

Session 7

From Revit to 3D Print in 75 minutes and under a grand!

Paul F. Aubin: www.paulaubin.com

Class Description

3D Printing has been around for years. But until recently you had to have access to very pricy equipment in educational institutions or large corporations. But with the advent of many consumer and prosumer level machines priced around \$1000, 3D printing is poised to become mainstream. Add to this the ability to create 3D printer ready models directly from the software you use every day, and 3D printing is more accessible than ever! In this session, I will showcase a small 3D printer that you can purchase as a kit, assemble yourself and with free software, begin creating 3D printed models at home or in your office. We'll discuss the machine (which I will have physically on premises), building the model in Revit and the accompanying considerations, and then show the print actually being made as well as a series of finished products.

About the Speaker:

Paul F. Aubin is the author of many Revit book titles including the widely acclaimed: *The Aubin Academy Mastering Series*, his all new *Renaissance Revit* and Revit video training at www.lynda.com/paulaubin. Paul is an independent architectural consultant providing Revit® Architecture implementation, training, and support services. Paul's involvement in the architectural profession spans over 20 years, with experience in design, production, CAD management, mentoring, coaching and training. He is an active member of the Autodesk user community, an Expert Elite and is a high-rated repeat speaker at Autodesk University, Revit Technology Conference and the BIM Workshops. His diverse experience in architectural firms, as a CAD manager, and as an educator gives his writing and his classroom instruction a fresh and credible focus. Paul is an associate member of the American Institute of Architects. He lives right here in Chicago with his wife and three children.





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Introduction

As I write this my 3D printer is humming and chirping its way through yet another “additive manufacturing” masterpiece. There are many 3D printing technologies out there and I make no claims to be expert in all (or even really any) of them. This paper and course was conceived from a simple idea: I learned that the price of 3D printers has come down significantly and I wanted to see how successful I could be creating 3D prints directly from Revit. So the main thrust of this paper will be the process I followed to get 3D prints from Revit models. I will discuss other items as appropriate, but this is the main goal.

Opportunities and Disclosure

Revit Technology Conference is in the Chicago area this year. I just happen to live in the Chicago area, so this presented a unique opportunity for me in this class. Since I did not have to fly to attend the conference, I am bringing my 3D printer and several 3D printed models with me to class. This would not be practical if I were not driving to the class. So this unique opportunity also informed the nature of the class.

Finally, the “disclosure” is really just to say that not all of the model I will have on hand in the class were created by me in Revit. So while the title of the course and focus of the class is on models created and printed with Revit, I have found many wonderful models to print on www.Thingiverse.com. You should definitely check it out. Now let's get to it.

The Hardware

I assume that most of you have heard of Makerbot. They are perhaps the most popular 3D printer manufacturer on the market. They make great machines in a variety of price ranges and I certainly have my eye on their new product line when I am ready to upgrade:





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INTRODUCING
DESKTOP 3.1.1
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The newest Makerbot line of 3D Printers

As awesome as these devices are, this is not the device I will have onsite at RTC nor do I currently own one. Instead I have a device by a company called Printrbot. (Yes there is no "e" and that is spelled correctly).

Printrbot makes the most affordable 3D printer on the market. They have several devices in their product line in a range of features and price points. But if you want the absolute cheapest entry point into the world of desktop 3D printing, then you want the **Printrbot Simple**. This is the device that I have purchased and will have onsite at RTC.

You can learn all about the Simple and the other Printrbot devices at:
www.printrbot.com





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\$349.00 \$1,299.00 (Assembled) \$599.00 (Assembled) \$1,699.00-\$1,999.00 \$20.00

Printbot has a range of devices for any budget

The Simple is awesome for reasons other than price. It is a very compact little device that is capable of high quality prints as you will see here today. But what really got my “geek on” about the Simple is you can buy it as a kit! So let me get this straight, I can buy a 3D printer for \$350 and I can build it myself? Awesome. Now if building it yourself is not for you, they also sell it assembled. It will cost more, but you can start printing that much sooner.

Hardware Cost

In the title of this course, I say “under a grand”. Well with the Simple kit it is significantly under a grand. The kit I bought was \$300. It now costs \$350, but this includes aluminium upgrades that I actually purchased, so I ended spending the same \$350 for my current build. I have purchased





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some other replacement parts and a new upgrade kit as well. But with all of this, my total cost is still under \$500.

Filament

I have actually spent almost this much on filament at this point. So just like 2D printers, your consumables need to be factored into total cost. The two places I buy filament are directly from Printbot at about \$35 for a reel. This is very economical, but you are locked into one color for a LONG time.

The other option is more expensive, but gives much more variety. That is to use: <http://www.faberdashery.co.uk/>. They sell filament by the meter. You can buy 1 or 100. It is about \$0.50 a meter. So it is more costly. But they have lots of colors including glow in the dark—cool!

Tools and Supplies

Other tools and supplies that will be necessary are some basic tools like screwdrivers, a wrench and especially a good pair of needle nose pliers. I also always have an exacto knife on hand as well as simple razor blade.

Blue Painter's tape is also a must. You cover the print bed with this and it helps the filament adhere. If you do not get good adhesion on your first layer, your print will be ruined.

It is also nice to have a hot glue gun, digital callipers, sandpaper and/or a Dremel, some nippers, allen wrenches and a nice fine bladed flat screwdriver.

The First Print

I will not go into all of the details of building the kit since it is well documented on the Printbot website and you may not choose the kit option and opt instead for a pre-assembled unit. However I will say that assembly was fairly straightforward and took an afternoon to complete.

Once I had the machine built, I was anxious to dive in, so naturally I took my most complex Revit model and sent it to the printer. Not surprisingly the results were less than stellar:





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My first print—boy did I have a lot to learn...

So the first thing I learned about was “Supports”. (I’ll get to the details later). But as you can see, it is tough to print in mid-air. So supports provide temporary support structures that get printed with your model to support overhanging features like the leaves of a Corinthian capital.

But I’m getting ahead of the game here. Let’s back up and be a bit more systematic.

Optimizing Hardware

I want to make a few more points on the hardware before I move on to models and printing. Naturally each device is a little different and will have its own quirks. So these issues may or may not be important to you if you are using a different device. So please take with a grain of salt.

Filament Loading

I have no idea if this is universal, but I have found that I get much better results if I feed the filament from above the unit. I have tried it in a homemade apparatus mounted parallel to the unit and sitting loose on

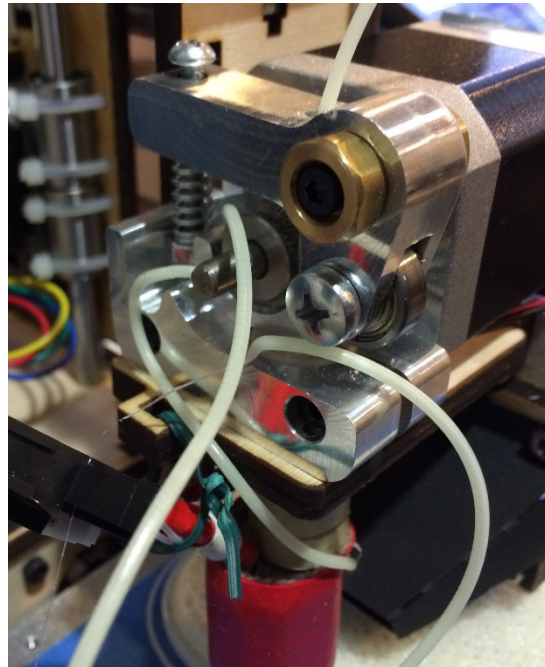
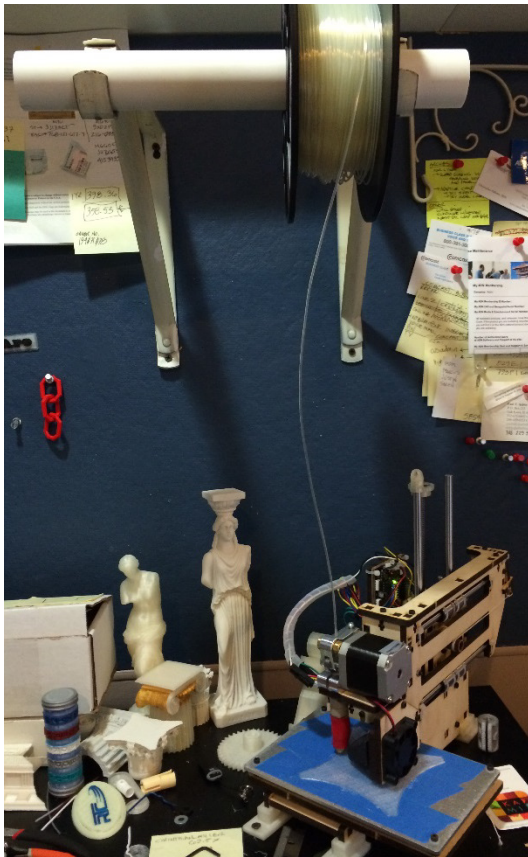




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the floor. In both cases, tangles and jams seem more common than when feeding from a spool above the printer.



Feed filament from above for best results and to help avoid jams

Another really fascinating (and potentially troubling) is that you can use your printer to print parts for your printer... (Anyone see Terminator recently...) I have printed a few things which help improve my printing experience. The most useful one is some feet to keep the printer stationary. These are screwed down to the tabletop that I have the printer sitting on and then the printer is held securely in the feet (you can see a picture below in the image in the "Poor Adhesion" topic). Before doing this, my printer would sometimes "walk" right to the edge of the table. Not good if you don't happen to be in the room when this occurs. I have also printed filament guides, couplers and a Z axis knob to manually adjust the Z axis height. This is very helpful on the crucial first layer.





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Levelling the Bed and Calibration

The Simple is so-called because it is bare-bones and contains no frills. It is "simple." One place this is very apparent is in the use of fishing line and sand paper pulleys to drive the X and Y axes. That's right, fishing line. So you can imagine that it is important to have this tight at all times. I have had times when it slackens and it definitely has an impact on the print quality. There are easy to follow instructions on the website and in the installation guides to calibrate all the axes and motors. This is a critical step. The print bed must also be levelled. This does not necessarily mean "level" as in plumb and level, but rather think of it as perpendicular to the extruder. More expensive devices have mechanisms that do this automatically. But with the Simple, you have to painstakingly adjust four screws at the corners of the bed.¹

If you buy a simple, this post is a must:

<http://www.printrbottalk.com/forum/viewtopic.php?f=105&t=4454>

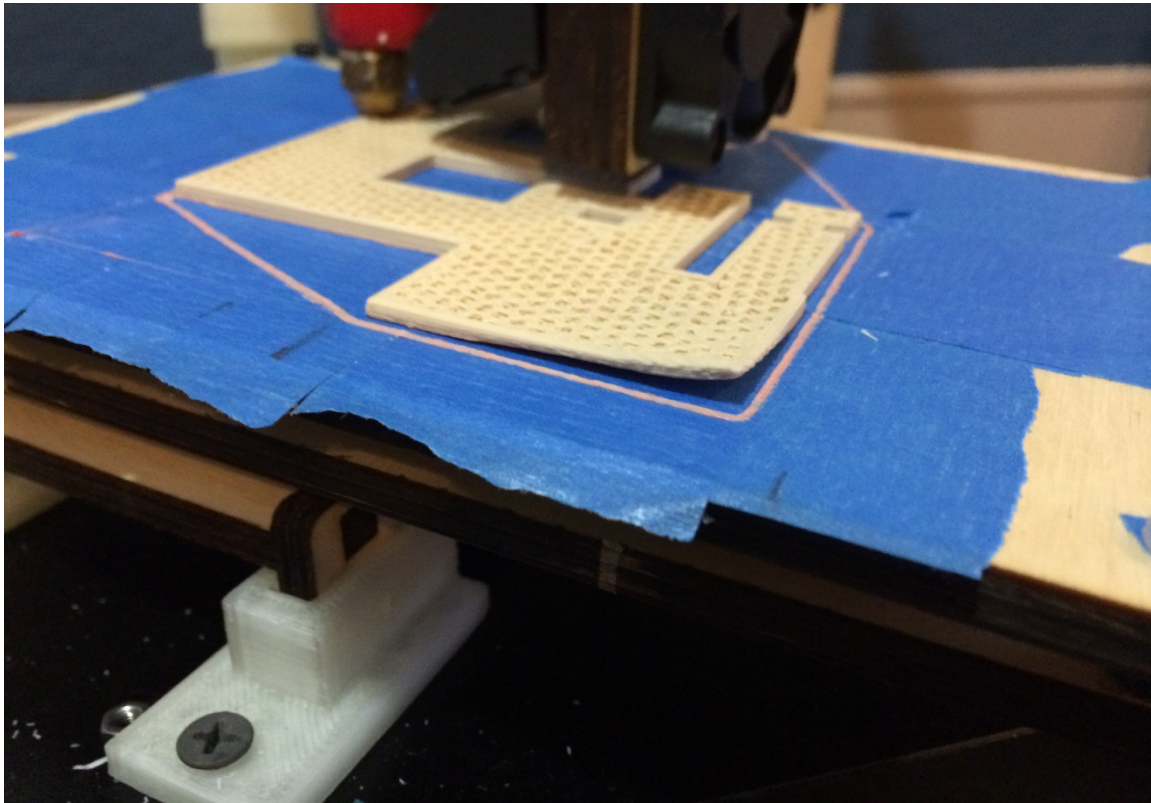
Poor Adhesion

When printed with extruded PLA or ABS plastic filament, the first layer **MUST** adhere to the print bed in order to have a successful print. The most expensive units have heated print beds which help with adhesion. I have tried both the original plywood bed and I now currently use an aluminium bed. I find that the best tool to help with adhesion is the blue painter's tape. I nice smooth layer across the entire bed which gives me good results. (I have also heard that some folks use Kapton tape and even glue sticks. I have not tried either of these, so I have no idea if they are better). A level bed is also critical. So the previous topic helps a lot here.

Sometimes the corners raise up. I have not found a solution to this and usually just let the print finish. It is not ideal as you get a distorted edge, but depending on your schedule it can be preferable to starting over.

¹ There is a new upgrade kit for the Simple which includes belts to replace the fishing line and a self-leveling device. I have purchased this kit, but so far it has not arrived. But I am looking forward to receiving and installing it.





Sometimes a corner won't adhere properly and you get a raised corner

Software

Like so many things on computers, hardware is only the start. Most things happen in software and 3D printing is no exception. What is the exception is that as far as I can tell, almost all 3D printing software is free. So after you build your kit, or install your pre-assembled device, you simply download your software of choice and begin processing 3D models for printing.

There are a few steps. Here is what you generally need:

- **Authoring Software** (Revit, AutoCAD, Meshmixer, other)
- **Other Utilities** (Autodesk Miller, Autodesk 3D Print Utility, etc.)
- **3D Printer driver** (usually provided by the manufacturer, one-time install and setup)
- **3D Printer Interface software** (basically the printer control panel)
- **Slicing Software** (converts a 3D model to 3D printable paths)
- **Finishing** the final output (gluing, painting, etc)





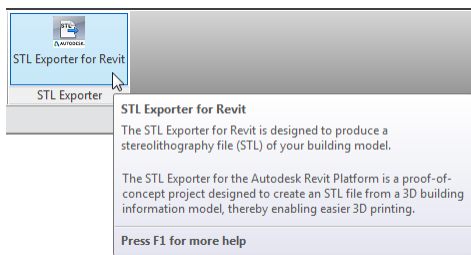
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Authoring Software

You can build your model in almost any 3D software. This being RTC, I'll naturally focus on Revit. 3D Printers usually use 3D files saved in the STL or OBJ formats. Revit does not save these formats natively. However, there is a plugin for Revit on the Exchange Apps store; and it's free! Visit Exchange Apps and search for **STL Exporter**. At the time of this writing, the 2015 version can be found at:

http://apps.exchange.autodesk.com/RVT/en/Detail/Index?id=appstore.exchange.autodesk.com%3astlexporter_windows64%3aen



After install, STL Exporter appears on the Add-Ins tab

This plug-in is about as easy as it comes. Simply open a 3D view in Revit. Make sure to make the view look exactly like what you want to include in your STL. In other words, you can hide anything you don't want to export with either temporary or permanent hide. I usually make a view specifically for exporting to 3D printing and name it accordingly. This makes it easy to go back and export again if necessary.

Next go to the Add-Ins tab and click the STL Exporter button. Most of the time the defaults work fine. But you have options to export as binary or ASCII and choose your preferred unit. Most 3D Printer software lets you scale the imported STL, so just make note of the unit selected to make calculating your scale factor easier. Click Save. That's it.

Watertight Meshes

If you have used 3D software for a while, you are familiar with faces, solids vs surface models and face normal. All of these concepts apply to any 3D software, Revit included. Most of the time, you will get solid models from Revit with correctly oriented surfaces and normals. But not always. So you





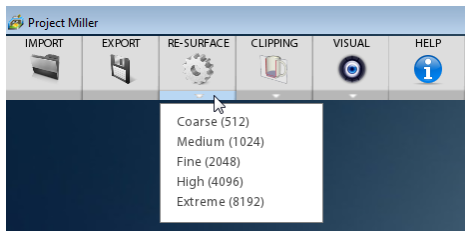
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may need to clean up the model. This can be done in a variety of 3D Printer software packages. I have dabbled a little with Autodesk's Mesh Mixer, but have to say that mastery of this software has alluded me. There is also the 123D series of products from Autodesk. If we look beyond Autodesk, the choices are almost as prevalent as the number of 3D printers out there. Since my goal is to take a Revit model and print it in the fewest number of steps, I have tried to avoid lots of post processing. Instead, I try to perfect my model in Revit, send it out with STL Exporter and then only post process the mesh if the 3D Printer software is unhappy.

To this end, I have gotten very good results with **Autodesk Project Miller**. Project Miller is a technology preview from Autodesk. Like all technology previews, there is no guarantee that it will be promoted to a full-fledged product, but I sure hope it does because I use it all the time. The feature I use most is the Re-Surface feature that allows you to basically shrink-wrap a model with a new skin. This almost always solves any normal orientation issues and gives a nice watertight mesh as a result. You can learn more about Project Miller here:

<https://beta.autodesk.com/callout/?callid=1CCF3BABDF7C49B4A1A043527265EED6>



Re-surface geometry to create a watertight mesh in Project Miller

On occasion I want to fiddle with an STL file. MeshMixer and the other consumer level 3D software can open and edit STL files. But I find the interfaces a little lacking. So I fall back on what I know and what I am comfortable with: Revit and AutoCAD. You cannot import an STL to Revit (at least I have not found an add-in for this yet). There is an add-in for AutoCAD called: **Mesh Import**. It is not free. It costs \$29.99, so it is not too bad. So far, they do not have a 2015 version, so I am using the 2014 version. You can learn more at: <http://www.codedog.com.au/>





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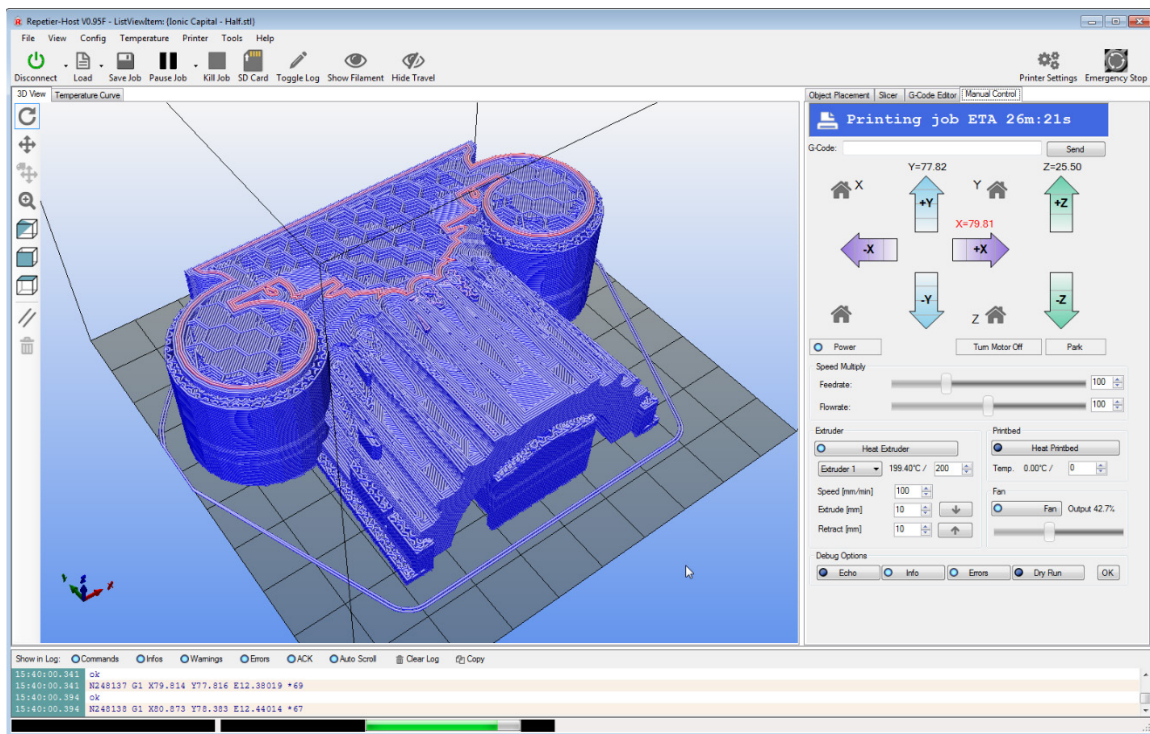
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3D Printer Driver

There is not much to say on this topic. Simply download and install whatever driver software is required by your device. This is a one-time setup and should be straight forward.

3D Printer Interface software

There are many players in this space. For the Printrbot, they rely on free open source tools. The tool I use is called: Repetier-Host. The software opens to a 3D view that has a workspace matching the volume of your printer bed. The Simple can print approximately a 4" cube. It is actually a 100mm cube. When you first install your printer, you will install the software and set this and any other manufacturer required settings. The link above in the "Levelling the Bed and Calibration" topic has excellent instructions on all the first-time setup for the Simple.



Repetier-Host is my primary interface to the Printrbot Simple

Once you have it configured, you use this software to send jobs to the printer. Open the software and click the Connect button. This will establish the connection to the printer. Next you can Load a model. There are four





tabs on the right. The first (Object Placement) deals with loading the models. The second (Slicer) is where you slice your model into layers that the printer will print. This process creates gcode. Gcode is the language that the printer speaks. It is basically a text file containing all of the X,Y & Z movements that the printer needs to make and also instructions on how to feed the filament (the E motor). While I have not mastered gcode, I have learned a few phrases. It is possible to open the G-Code Editor tab and just start typing if that's your thing... The final tab; (Manual Control) allows you to move the printer manually. This is where you go to home the axes, pause the print, manually feed filament, heat the extruder, etc.

This is the process I usually follow in Repetier-Host:

- Launch the software and connect to the printer
- Click on Manual Control and heat the extruder (be sure to click OK, I always forget)
- Feed a little filament to make sure everything is working
- Load a model, optionally scale, rotate and center it as required.
- Click the Slicer tab and slice the model.
- Double-check everything, make sure I have enough filament and click Run.

Always watch the first layer go down. It is really important that you get that good adhesion on the first layer. After that you can do other things or even walk away, but bad things always seem to happen when I walk away, so I always stay close by.

SD Card Printing

It is possible to use an SD Card with the Simple instead of being directly connected to Repetier. This is what I will be doing at RTC during the class so we can use Repetier at the same time. However, the Simple does not have a screen. So you get no feedback while printing this way. I much prefer to print while connected to my PC using Repetier.

Slicing

I am only going to make some general recommendation on slicing. I use Slic3r. This is free open source slicing software. You can use other slicers if





you prefer. I have not tried any others, so I cannot really comment on them or frankly on how good slic3r is since it is the only one I know. You can learn more about Slic3r at: <http://slic3r.org/>

Early on I found a very useful link that gave recommendations on how to configure Repetier and Slic3r for the Printbot Simple. You can find this post here: <http://www.instructables.com/id/How-to-configure-Repetier-V095-settings-for-BEST-P/>

To this day I use these settings as a base for any of my modified setups. Basically the settings I tend to vary are:

Infill—When you print a solid object, it will infill the solid areas with a pattern to save material. The density and shape of the pattern can be adjusted. I tend to use honeycomb the most and vary the density depending on the print. Often I try to get away with a less dense setting about .15-.20 to save material and time.

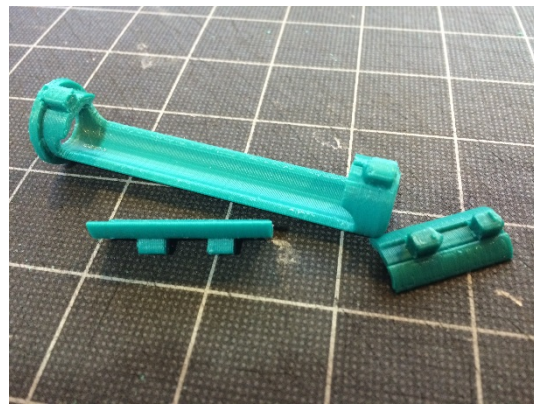
Layer Height—I typically stick with 0.25mm layer height, but sometime will vary to adjust resolution. Smaller layer heights give greater resolution but take longer to print.

Skirt and Brim—The printer will create a loop around the extents of the print before it starts. It is like the printer is marking its territory. What this does is ensure that everything is working before starting the actual part. Since the Simple has a small bed size, I frequently adjust this setting to maximize the space I have for printing. I sometimes use a Distance from object of only 0.25mm for example.

Support Material

I mentioned support material above. This is actually one of the many settings in Slic3r, but I made its own heading because it is one of the more important settings. If you have any overhanging geometry in your model, you have to enable support material to print it. It is like scaffolding for your model. The software will create supports at the same time that it prints the model. It uses a different algorithm to general support material and prints it after each layer is complete to make it easier to break off later. But you have to break it off later. So be careful and choose these settings carefully.





If you don't remove support material carefully, you can ruin your printed part

In general I consider support material at best a necessary evil which sometimes cannot be avoided. Therefore, I always try to figure out a way to print without it. (I will share some examples below). It is not always possible to do this however, so experiment with the settings to find the best compromise between the required support and easy removal.

Finishing

Once you have finished your 3D print, you may be done. But often you will choose to print a model in pieces. This might be required because the model itself is in pieces, or because you have chosen to break it up to optimize some aspect of printing. For example, I often break a model up into pieces to try to avoid support material or to print the overall model larger. Remember your key limiting factor is the print volume of your device. You can't go bigger than this unless you break the model into pieces and print them separately.

So how do you assembly them? That is really up to you. I have had good success with hot glue, crazy glue and friction fitting. Sometimes I just leave them unattached and stacked on top of each other. It depends on the model.

The Simple uses PLA. PLA can be sanded, glued and painted. I have tried all of these. In general, it looks best if you just leave it alone; but this is my opinion of course. If your printer can use ABS, I understand that there are more finishing options. But often they involve smelly and toxic chemicals





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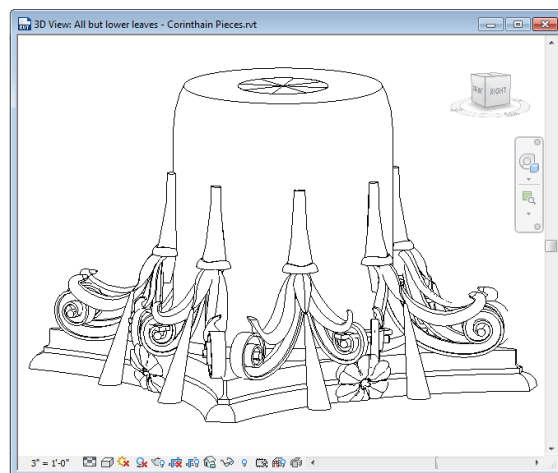
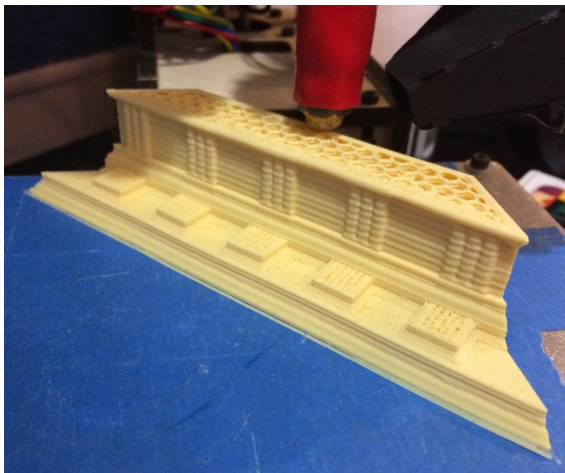
like acetone, so use at your own risk. PLA is easier to work with, non-toxic and biodegradable. So I like it better anyhow.

3D Printing the Classical Orders

I want to leave you with some lessons learned when I tried to print the custom classical families that I built for my book Renaissance Revit. The book takes a deep dive into the Revit family editor and explores in detailed step-by-step tutorials how to create for of the five classical orders of Architecture: Tuscan, Doric, Ionic and Corinthian. Naturally the Corinthian is the most complex of the set. While writing the book, I was not planning to 3D print the models. But once I got the 3D printer, well of course I was going to try. So far I have printed the Doric, Ionic and Corinthian.

General Strategies

As you might expect, the Doric was easiest. With Doric I did both the column and the entablature. To avoid supports, printing it upside down works best. You can rotate in Repetier, or before exporting in Revit.



Often rotating an element will make it print more optimally

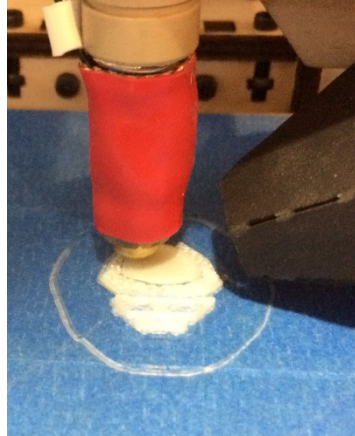
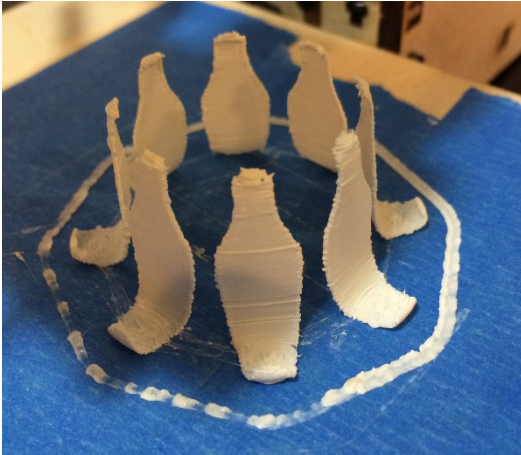
Sometimes you print multiple objects on the print bed at once. However, if one object fails, it can cause you to kill the whole job. For example if one of the objects loses adhesion and comes loose. This will mess up the rest of the print. So I tend to print one object at a time unless they are really small.





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You can print several small objects together, but sometimes it is better to do them separately

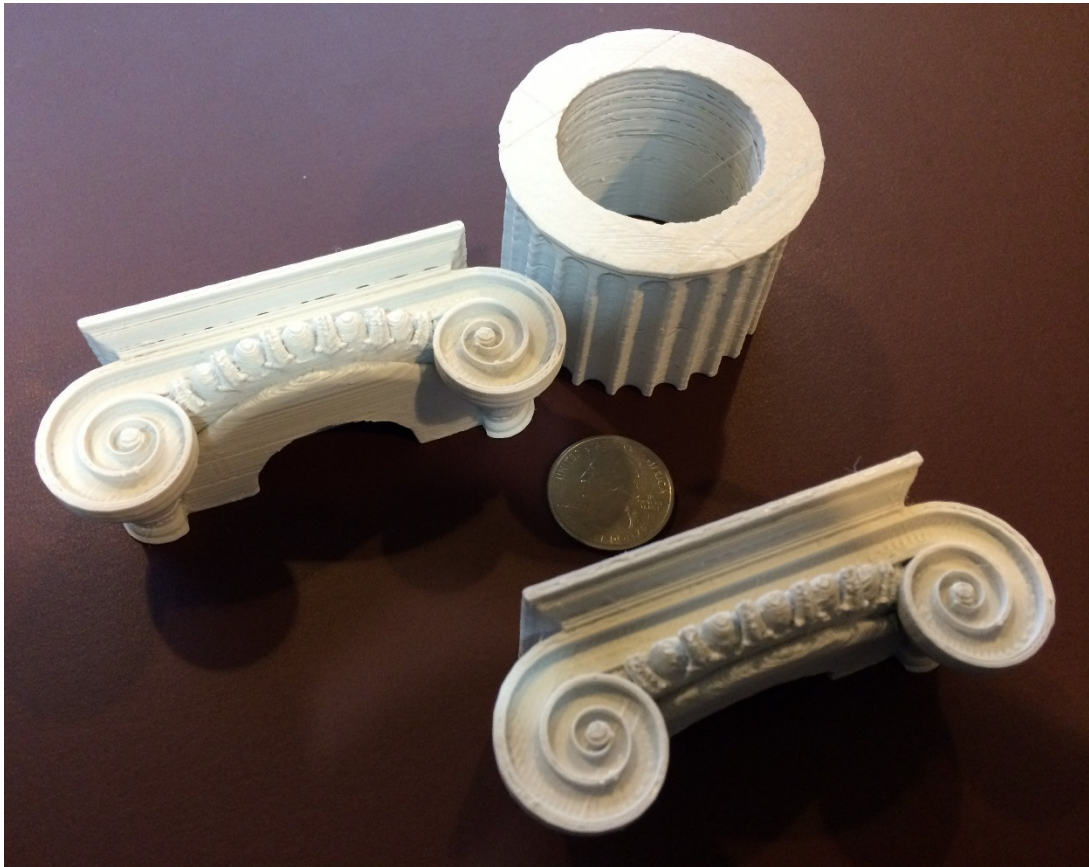
With the Ionic capital, I wanted the volutes to print flat so that the spirals would be continuous and not layered. However, this did a poor job on the fluted shaft. So I ended breaking it into three pieces.





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You can print several small objects together, but sometimes it is better to do them separately

For the Corinthian, I had a few challenges. First, given its complexity, I could not simply cut it in half and print like the Ionic or Doric. Any orientation was still giving poor results so some part of the leaves of capital. So I made several attempts to break it up into many smaller pieces. This approach was mostly successful, but I still had to resolve a few issues. Ultimately, I decided to print each of the two rows of bottom leaves, 16 in all, individually and later glue them back in place. The top row of leaves I left part of the overall so that they could properly engage the geometry of the volutes and abacus. It needs to look like it is carved from stone. So while the leaves at the bottom two rows work printed separately, the rest had to be done in-situ.

Breaking up the model in Revit

So just how do you break up your model? Well, as much as possible, I tried to do this in Revit. The STL Export add-in works from both the project and





family editor environments. So depending on the model, it was sometimes possible to export directly from the family. But in cases where I wanted to reorient things, I often found it easier to load the model into an empty project and manipulate it there. For example, most column capitals print better upside down. This is easily accomplished by loading them into a project and then in an elevation view, rotating them 180°.

For the Ionic I wanted to print the volutes horizontally to take advantage of the layering of the extruder: your model is sliced into several thin layers and each is printed on top of the previous. If you want a nice smooth curve, it is best to try to print these parallel to the print bed. This is not always possible like in the case of ball or other shape that is round three-dimensionally, but if the curvature is in two directions only, you can easily optimize the orientation to the print bed. Some 3D printer software even has a function to optimize the orientation, or you can rotate manually in your authoring software and save it out that way. This is what I tried to do in most cases.

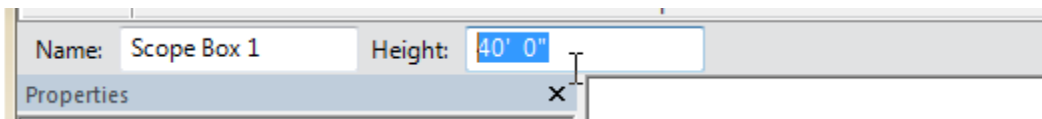




The Ionic presented another issue. It is symmetrically and has the scrolling volutes on both sides. There was also the egg and dart molding that runs just beneath the volutes. To avoid having to use support material, the best solution was to split the top portion of the capital in half and then print each half rotated 90°. I did use supports, but since I optimized the orientation, they were only required on the undersides of the volutes as you can see in the previous image on the left. The right side has the supports removed already.

Section Boxes and Scope Boxes

To split the model in Revit, I simply used a 3D Section Box. You can create a custom 3D view and then on the Properties palette, check the Section Box option, or right-click the ViewCube and choose Orient to View. You can select any existing section, plan or elevation and it will make the 3D Section Box match the extents of that view. When I need a great deal of precision, I first create a scope box. I size the scope box as precisely as I can first. To do this, pay attention to the Options Bar when you create a scope box. This is the only opportunity you get to set its height numerically.



The width and depth you have to set using grips in a plan view. The other tricky part of scope boxes is the View Visible setting. There is a button next to this setting on the Properties palette. Make sure that the Automatic Visibility is set to Visible in any view where you want to see the scope box. If it is not, you can use the Override column to override it.

Once you have a scope box, you can assign it to the extents of any 2D view (not 3D views) on the Properties palette. This will size the crop exactly to the scope box. However, once you have a 2D sized to the scope box, you can then use the Orient to View feature on the ViewCube.

To summarize the process, create a scope box by first setting the exact height on the Options Bar. Adjust the other dimensions and visibility settings as required. Next create or edit a 2D view like a plan or section. I usually use a section. Assign the scope box to this view's extents. Next

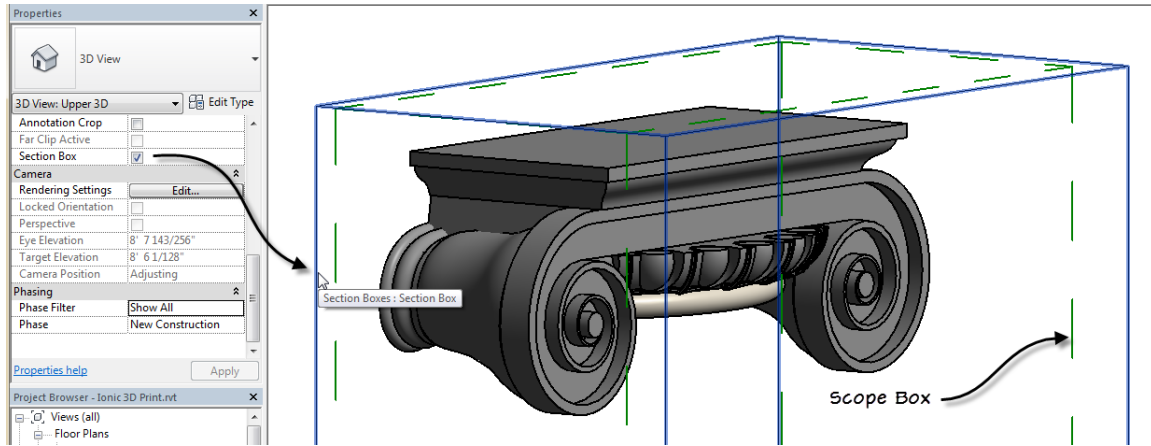




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create a 3D view and orient to the section view using the right-click option on the ViewCube. This will yield a cropped 3D view of the model that you can export.



The other alternative is that you can use a void and cut away the portion of the model you don't need. This will typically give higher precision than than even the most carefully planned scope box/section box. In fact, ultimately this is what I used to be sure I was cutting the Ionic capital exactly in half. The down side of a void is you have to do a save as on your family and make a special version for 3D printing. When I first got started, I was really reluctant to do this, feeling like it was cheating and also being concerned about maintaining multiple versions. But alas, in many cases, doing a save as is simply the best way to ensure optimal results. One very nice thing about save as is that you gain much more freedom to add and delete elements, make custom views and hide and show elements as needed. Remember, whatever is visible in the view is what gets exported to STL. So your last step is usually to hide in view those elements you don't want to include.

Size and Resolution

Size and resolution was the next obstacle. When printing smaller, all of the details were small and too dainty. This also exposed issues with my original model. While the model that I outline in the book is printable, it is not ideal. The leaves are too thin and the volutes don't touch at the corners. To fix these issues, I had to work both inside and outside of Revit. I fixed the volutes inside Revit by just adjusting the parameters slightly and massaging





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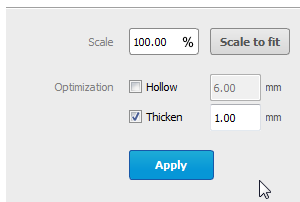
the locations and scales of profiles used to create the 3D forms. It took a lot of trial and error, but gave good results.

I could have accomplished the same thing with the leaves, and in fact I did make some adjustments to the leaves directly in Revit. In the Revit model, the leaves are simply arrayed around the drum, but they don't engage one another. To make a sound 3D model, it is better if there were some backup material behind each leaf that engaged the drum and surrounding leaves; just the way it would be if carved from stone. So I added this to the model directly in Revit.

Thickness of parts

Overall I wanted the leaves to be thicker. I could have done the same trial and error process as above to achieve this but I was concerned about distorting the shape of the leaves. So instead I used Autodesk's 3D Print Utility 1.1.1. <http://apps.123dapp.com/3dprint/install.html>

The 3D Print Utility has many useful features and even interfaces directly with certain popular printers (sadly the Simple is not one of them). But the feature that I used was the "Thicken" feature. This feature adds thickness all the way around the thin elements and was perfect for the leaves.

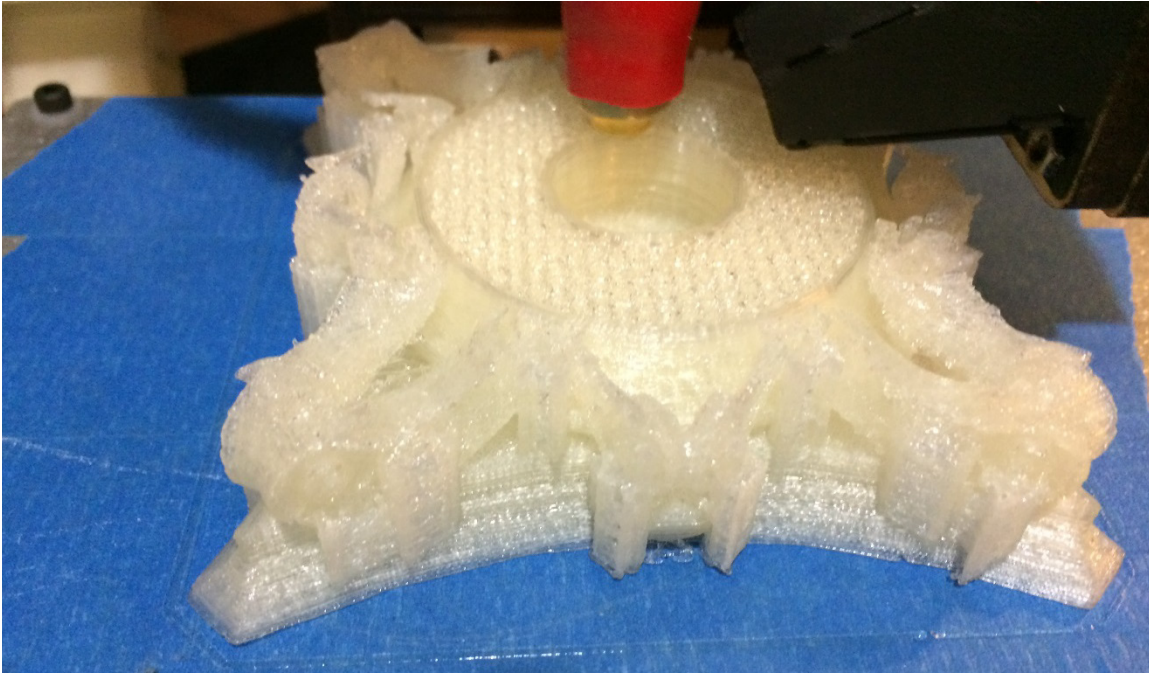


Use Thicken to increase the thickness of thin objects

Faux Supports

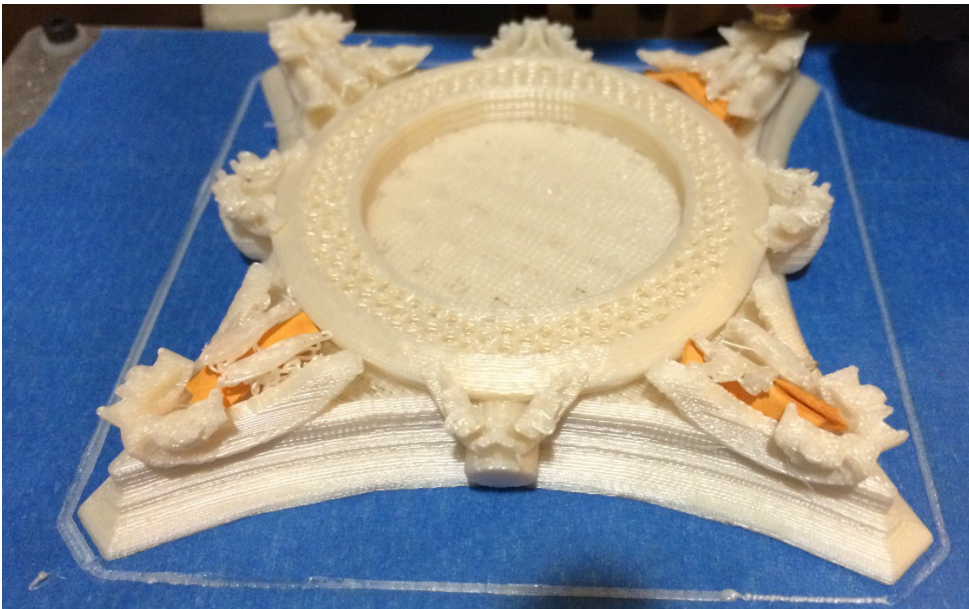
I tried several tests to print the top portion, but ultimately, using support material just did not give results to my liking.





Support material on the top portion of the Corinthian is very difficult to remove

I ended up printing the drum and top tier of volutes and leaves as a single print without support material. When it got to the leaves, I paused the print and inserted some cardboard strips to serve as the supports. It introduced some flaws, but overall I think the results were better than the auto-generated supports.



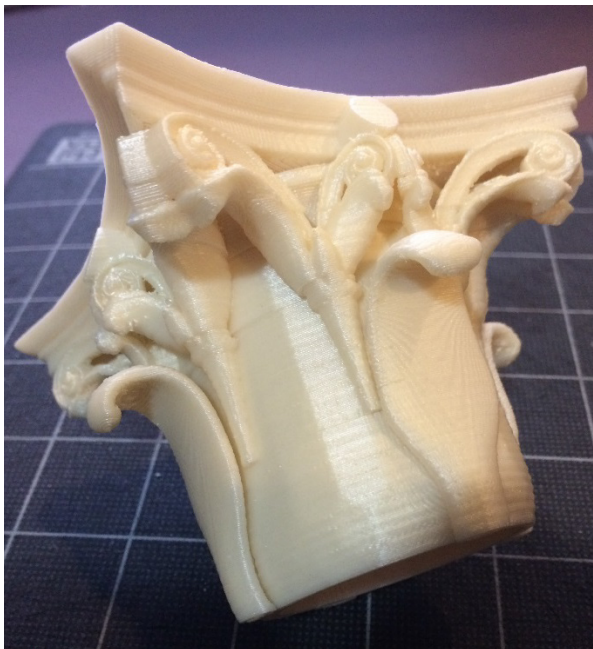
Manually created cardboard "supports"





Finishing

The final result came out quite nice. A little hot glue and assembly and the Corinthian capital is quite a success.



Hot Glue is used to glue everything together





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I have been slowly printing the shaft. It's coming out quite nice and I'm pleased, but I am beginning to think it would be faster to carve it out of stone... ☺

Conclusions

I have had my Printrbot Simple for about 6 months now. I do not think that his specific device is for everyone. 3D printing is still bordering between an enthusiast's activity to becoming fully mainstream. Companies like Makerbot are leading the way toward making practical plug and play style machines loaded with compelling features. Their latest models have WiFi and web cams, and be started and monitored remotely from a smart phone and boast high resolutions and fast speeds. The Printrbot Simple is on the opposite end of the spectrum. Each iteration improves the device and its price point is so attractive that if you are a causal user you can easily overlook some of its shortcomings. The important point to realize is that like so many similar technologies, the hardware is only one aspect. The software, strategies and modelling workflows share consistency across devices. So if you are like me and want an inexpensive entry point to begin a first-hand exploration into the maker movement, I think it is hard to go wrong with a device like the PrintrBot Simple and a little time and effort.

As they say over at Faberdashery: "Happy Fabbing."

