

# 3-D Printing – A Beginner’s Guide to Best Practices

## Resolution

When printing with a 3-D printer it is important to take in to consideration what resolution you will be using for printing. Much like an LED screen on your smartphone or computer, a high-resolution image is made up of smaller parts. In the case of a LED a high-resolution screen has smaller pixels, and for 3-D printers a high-resolution has thinner slices that can show more detail

Another important consideration is time. Although you might want the highest quality final product, the amount of time to print increases exponentially. 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. Try to find that right balance between quality, functionality, and printing time when you design your product. Take in to consideration whether you are making a prototype, or a production quality final product.



**Resolution:** 0.15mm  
150 microns  
**Time:** 26 minutes

**Resolution:** 0.20mm  
200 microns  
**Time:** 19 minutes

**Makerbot Default**  
**Resolution:** 0.27mm  
270 microns  
**Time:** 14 minutes

**Resolution:** 0.35mm  
350 microns  
**Time:** 10 minutes

**Resolution:** 0.40mm  
400 microns  
**Time:** 9 minutes

Image source: Larson, J. (13 January 2013) *What’s your resolution?* Retrieved from <http://joesmakerbot.blogspot.com/2013/01/whats-your-resolution.html>

## 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.



Image source: Naique, S. (3 July 2012) *Designing for 3D Printing*. Retrieved from <http://sidnaique.blogspot.com/2012/07/3d-printing-and-zbrush-02orientation.html>

## 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.

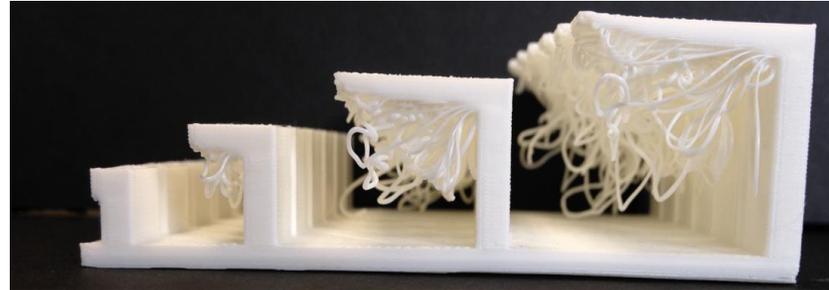
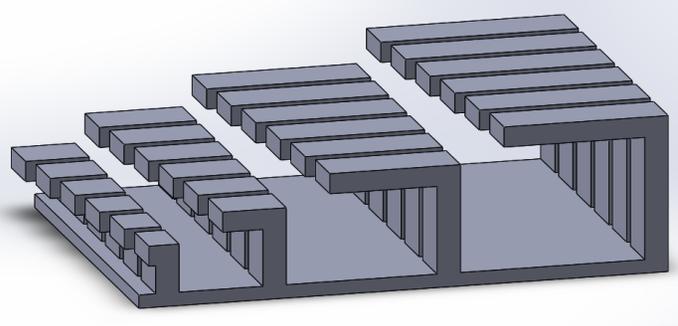
Makerbot Replicator (5<sup>th</sup> generation)

Build Dimensions: 25.2 L x 19.9 W x 15.0 H cm [9.9 x 7.8 x 5.9 in]

Build volume: 7,522 cubic centimeters [456 cubic inches]

## 45° Rule

When printing on a 3-D printer, you should follow the 45° rule. This means if you have any piece of your design that overhangs by 45° or more you should add a support to the structure. Below are examples of 90° overhangs that were printed with no supports.



Failed Horizontal Overhangs

Image source: The University of Texas at Austin. *Tips for Designing 3D Printed Parts*, The Innovation Station. Retrieved from <https://innovationstation.utexas.edu/tip-design>

## Supports

To solve the problems we encounter with the 45° rule, it's important to add supports. These extra pieces of plastic can be removed after the 3-D print job is done. Be sure to check whether your 3-D modeling, and 3-D printing software can automatically generate these supports for you (such as Makerware or MakerBot Desktop)

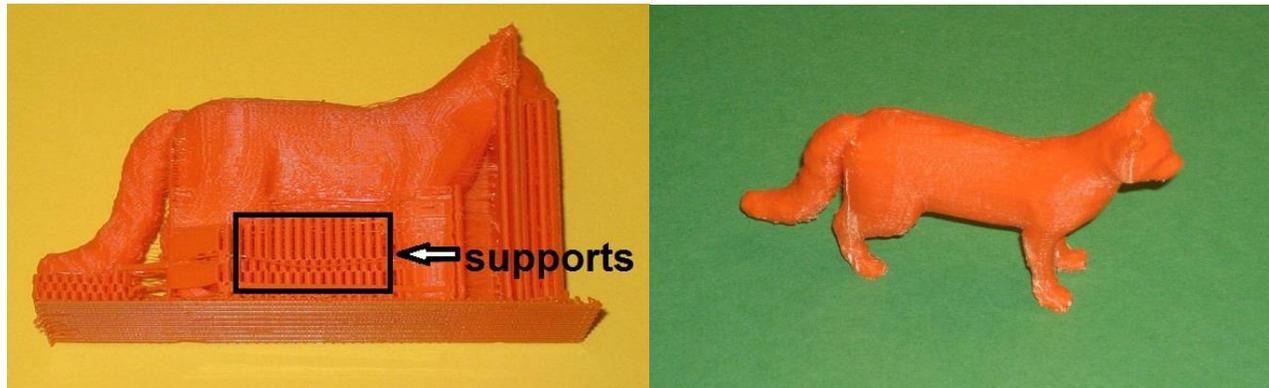


Image source: The University of Texas at Austin. *Tips for Designing 3D Printed Parts*, The Innovation Station. Retrieved from <https://innovationstation.utexas.edu/tip-design>

## Rafts

Rafts are a technique that is used to prevent warping. Parts are built on top of a 'raft' of disposable material instead of directly on the build surface. This technique is best used for 3-D printers that do not have a heated surface, where less surface area makes the model easier to remove from the glass. If your 3-D printer has a heated surface this technique is rarely used.

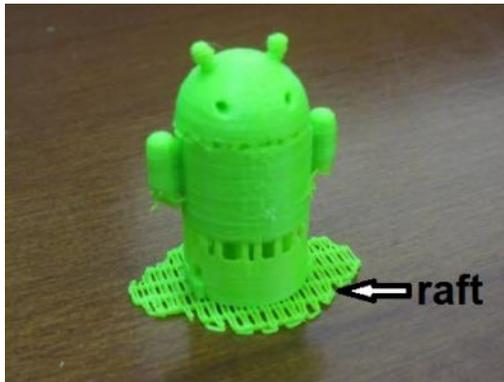


Image source: Georgia Tech, *3D printers*, Invention Studio. Retrieved from <http://inventionstudio.gatech.edu/w/images/thumb/e/ef/RaftAndroid.jpg/400px-RaftAndroid.jpg>

## Shell and Infill

Shell and infill are settings when you do your final 3-D print. The shell is the outer layer, and the infill is the percentage of plastic that fills the middle of your model. Generally speaking, 2-3 layers of shell, and 10-20% infill is sufficient for a model. If you need a model that is more durable (like a hinge for a door), you may consider upping the number of shells or percentage of infill (generally there is no advantage over 60%.)

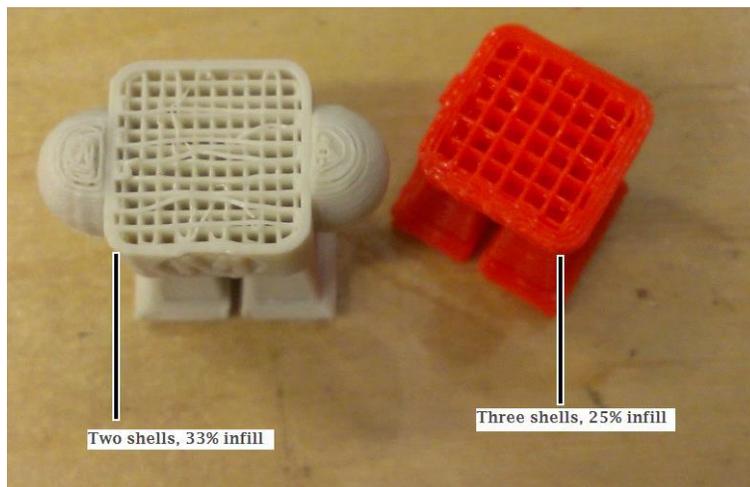


Image Source: 405<sup>th</sup> Wiki, *3d Printing*. Retrieved from [http://img1.wikia.nocookie.net/\\_cb20130823061809/405th/images/1/11/IMAG1290.jpg](http://img1.wikia.nocookie.net/_cb20130823061809/405th/images/1/11/IMAG1290.jpg)