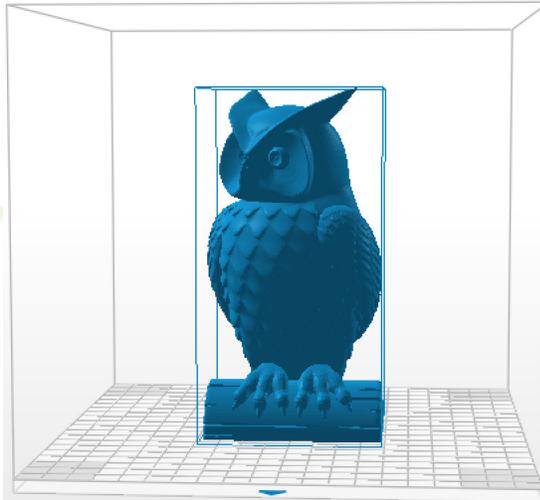


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3D Printing Best Practices

Foundation and Orientation

3D printers seemingly start from nothing, but there must be a solid foundation for a model to print successfully. The best 3D models have a solid foundation for the rest of the print to build upon. One can think of 3D printing like building a layer cake, if one starts with an entire canister of frosting as the first layer, your cake isn't going to be very stable. There is a process to build a successful print (you start with cake, or a good foundation). Making a successful 3D print is also like building a house, a solid foundation will allow the house to stand for years to come. Objects processed without a strong foundation may have to be printed with complex supports or even changed.



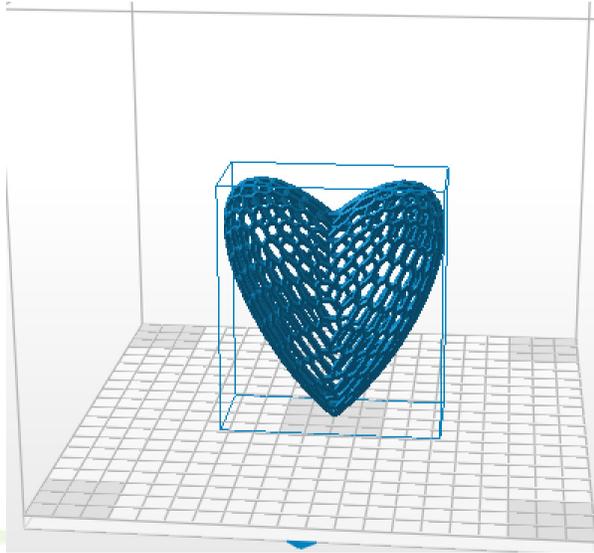
Good example

This owl sits on a branch, and for good reason, the branch allows for a sturdy foundation. If one can imagine the owl just printed with just the curved feet, this would allow for less surface area to support the remaining object.

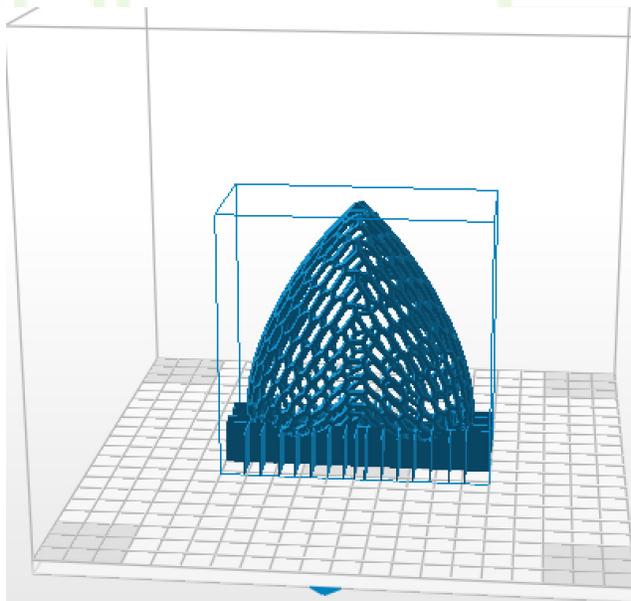
The top of the owl may need supports. For anything 45 degrees or greater on an object (see the 45 degree rule) you will need to consider adding in supports as you build or use the slicer software to add supports in.

<http://www.thingiverse.com/thing:18218>

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Bad Example The heart barely touches the bottom area (build plate), and the print's width increases from the point at which it touches the build plate. This particular type of print (voronoi) can be very difficult without proper supports and a good foundation. Luckily the designer of this print made another version with a proper foundation.



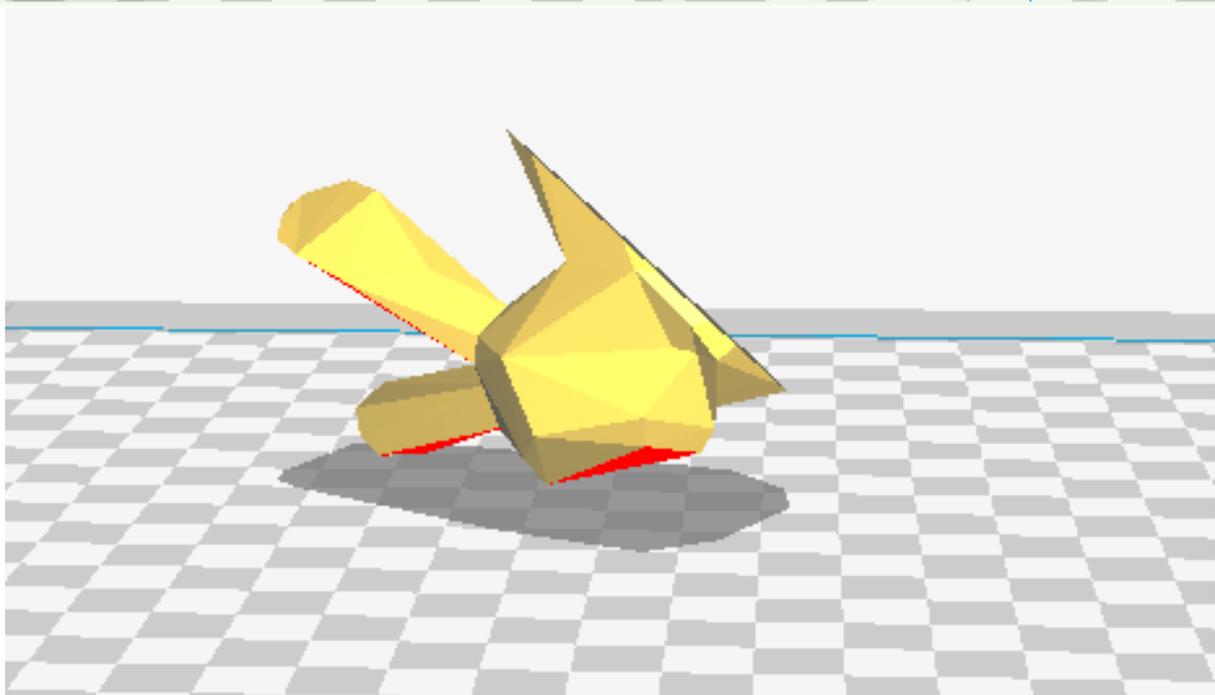
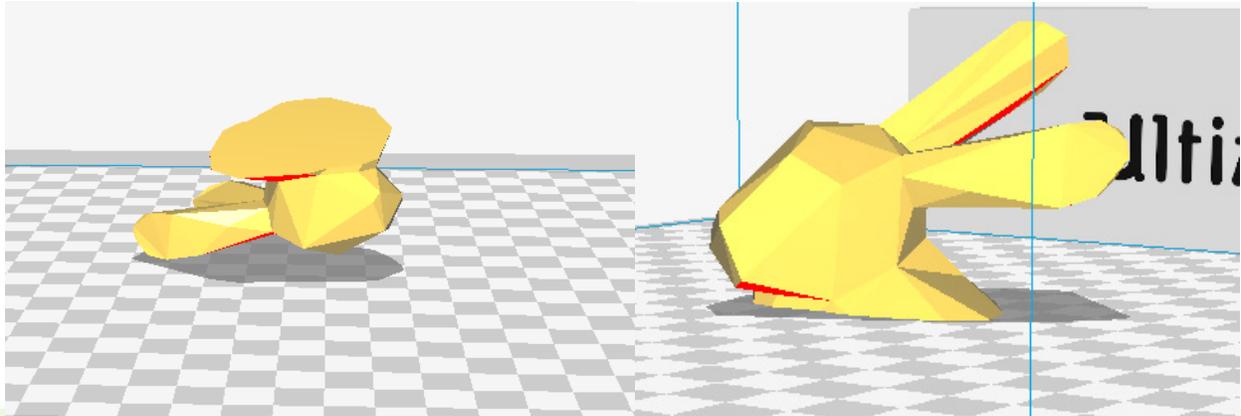
Repaired As you can see the print is flipped on its other side with more foundational support. With this foundation, this print will come out much better!

<http://www.thingiverse.com/thing:345775>

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Print Orientation

It's important to take in to consideration the X, Y or Z orientation when you are printing your project. This can have an impact on the strength of your project, and whether it prints successfully.

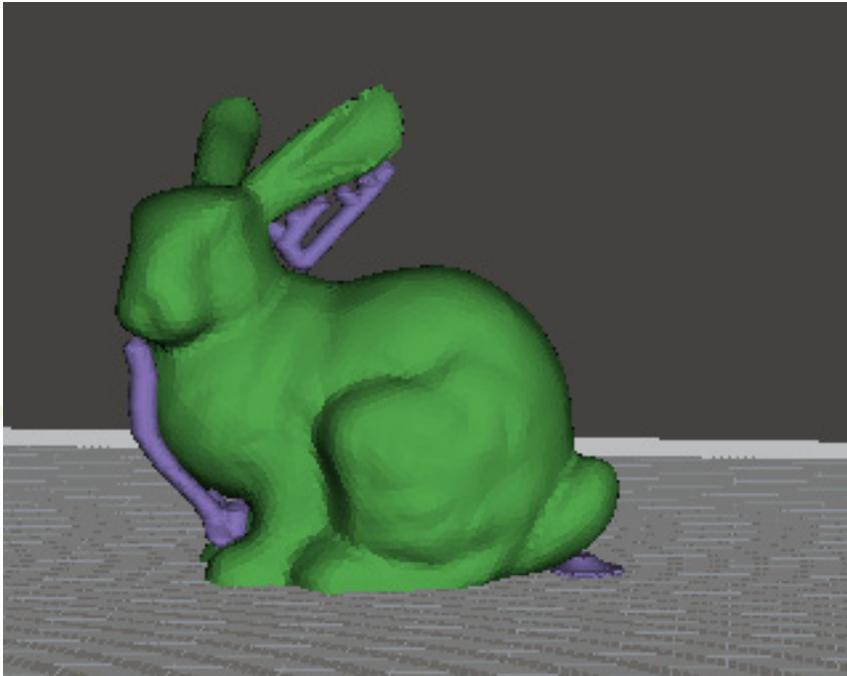


Supports

Objects that don't have a strong foundation, have slicing errors, have free floating elements, or objects with unsupported overhangs will likely not come out correctly without supports. Supports are like a scaffold for 3D printing (ELAArea Public Library). They are parts printed to help hold up certain parts of an object while it is printing, supports can be automated in software or they can be added in by the user during design creation or repair. They are disposable, designed to be taken off after

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printing has been completed successfully. There are companies developing rinse away support material (we don't have that yet) so the future of making very clean prints that still need support is already a reality. Supports are really a part of using FDM printers, just recognize that a bit more work smoothing and making a print ready for display will be the designers' responsibility if supports are needed or required for a successful print.



45 Degree Rule

Generally speaking, angles of more than 45 degrees will need to be printed with supports, otherwise your print may not come out correctly, this is something to look for when designing your initial 3D print or when printing your object. This is sometimes called the “Y” rule. If you look at how the letter “Y” and think about 3D printing it, it likely wouldn't need supports given the angles of the letter “Y” but if you then think about “T” or “P” you would need supports!

Dimensional Constraints

There is only so much room to print inside of the printer, therefore the dimensional constraints should be taken in to account when you design your project. The dimensions on our current set of printers are as follows:

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Taz Lulzbot 5
Build Volume
290 x 275 x 250 mm
(11.4 x 10.8 x 9.8 inches)

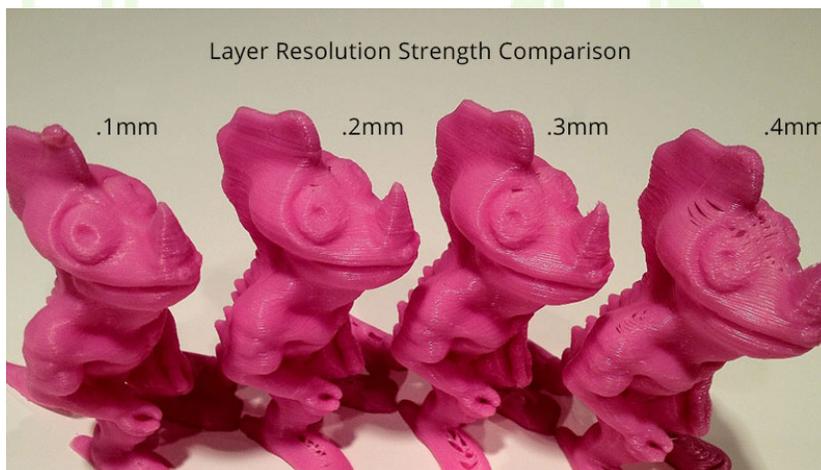
Ultimaker 2 Extended +
Build volume
223 x 223 x 305 mm
(8.8 x 8.8 x 12.0 inches)

Zortrax M200
Build volume
200 x 200 x 180 mm
(7.9 x 7.9 x 7.1 inches)

Rafts

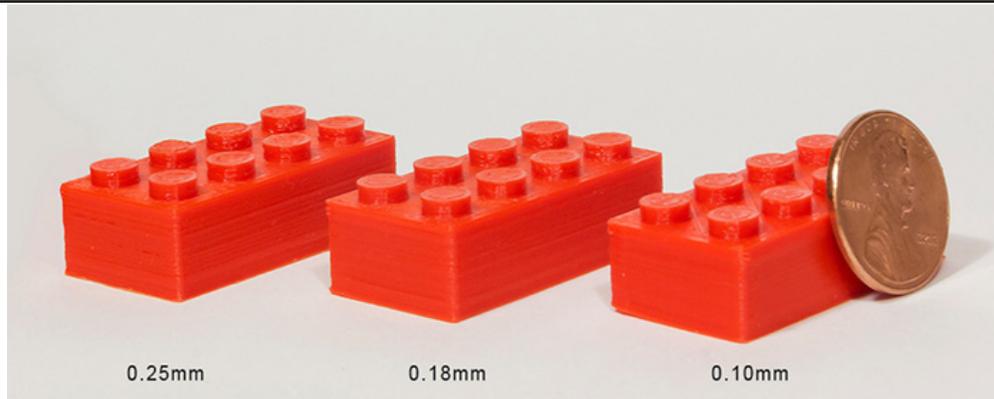
Rafts help secure print(s) to the print bed and are designed to be easily peeled off the print by the user. A raft will cost the person making the print a bit more money, but if your print has a good flat foundation a raft is not necessary. Temperature variation in the room where the printer(s) are located can create a need to use rafts. Cura, the software we use for two of our current printers, also has a brim option (which uses less material). A brim goes around the exterior of a print to secure the print to the bed, but can be more difficult to remove. For a printer with a unheated bed a raft is generally a good idea.

Resolution i.e. Shells and Parameters



<http://tobuya3dprinter.com/wp-content/uploads/2014/05/layer-resolution-strength.jpg>

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Shells

<http://tobuya3dprinter.com/3d-printing-resolution-structural-strength/>

If we think about each printed layer of an object as a two-dimensional drawing laid out on the X and Y axes, then the number of shells on the object refers to the number of times the outline of the drawing is retraced. If the printer only traces the outline once, it is said to have one shell, if it retraces the outline a second time then it is said to have two shells.

They are called shells because they are the outer most layer of the object and ultimately the part of the object we see and interact with. The more shells on an object, the stronger it is. However, adding shells will also increase the print time significantly. Shells are also referred to as perimeters in some software and documentation (Budman).

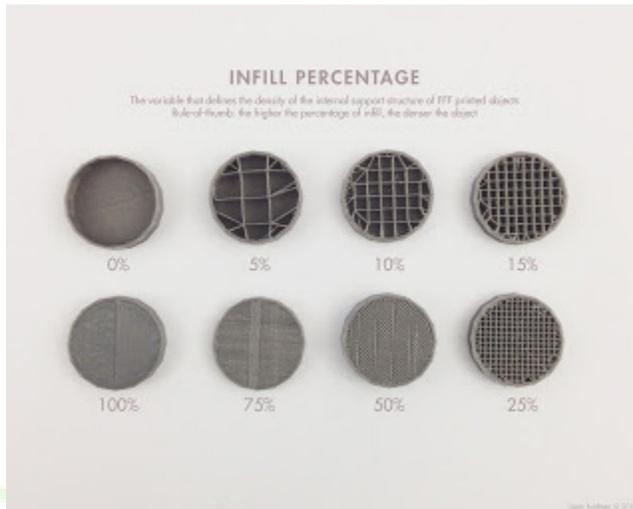
Layer Height

A high-resolution print has thinner slices that can show more detail, but do keep in mind when you print with a higher resolution your print will take longer. This part of printing is often referred to as layer height. This means that if you double the resolution (i.e. 0.40mm to 0.20mm) it will take more than twice the time to print

(3-D Printing – A Beginner’s Guide to Best Practices). Try to find that right balance between quality, functionality and printing time when you design your item. Take in to consideration whether you are making a prototype or a production quality final product.

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Infill



<http://blog.teambudmen.com/2013/09/understanding-shells-layer-height-and.html>

Infill is the material used to fill the empty space inside the shell of an object, it refers to the density. Infill is measured by percentage, so an object printed at 100% infill will be 100% solid. More infill will make an object stronger, heavier, and slower to build. Likewise, less infill is lighter and quicker to build.

A 3D printer can extrude infill in several patterns. Some slicing engines create a grid pattern while others will use hexagonal or other geometric patterns. Items printed for display purposes rarely need more than 10%-20% infill, but functioning mechanical parts and pieces that will take more abuse will need 75%-100% infill.

Use less infill on test objects and prototypes that won't be subjected much stress, use more infill on functional mechanical parts and objects that need to be durable (Budman)

Works Cited

ELAArea Public Library. "3D Printing Best Practices."

<http://eapl.org/sites/default/files/docs/3D%20printing%20best%20practices.pdf>

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PDF File. Accessed 16 November 2016.

Budman, Issac. "Understanding Shells, Layer Height and Infill." <http://blog.teambudmen.com/2013/09/understanding-shells-layer-height-and.html> Accessed 16 November 2016.