

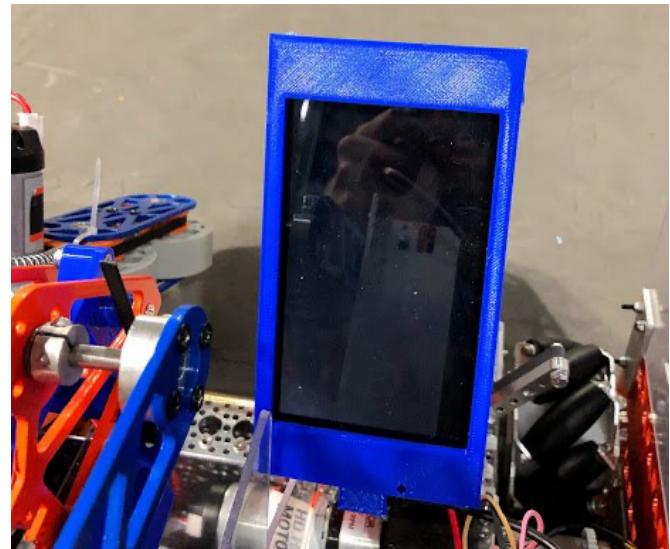
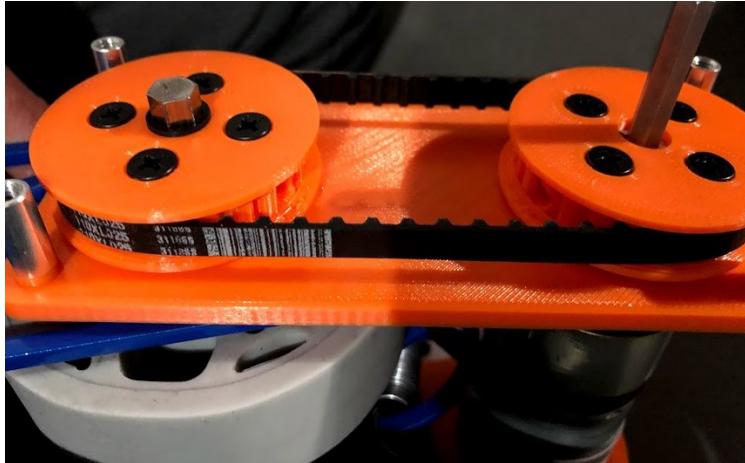
3D Printing

The Antidote - FTC 14320



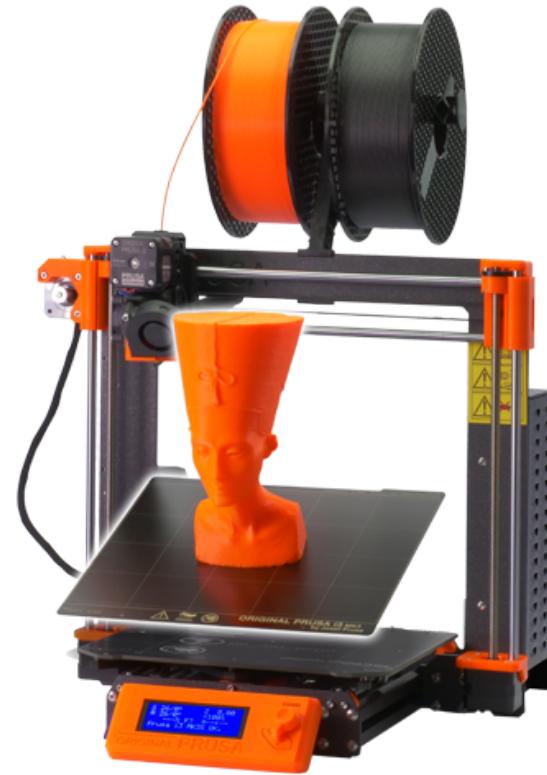
What is 3D Printing?

- A process of creating a three-dimensional solid objects by adding material layer by layer.
- Can make products of almost any shape and form
- Can create complex geometrical shapes and parts – which may not be able to be manufactured using traditional methods



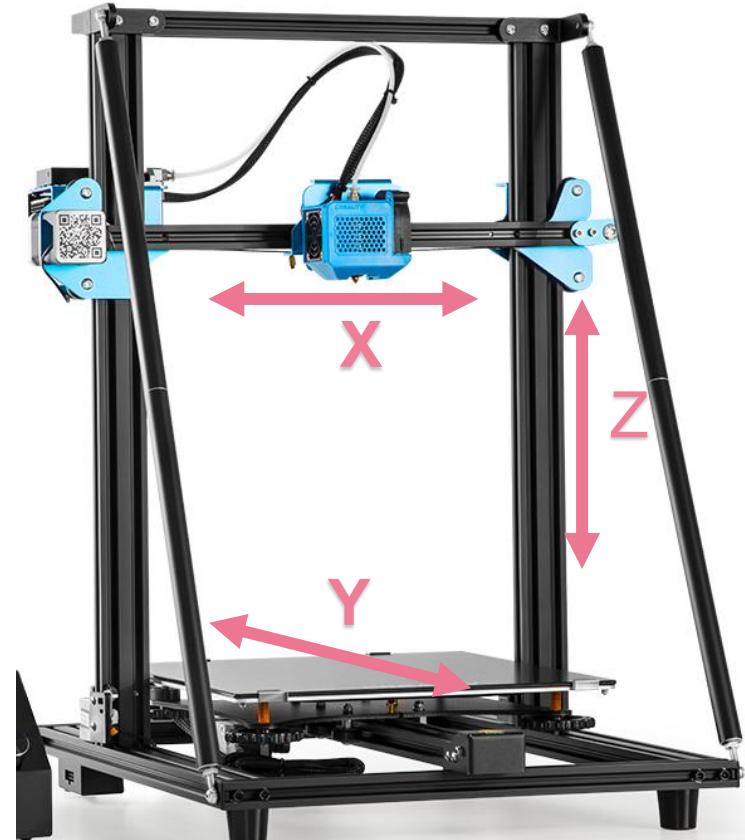
Advantages of 3D Printing

- Fabricate 3D models that can be printed in a relatively short period of time
- PLA (and most other materials) are **strong** enough to sustain the rigors of the game
- Easy to develop **prototypes** throughout the Engineering Design process
- Can sometimes replace COTS parts to **save money**



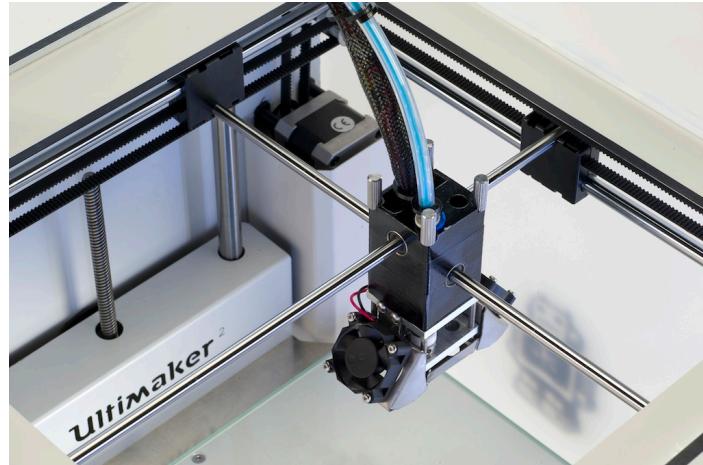
Types of 3D Printers

- **Cartesian Printer** (Bedslinger)
- All axes move **independently**
- X axis moves left / right
- Y axis moves forward / backward
- Z axis moves up / down
- Bed moves on the Y axis
- Hot end carried on the x axis
 - The extruder drives the filament into the hot end and gets extruded through the nozzle



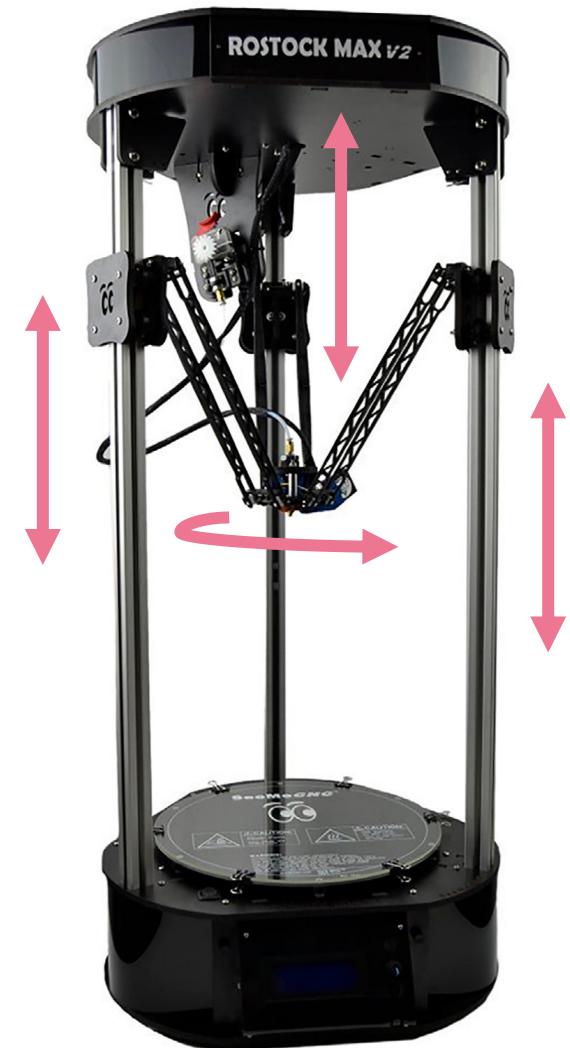
Types of 3D Printers

- **CoreXY Printer**
- The X and Y axes **move together**
- Z axis moves up / down
- Bed is **stationary** but moves down with the Z axis
- Hot end carried on the X and Y axis



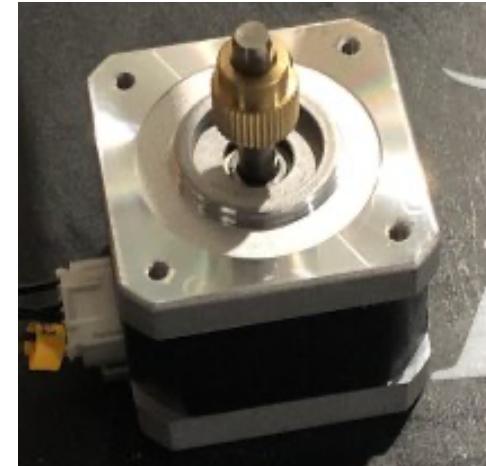
Delta Printer

- Features a **non-moving circular** bed
- Instead of axes, the printer uses three arms to move the hot end around
- The main advantage over other types of printers is **speed**
- Because it is not very precise, we **do not recommend** this style of printer



Parts of a Printer

- Most 3D printers consist of **extrusion**-based frames to create rigidity
- Bowden Tube or Direct Drive Extruder
- Heated Bed
- Hot End (melts the filament)
- Moving Parts
 - Stepper motor – Brushless DC motor capable of **high** precision
 - Four stepper motors control each axis as well as the extruder



What is Filament?

- Filament is a **thermoplastic** that can be heated up to a certain temperature and extruded to create 3D models
- There are several filament types with separate properties
 - PLA, PETG, ABS, TPU
 - **PLA** is the most popular
- Filament is typically **1.75 mm**, but can be found at a 2.85 mm size
- Spools typically contain 1 KG of filament, and cost around **\$20**
- Filament can **absorb moisture** (bad!) so keep them in a dry environment and only open the seal when being used



The 3D Printing Process

- Create a model using a CAD program such as Solidworks, Onshape or Fusion 360
- Save as STL (*Surface Tessellation Language*) file
 - Or alternatively download an STL from the internet
- Open the STL file in a Slicer such as Cura or PrusaSlicer
 - Slicers contain the multitudes of settings that you can change in order to get calibrated prints
 - This is the (sometimes) fun part!
 - Slicers split the model into **many** thin layers that will be stacked to create the model
- Save as a GCODE file and print!
 - The printer creates the model layer-by-layer



The 3D Printing Process

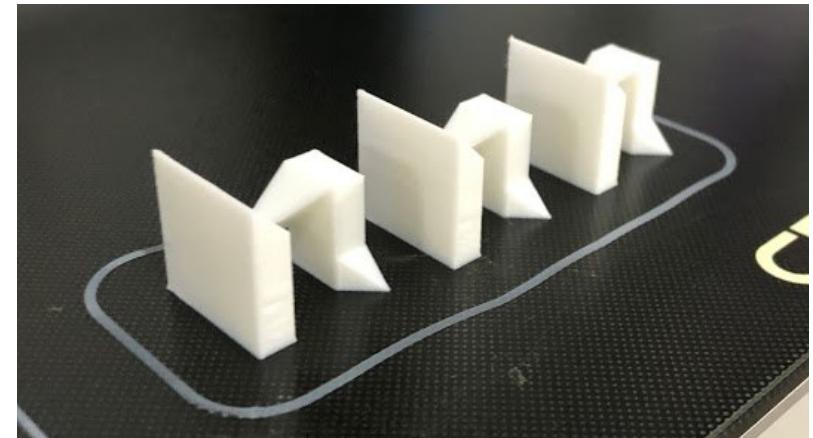
- Once the heated bed has cooled down, simply grasp the model firmly and **snap** it off from the platform
 - If you have a magnetic bed, you can peel the print right off of the surface!
 - You can use a 3D printing spatula (usually included) and a rubber mallet on the edges of the print to knock it off
- You can use flush cutters (usually included) to clean up any messy spots
- A heat gun (or hair dryer) can remove any stringing on your model

Recommended Settings

- All of these are **suggestions**: we recommend playing around with the settings to see how to get the best print
 - Default settings are a good starting point!
- **Layer Height** (how thick should each layer be): 0.20 mm
 - Should be no more than 80% of your nozzle diameter
 - The larger the layer height, the faster the print, and the less the resolution
- **Line Width** (how wide is each line): 0.60 mm
 - Should be larger than your nozzle diameter
- **Infill** (how much material should support the model): 20-50%
- **Temperature** depends on the type of filament you are using

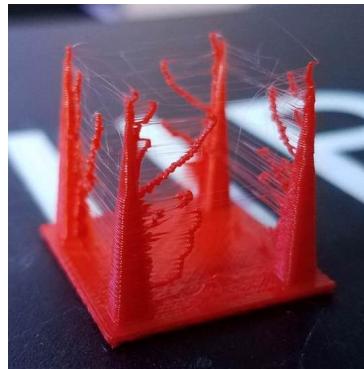
Challenges

- Here are a few challenges you may experience as you print!
- **Bed Adhesion**
 - The model may not stay attached to the bed while printing (bad!)
 - Some glue can help keep the print on the bed
- **Bed Leveling**
 - Most printers use manual bed leveling – Turning knobs to level the bed (a printer paper should fit between your nozzle and bed)
 - A skirt (lines around the model) is a visual indicator if the bed is level
 - Automatic Bed Leveling Systems (like the BLTouch) makes printing **easier**



Challenges

- **Support Material**
 - Models that have overhangs (like in the picture) may require **support** to print 'in the air'
 - Support material can be hard to take off, so it is **important** to dial in your support settings!
- **Stringing**
 - Not super prevalent but can be tough when dealing with multiple tall and thin objects.
 - Try tinkering with **retraction**, **print speed**, and **temperature**.



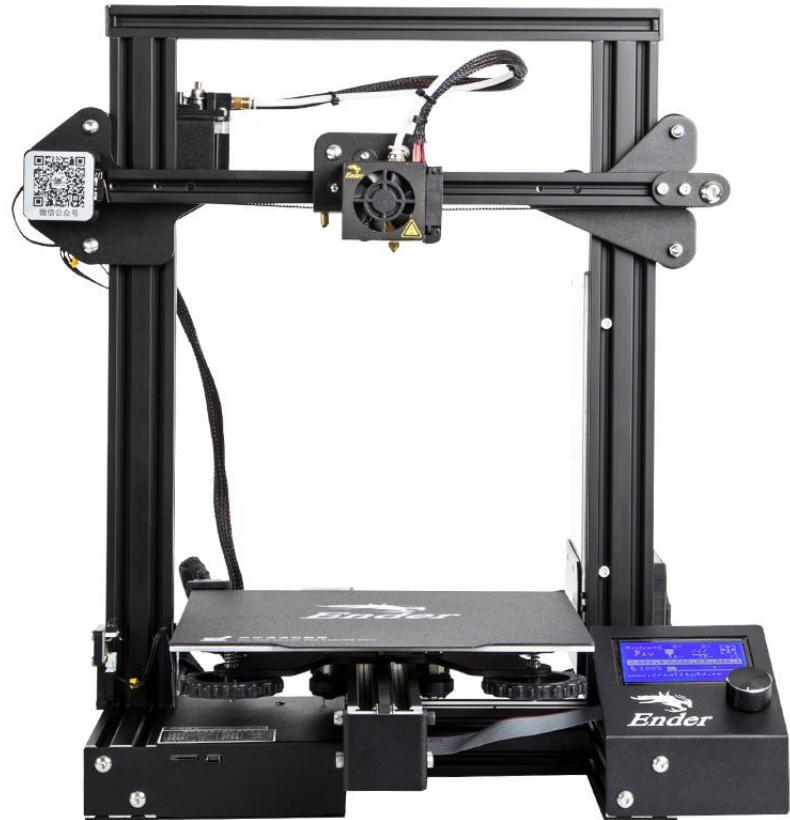
Calibration Test Prints

- XYZ Calibration Cube
 - This cube acts a test to see if the printer is capable of printing with accuracy
 - Each dimension should be 20 mm
 - Can easily check for over/underextrusion or any other problem
- 3D Benchy
 - Our favorite calibration print
 - Tests your printer's bridging, overhangs, stringing, and other details



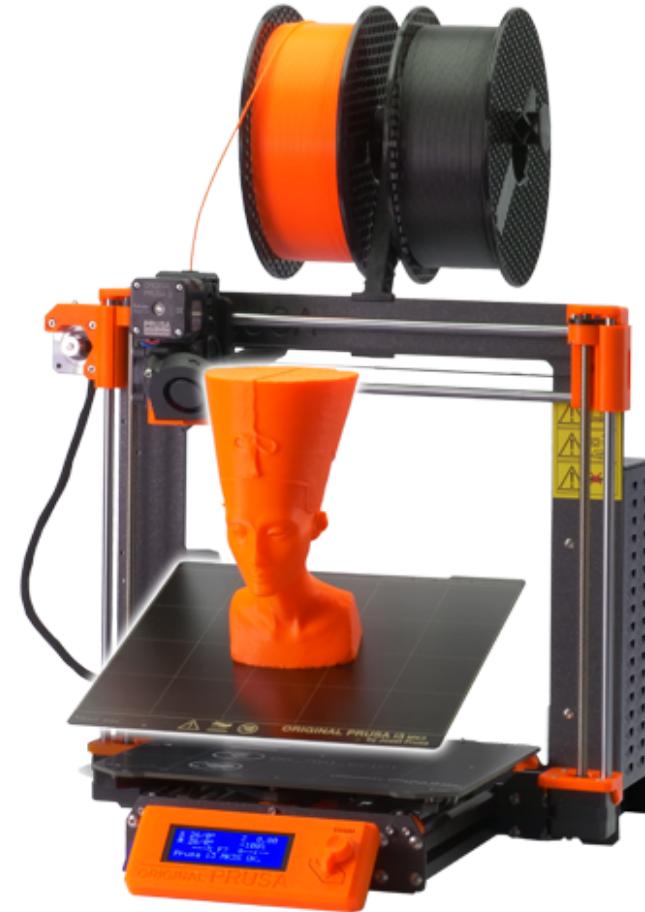
Recommended 3D Printers

- **Creality Ender 3 Pro**
 - Retails at around \$250
 - One of the most popular 3D printers available on the market
 - Relatively easy construction and doesn't take long to set up
 - Because this is a 'cheaper' 3D printer, the quality and the endurance of the printer may suffer



Recommended 3D Printers

- **Prusa i3 MK3S**
 - Retails at \$750
 - One of the most popular 3D printers available on the market
 - Each part is tried-and-true and reliably works
 - This is one of the higher-end printers, although its sustainability and reliability dominates the market



Recommended Upgrades

- **Metal Extruder**

- Typically for the **Ender 3 Pro**
- The **plastic** extruder on the E3P typically wears down after a few months of prolonged use
- The **aluminum** extruder will not wear down, and stay consistent with e-step extrusion



- **Glass Bed**

- **Different** sizes for different printers
- **Easier** to take prints off compared to a magnetic bed
- Glossy finish on the bottom side of the print



Handy Tools

- **Calipers**

- Used to measure distance between two sides of an object **accurately**
- Can measure outer diameter, inner diameter, and thickness
- Helps with printer calibration



- **Flush Cutters**

- Useful for **print cleanup**
- Can be used to remove excess 3D printed material or supports
- One flush cutter comes in any Creality 3D Printer kit



Credits

- This lesson was written by The Antidote 14320 for FTCTutorials.com
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