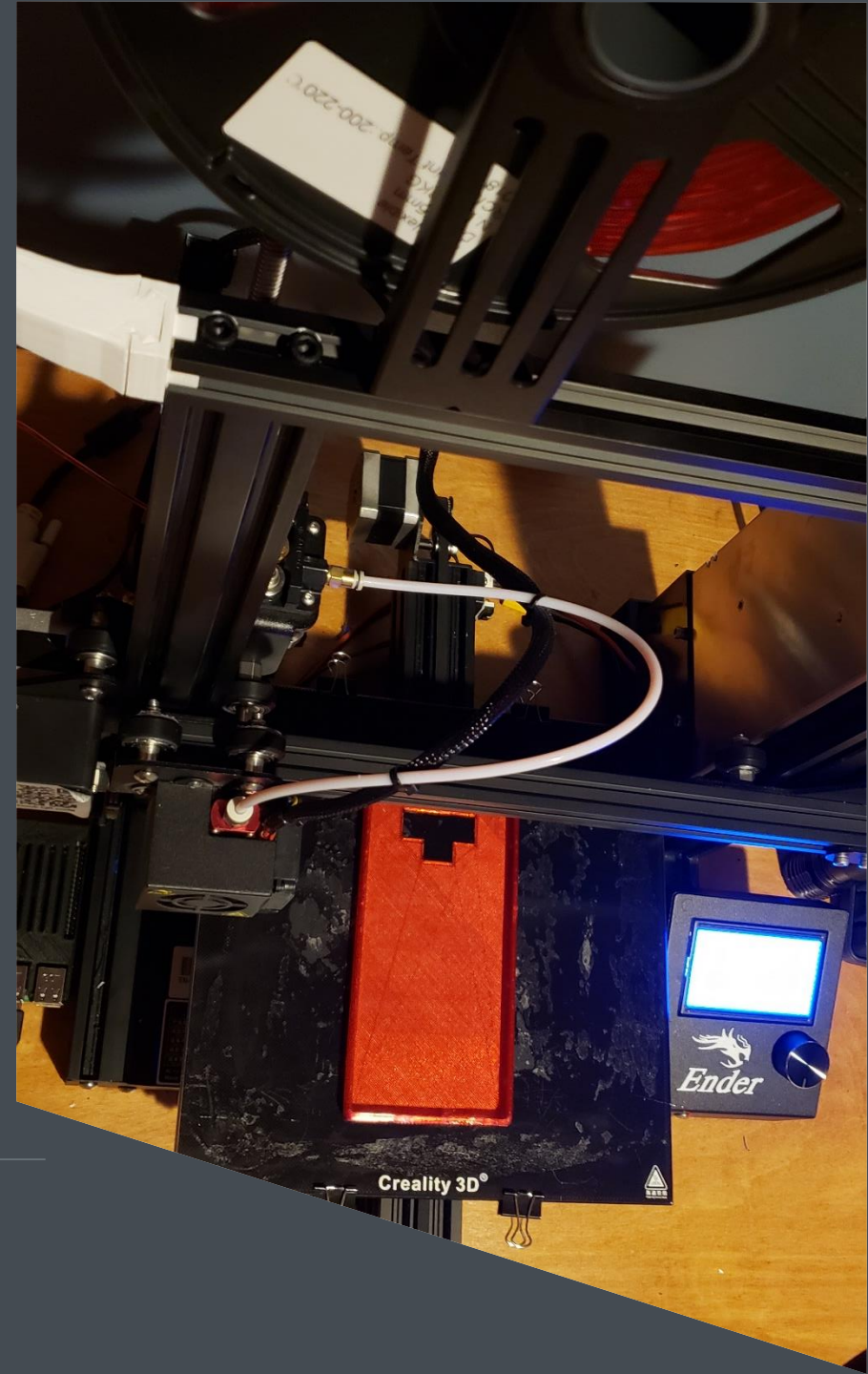


# 3D Printing Basics



# Overview

- Getting set up
- Slicing models
- Building a print server with OctoPi
- Creating your own model



# Getting set up

# Selecting a printer

- Start simple, you can always upgrade later
- A heated print bed is imperative
- Higher temps are better but again, you can always upgrade later
- Look for a robust community for the model you select

# Assembly Tips

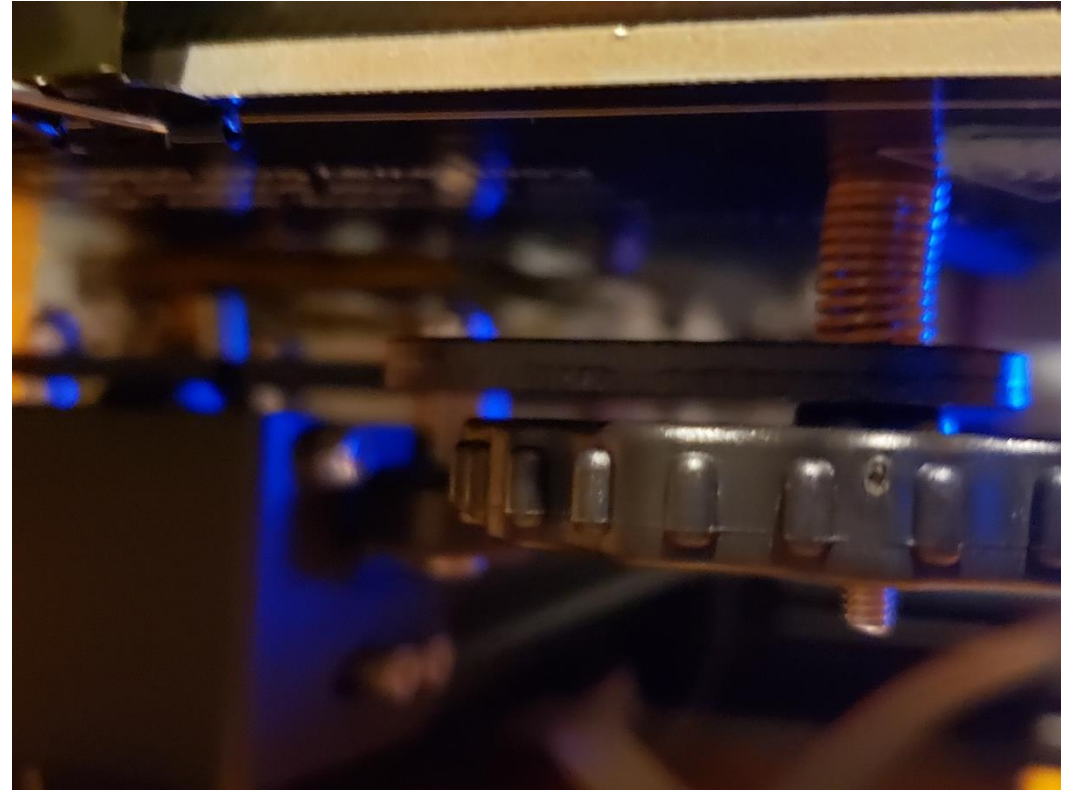
- When assembling extrusion rails tighten slowly and ensure rails are square
- Place your printer on a level surface
- Don't overtighten concentric nuts
- Watch several assembly videos on YouTube before you begin assembling your printer. The printer instructions may not tell you everything you want to know
- Update your firmware!





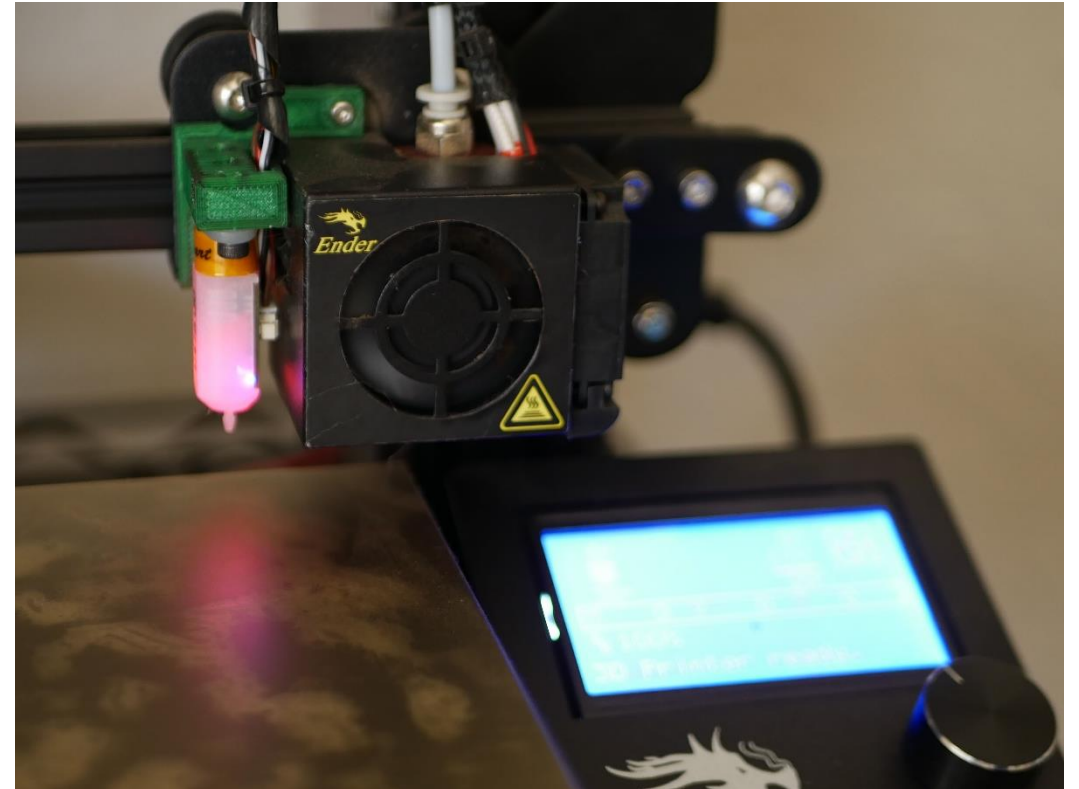
# Manual Bed Leveling

- Demo
- Stiff springs are really helpful



# Automatic Bed Leveling Methods

- Auto-leveling
  - Touch sensor (BL-Touch)
  - Inductive sensor
  - Optical sensor
- May require custom firmware (such as [Marlin](#))



# Choosing a filament



# A little about filament

- Mind your diameter
- Type of plastic
- Quality matters
- Start with a common, brand name PLA
- Many types of plastics to choose from



# PLA – Polylactic Acid

- Most common material
- Biodegradable
- Large diversity of colors
- Large diversity of specialty blends (wood, metal, carbon fiber, etc)
- Low printing temperature (190°-220°C)
- Low glass transition temperature (60°-65°C)
- Moisture issues
- Not suitable for high temperature applications
- Not UV-resistant
- Brittle
- Little or no fumes

# ABS – Acrylonitrile Butadiene Styrene

- Second most common material
- Lower friction coefficient than PLA (easier to extrude)
- Large diversity of colors
- Few specialty blends
- Higher printing temperature (200°-250°C)
- Higher glass transition temperature (~105°C)
- No moisture issues
- Not suitable for high temperature applications
- Not UV-resistant
- Temperature sensitive, prone to warping and layer separation
- Brittle
- Mild fumes possible. Ventilation recommended

# TPE/TPU – Thermoplastic Elastomer / Thermoplastic Polyurethane

- TPU is a type of TPE but is firmer
- Common material
- Higher friction coefficient than PLA (harder to extrude)
- Large diversity of colors
- Flexible and/or stretchable
- Similar printing temperature (210°-240°C)
- Similar glass transition temperature 20°-70°C)
- Higher chemical resistance
- Not suitable for high temperature applications
- Prone to stringing
- Think flexible and impact resistant
- Little or no fumes

# ASA – Acrylonitrile Styrene Acrylate

- Less common material
- Similar to ABS
- Large diversity of colors
- Few or no specialty blends
- Higher printing temperature (230°-250°C)
- Higher glass transition temperature (~110°C)
- No moisture issues
- Not suitable for high temperature applications, but better
- UV-resistant, great for outdoor applications!
- Temperature sensitive, prone to warping and layer separation
- Higher cost
- Mild fumes possible. Ventilation recommended

# PET – Polyethylene terephthalate

- Several variants: PETG, PETE, PETT
- Less common material
- Large diversity of colors
- Glossy and smooth finish
- Few or no specialty blends
- Higher printing temperature (230°-250°C)
- Higher glass transition temperature (75°-90°C)
- No moisture issues
- Not suitable for high temperature applications, but better
- Some grades have UV-resistance, may be suitable for outdoor applications
- Good bed and layer adhesion
- Food-grade (FDA approved) filaments available
- May create intense fumes that are dangerous to people and pets. Ventilation recommended.



# Nylon

- Less common material
- Large diversity of colors
- Few or no specialty blends
- Very high printing temperature ( $>240^{\circ}\text{C}$ )
- Wide range of glass transition temperatures, depending on bed material ( $55^{\circ}\text{-}80^{\circ}\text{C}$ )
- Extremely moisture sensitive, should be dried before printing
- More suitable for high temperature applications
- Some grades have UV-resistance, may be suitable for outdoor applications
- Temperature sensitive, prone to warping and layer separation
- Extremely tough and impact resistant
- May create intense fumes that are dangerous to people and pets. Ventilation recommended.

# Finding and Making Models

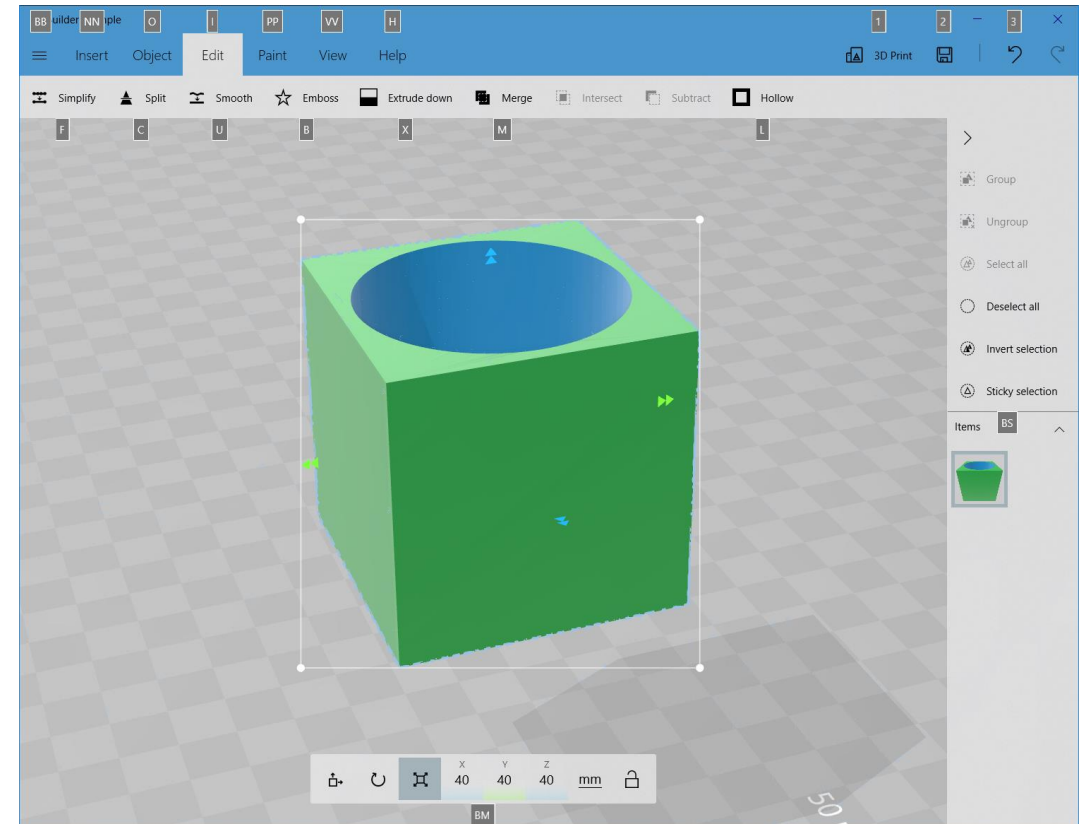
# About printable models

- STL Format
    - (STereoLithography, Standard Triangle Language, Standard Tessellation Language)
    - Created by 3D Systems
    - Common format for 3D-printable models
    - Also common for CNC Routing
    - See [http://www.fabbers.com/tech/STL\\_Format](http://www.fabbers.com/tech/STL_Format)
  - 3MF Format
    - 3D ManuFacturing
    - Common format for 3D-printable models and slicers
    - Contains all necessary model, material, and property information
    - See <https://3mf.io/>
  - Many 3D design apps can output to STL or 3MF
- Finding models
    - [thingiverse.com](http://thingiverse.com)
    - [turbosquid.com](http://turbosquid.com)
    - [cgtrader.com](http://cgtrader.com)
    - [myminifactory.com](http://myminifactory.com)

# Creating 3D Models

- SketchUp
  - Has plugins for importing/exporting STL files
  - Free version
- Autodesk Tinkercad
  - All online
  - Free
- Microsoft 3D Builder
  - Free for Windows 8.1/10
- Others
  - Autodesk AutoCAD
  - Blender
  - FreeCAD
  - More

# Demonstration



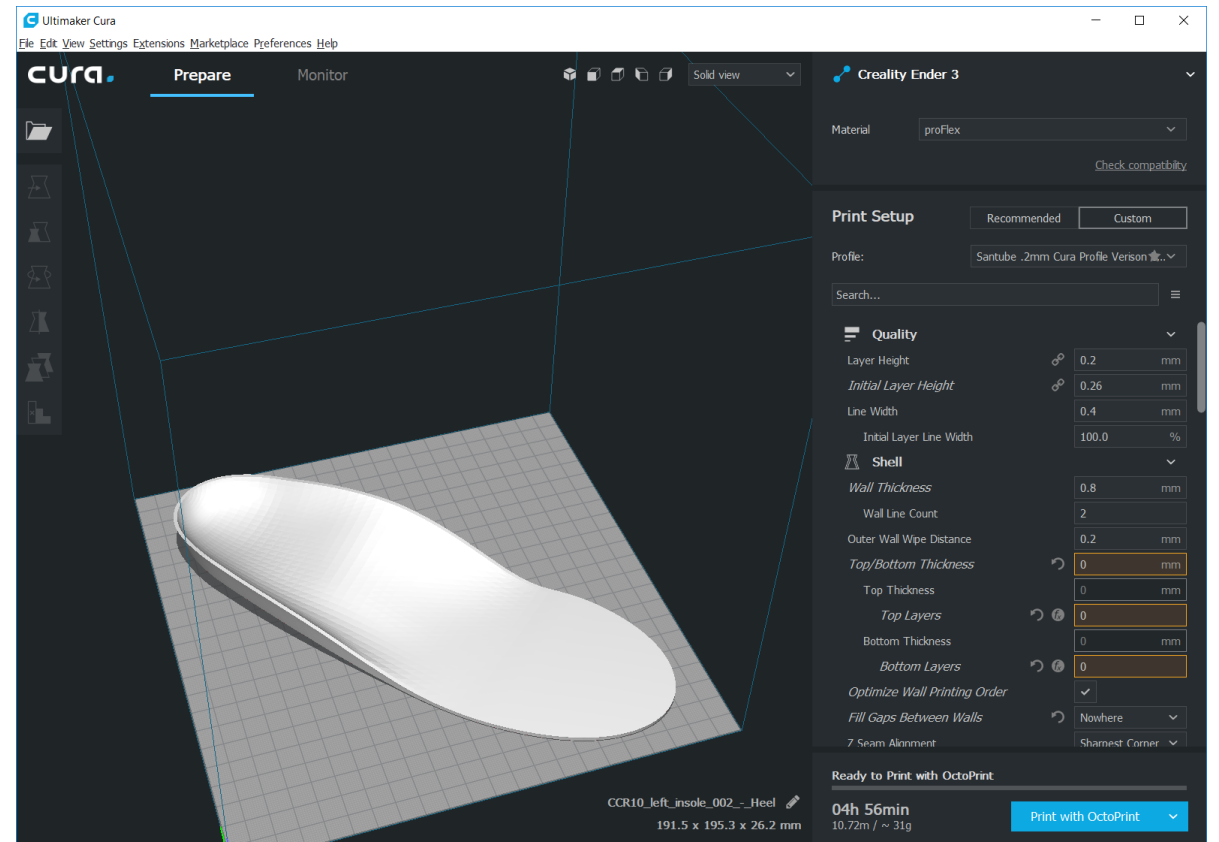
# Preparing the Model



# Slicing

- Applies printer and material-specific parameters to the model
  - Slices the model and produces optimized instructions for the printer to follow
  - Allows the user to customize parameters to produce better prints
- Some Popular Slicers
    - [Ultimaker Cura](#)
    - [Slic3r](#)
    - [Repetier-Host](#)
    - [Raise3D ideaMaker](#)
    - Many others

# Slicer Demo



# Adding a Print Server

# OctoPrint

- Provides a web interface for remote control and monitoring
- Powerful plugin system
- Integration with slicer software (such as Cura) for direct printing
- Can be run on a Raspberry PI using OctoPi
  - Raspberry PI 3B or 3B+ recommended
  - Download at <https://octoprint.org/download>
  - Note slightly different Wi-Fi configuration
  - Can support web cam or Pi Camera

# OctoPrint

OctoPrint

🔧

🔌

🔔

jsruckeba

📶 Connection

📶

State

State: **Operational**

File:

Timelapse: -

Approx. Total Print Time: -

Print Time: -

Print Time Left: -

Printed: -

🖨️ Print

⏸️ Pause

🚫 Cancel

📁 Files

🔍

Search...

CCR10\_Base\_plate\_Tool\_holder\_Endr3.gcode

Uploaded: 9 days ago

Size: 13.6MB

📄 📁 🗑️

CCR10\_Cable Chain 15 Links.gcode

Internal: CCR10\_Cable\_Chain\_15\_Links.gcode

Uploaded: a month ago

Size: 8.6MB

📄 📁 🗑️

CCR10\_Camera Housing Top V2.gcode

Internal: CCR10\_Camera\_Housing\_Top\_V2.gcode

Uploaded: 3 months ago

Free: 5.2GB / Total: 7.2GB

📁 Create folder...

📄 Upload

📄 Upload to SD

Hint: You can also drag and drop files on this page to upload them.

Temperature

Control

GCode Viewer

Terminal

Timelapse

300°C

250°C

200°C

150°C

100°C

50°C

🦑

Actual T: 23.9°C

Target T: off

Actual bed: 64.6°C

Target Bed: 65.0°C

-12 min

-10 min

-8 min

-6 min

-4 min

-2 min

	Actual	Target	Offset
Tool	23.9°C	<div>⬅️ off °C ➡️</div> <div>✅</div>	<div>0 °C</div> <div>🔧</div> <div>🗑️</div>
Bed	64.6°C	<div>⬅️ 65 °C ➡️</div> <div>✅</div>	<div>0 °C</div> <div>🔧</div> <div>🗑️</div>

# OctoPrint

OctoPrint

Connection

State

State: **Operational**

File: **CCR10\_Cable Chain 15 Links.gcode**

Timelapse: -

Filament (Tool 0): 10.22m

Approx. Total Print Time: 7.5 hours

Print Time: -

Print Time Left: -

Printed: - / 8.6MB

Print

Pause

Cancel

Files

Search...

CCR10\_Base\_plate\_Tool\_holder\_End  
r3.gcode  
Uploaded: 9 days ago  
Size: 13.6MB

CCR10\_Cable Chain 15 Links.gcode  
Internal: CCR10\_Cable\_Chain\_15\_Links.gcod  
e  
Uploaded: a month ago  
Size: 8.6MB

CCR10\_Camera Housing Top V2.gcod  
e  
Internal: CCR10\_Camera\_Housing\_Top\_V2.g  
code  
Uploaded: 3 months ago

Free: 5.2GB / Total: 7.2GB

Create folder...

Upload

Upload to SD

Hint: You can also drag and drop files on this page to upload them.

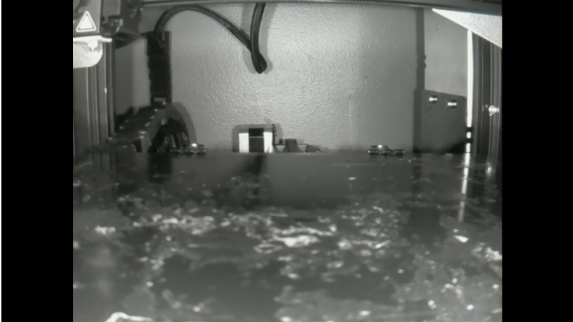
Temperature

Control

GCode Viewer

Terminal

Timelapse



Hint: If you move your mouse over the picture, you enter keyboard control mode.

X/Y

Z

Tool (E)

General

↑

←

→

↓

0.1

1

10

100

Feed rate:100%

↑

←

→

↓

Extrude

Retract

Flow rate:100%

Select Tool...

5 mm

Extrude

Retract

Flow rate:100%

Motors off

Fan on

Fan off

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# OctoPrint

Connection

State

State: **Operational**

File:  
**CCR10\_MinecraftLegoSword.gcode**

Timelapse: -

Filament (Tool 0): 17.70m

Approx. Total Print Time: 5.5 hours

Print Time: -

Print Time Left: -

Printed: - / 11.3MB

Print

Pause

Cancel

Files

Search...

CCR10\_Main\_Frame.gcode

Uploaded: 9 days ago

Size: 31.6MB

CCR10\_MinecraftLegoSword.gcode

Uploaded: 4 days ago

Size: 11.3MB

CCR10\_MultiPi -- Raspberry Pi Cluster Case! by jesse76 - Thingiverse.gcode

Internal: CCR10\_MultiPi\_-\_Raspberry\_Pi\_Cluster\_Case\_by\_jesse76\_-\_Thingiverse.gcode

Uploaded: 2 months ago

Size: 2.7MB

CCR10\_multi base.octocore

Free: 5.2GB / Total: 7.2GB

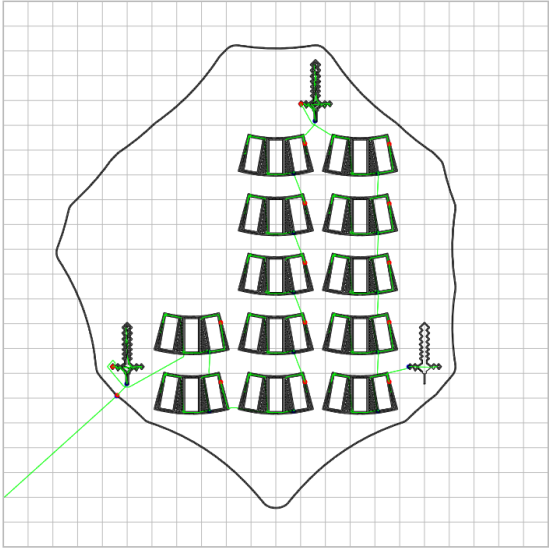
Create folder...

Upload

Upload to SD

Hint: You can also drag and drop files on this page to upload them.

Temperature Control GCode Viewer Terminal Timelapse



Previous layer

Next layer

Analyzed

Model info

Model size: 182.63mm x 186.96mm x 10.92mm

Estimated total print time: 4 hours

Estimated layer height: 0.27mm

Layer count: 41 printed, 54 visited

Renderer options

☒ Sync with job progress

☐ Center viewport on model

☐ Zoom in on model

☒ Show moves

☒ Show retracts

☐ Also show previous layer

Layer info

# OctoPrint

OctoPrint

jshuckeba

Connection

State

State: **Operational**

File:  
**CCR10\_MinecraftLegoSword.gcode**

Timelapse: -

Filament (Tool 0): **17.70m**

Approx. Total Print Time: **5.5 hours**

Print Time: -

Print Time Left: -

Printed: - / **11.3MB**

Print

Pause

Cancel

Files

Search...

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Uploaded: 2 months ago

Size: 2.7MB

CCR10\_multiPi\_base.gcode

Free: 5.2GB / Total: 7.2GB

Create folder...

Upload

Upload to SD

Hint: You can also drag and drop files on this page to upload them.

Temperature

Control

GCode Viewer

Terminal

Timelapse

Send: M105

Recv: ok T:23.0 /0.0 B:49.0 /0.0 T0:23.0 /0.0 @:0 B@:0

Send: M105

Recv: ok T:22.9 /0.0 B:48.9 /0.0 T0:22.9 /0.0 @:0 B@:0

Send: M105

Recv: ok T:23.0 /0.0 B:48.7 /0.0 T0:23.0 /0.0 @:0 B@:0

Send: M105

Recv: ok T:22.7 /0.0 B:48.5 /0.0 T0:22.7 /0.0 @:0 B@:0

Send: M105

Recv: ok T:22.9 /0.0 B:48.4 /0.0 T0:22.9 /0.0 @:0 B@:0

Send: M105

Recv: ok T:23.0 /0.0 B:48.3 /0.0 T0:23.0 /0.0 @:0 B@:0

Send: M105

Recv: ok T:22.7 /0.0 B:48.2 /0.0 T0:22.7 /0.0 @:0 B@:0

Send: M105

Recv: ok T:22.9 /0.0 B:48.0 /0.0 T0:22.9 /0.0 @:0 B@:0

Send: M105

Recv: ok T:22.6 /0.0 B:47.9 /0.0 T0:22.6 /0.0 @:0 B@:0

Send: M105

Send

Autoscroll | showing 308 lines (Scroll to end)

☐ Suppress temperature messages

☐ Suppress SD status messages

☐ Suppress wait responses

Advanced options

Copy all

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# A Little About GCode

# GCode

- Numerical control programming language for industrial applications
  - Is implemented by most RepRap printers
  - Is generated by slicer software
  - Can be modified to create highly customized prints (allow filament changes, etc)
  - Note: Not all firmware supports all commands the same
  - See <https://www.reprap.org/wiki/G-code>
- Numerical units usually millimeters for RepRap
  - Useful commands to know
    - M0 (stop / wait for user)
    - G28 (move to origin / home)
    - G1 (Linear Move)
      - X (x-axis)
      - Y (y-axis)
      - Z (z-axis)
      - F (acceleration)
      - E (extruder)

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- [www.linkedin.com/company/AgileThought](http://www.linkedin.com/company/AgileThought)
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Jeremy Huckeba

[github.com/jshuckeba/3DPrinting](https://github.com/jshuckeba/3DPrinting)

[linkedin.com/in/jshuckeba](https://linkedin.com/in/jshuckeba)

