have a unique camera or old camera and the part you need is extremely difficult to find, then having a MakerBot can save the day. langfordw's brother had an old Yashica camera, which were produced from 1957-73 by the Yashica Co., Ltd. in Japan, and parts are difficult to find. His brother wanted a lens hood for the Yashica—something that would twist and lock onto three flanges and required fine detail (see Figure 2-12). From *http://www.thingiverse.com/thing:685*:

For me what was so awesome was that the Makerbot allowed a very natural and intuitive design process/flow. I quickly mocked up a rough design and replicated it. This allowed me to see where problems were going to come up. I thickened it in areas and adjusted some dimensions and printed another. I went through another two iterations to finally come to the perfect design. This all happened within five hours of my brother even suggesting the idea while still having time to watch a full movie and eat dinner.

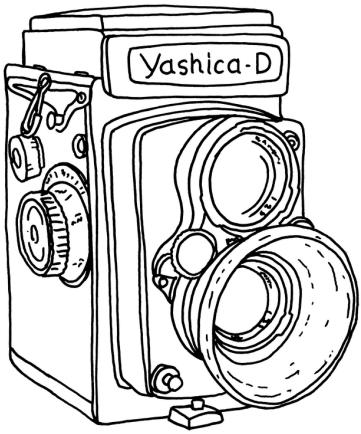

Figure 2-12. *Yashica-D with lens hood*

Bounce Back From a Bear Attack

This book has explored many uses for a MakerBot desktop 3D printer, but perhaps the most unusual was provided to us by 1oldclown. He had posted a 3D file and images of a bright yellow plastic side mirror bolted to the side of a VW Westfalia camper bus on Thingiverse (*http://www.thingiverse.com/thing:13071*) with the following intriguing description, "After the bear stripped the mirrors of my 85′ bus, trying to get in".

A bear attacking your vehicle is easily in the top 10 reasons for needing to print things on a MakerBot. We asked 1oldclown to provide us the details of his experience and how his MakerBot helped him to restore his vehicle after the bear attack (see Figure 2-13).

I live in Idaho. Not many people, lots of room for critters. It had been a tough year on the bears. A late summer meant not many berries and so the local black bears are hungry and bolder than usual. My gal and I were hiking in the local mountains. We parked my Westfalia full camper van a few miles off the main road and left for a few hour's hike.

When we returned to the camper it looked trashed. It was covered in mud, the lights were on, the wipers were pointing at the ground and the driver's side mirror was gone. There were streaks of mud from eye level down all around and roof vent was ripped open. Things inside were a mess. The cover for the speedo was off and seats were torn.

Then I saw the Poop. It was in the corner of the back seat and about the size of a dinner plate, sitting on this week's New Yorker magazine. I took this as a bear's political statement: "This is Idaho - not New Yorker country!" Although there was quite a bit of damage, it's hard to be angry at a hungry bear. Luckily, there was no food in the camper, so the bear pawed around looking for a way out, hence all the upholstery damage.

However, it is hard to drive a big camper van without a mirror. Luckily, I have a MakerBot! I drew one, replicated it during breakfast, bolted it on the original mount and voila'! The van is road worthy again!

Now, if only I could replicate fresh upholstery.

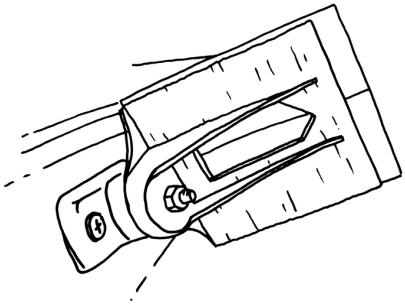

Figure 2-13. *1oldclown's mirror*

Moving Physical Objects into the Thingiverse

The masterworks of three-dimensional art are joining the digital commons. For art lovers, this technological moment represents a tremendous opportunity. *http://bloom.bg/LIvH9C*

— Virginia Postrel
Bloomberg View

In June 2012, the Metropolitan Museum of Art and MakerBot joined forces to make statues, sculptures, and other three dimensional artworks from the museum's collection available for anyone in the world to access virtually on Thingiverse. These models are all printable, and look great on the Replicator. (for more information, see *http://www.makerbot.com/blog/tag/met-makerbot-hackathon/*).

To create these scans, a group of artists, hackers, and educators from the MakerBot Community traveled thousands of miles for a two-day hackathon. The group toured the galleries of New York's landmark museum to capture works of art using cameras and Autodesk's free 123D Catch scanning software (see "123D Catch" (page 136)), establishing a novel approach to creating a public archive.

In keeping with the Museum's commitment to share its collection with the public, people can now examine artwork digitally online, or in person by reproducing the artwork on a MakerBot. Teachers can bring history straight into the classroom. Artists can modify, remix and re-imagine classics once set in stone.

When Bre was walking around capturing things in the museum, a guard pulled him aside and told him to be sure to get a model of a guardian lion (see *http://www.thingiverse.com/thing:24047*). The guard pointed out that it sits at about hand height, which means kids might eventually rub the nose right off of it. With the digital 3D version, we will always know what that nose looked like!

The Met MakerBot Hackathon is only the first chapter in MakerBot's effort to bring art back to life. MakerBot's asked others to join in with the "Capture Your Town" project.

The company has issued a challenge to its community: Capture Your Town! People all around the world have been using the same simple process and freely available tools to scan artwork, buildings, people, and things in 3D and share them in the Thingiverse. You can see the collection as it grows by checking out the `futuremuseum` tag on Thingiverse: *http://www.thingiverse.com/tag:futuremuseum*. If you scan a piece of your town, be sure to tag it on Thingiverse with the `futuremuseum` tag.

What Will You Make?

At its core, a MakerBot lets you make things. The cost of materials is so low that if the first result is not quite right, you can make it again. This is simple but very powerful. So many people get hung up in life when they meet with failure. Having a MakerBot means that you have access to a machine that will let you face challenges in the real world and fail as many times as it takes until you create a solution that satisfies you.

These stories of MakerBots solving problems and inventing things aren't reserved for people who aren't you. Once you start seeing the world through the new eyes of a MakerBot Operator, it won't be long until you'll invent something or solve a problem. Then you can share your invention on Thingiverse and share it with the world and solve that problem for everyone else.