



3D Printing:

What's It All About?

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Make Things



- ▶ Ham Specific

- ▶ Cases

- ▶ Knobs

- ▶ Antenna Components

- ▶ Brackets

- ▶ More.....

- ▶ <https://www.thingiverse.com/search?q=ham+radio&type=things&sort=relevant&page=1>

Two Fundamental Ways to Make Things

- ▶ Subtractive – Start with a block of something and remove pieces
 - ▶ Saw
 - ▶ Lathe
 - ▶ Mill / CNC
- ▶ Additive – Start with nothing and add pieces
 - ▶ Injection Molding
 - ▶ 3D Printing

Additive Manufacturing



- ▶ Injection molding
 - ▶ High startup costs
 - ▶ Inexpensive unit cost
 - ▶ Optimal for large volume manufacturing
- ▶ 3D Printing
 - ▶ Low startup costs
 - ▶ Higher unit cost
 - ▶ Slower manufacturing
 - ▶ Optimal for small(ish) manufacturing runs

3D Printing in manufacturing



Types of 3D Printing

- ▶ SLA – Stereo Lithography (i.e. resin)
 - ▶ Extremely fine detail (jewelry)
 - ▶ Small models
 - ▶ Moderately fast
 - ▶ Hazardous chemicals
- ▶ FDM – Fused Deposition Modeling (i.e. filament)
 - ▶ Fine detail
 - ▶ Large models
 - ▶ Slow
 - ▶ Non toxic

Types of 3D printing (cont)

- ▶ Resin
 - ▶ Expose a resin to UV light to cause it to harden
 - ▶ Can use a UV laser to irradiate a bit at a time
 - ▶ Can use a UV light source and mask to irradiate a layer at a time
- ▶ FDM
 - ▶ Melt a filament and deposit it point by point

Resin Printing



Resin Printing



Process

- ▶ Start with a 3D model (.sls file)
- ▶ Use software to slice it into layers and plot the path for the print head or laser
- ▶ Download file to printer and go

FDM Printer

Think numerically controlled glue gun!
(demo)

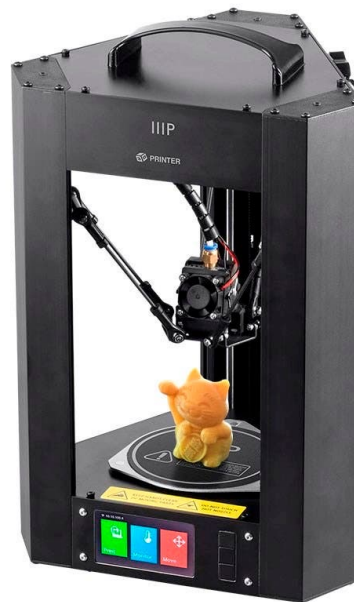
Printer types

- ▶ Cartesian
- ▶ Delta
- ▶ Single head /single material/color
- ▶ Multi-head / multimaterial/color
- ▶ Direct Drive
- ▶ Bowden Tube

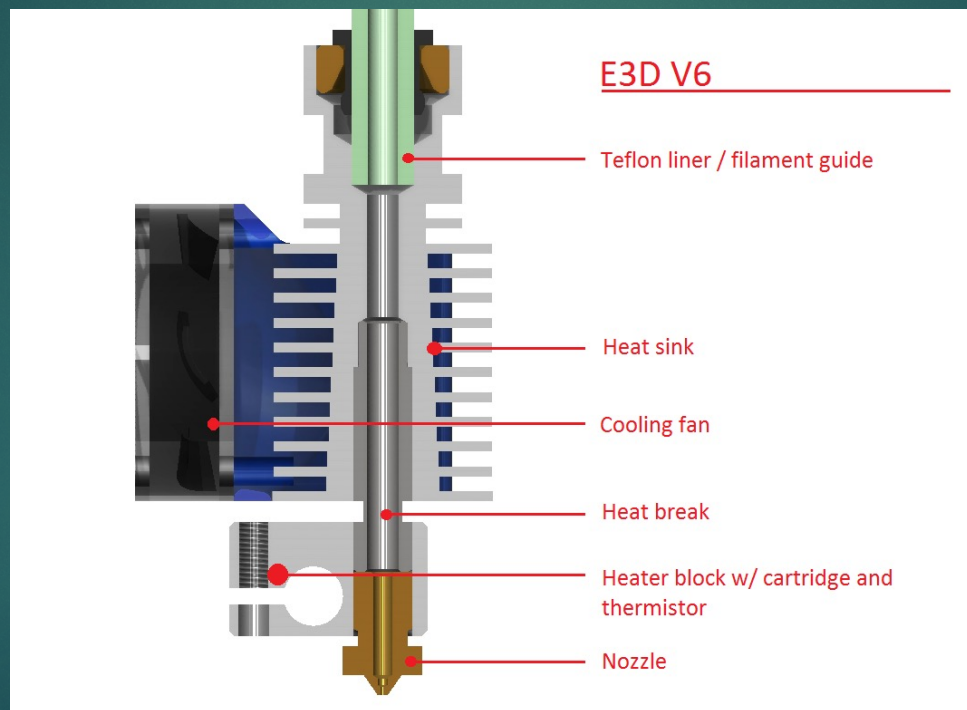
Cartesian



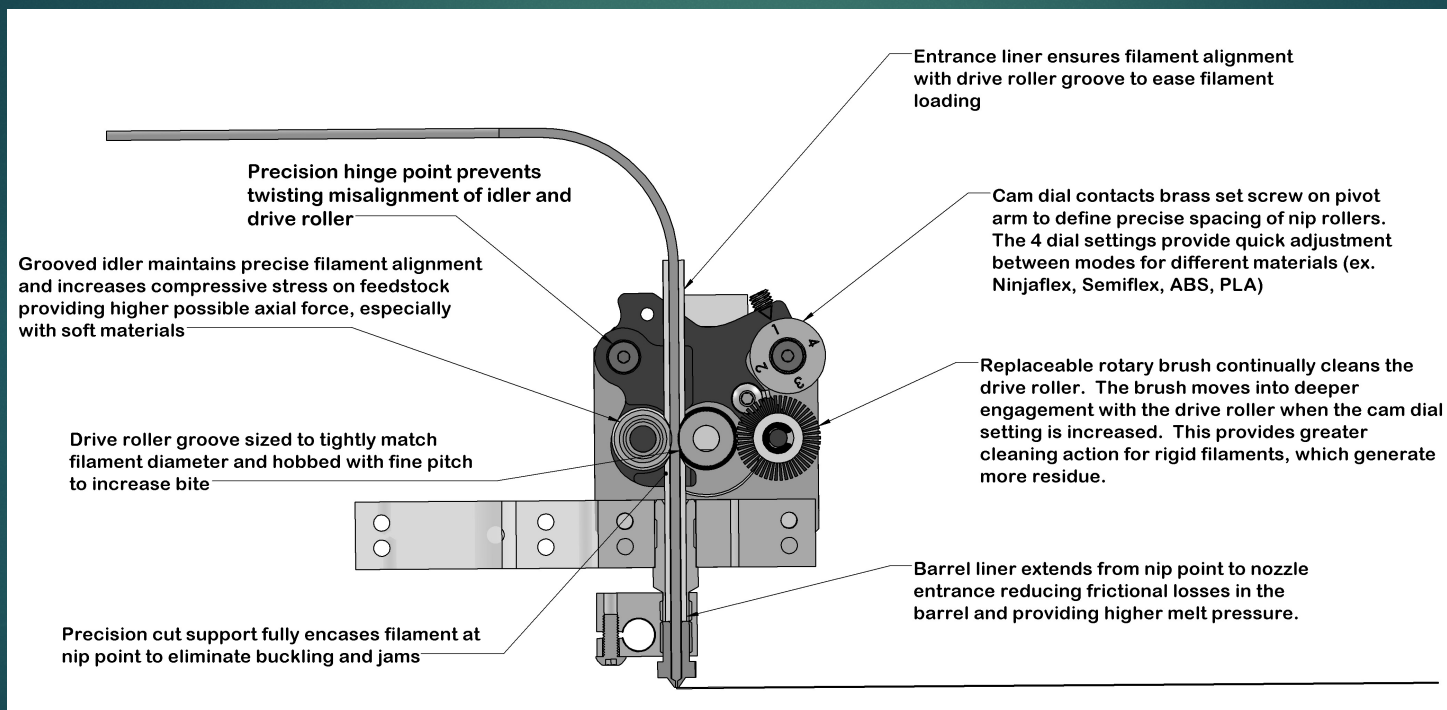
Delta



Hot End

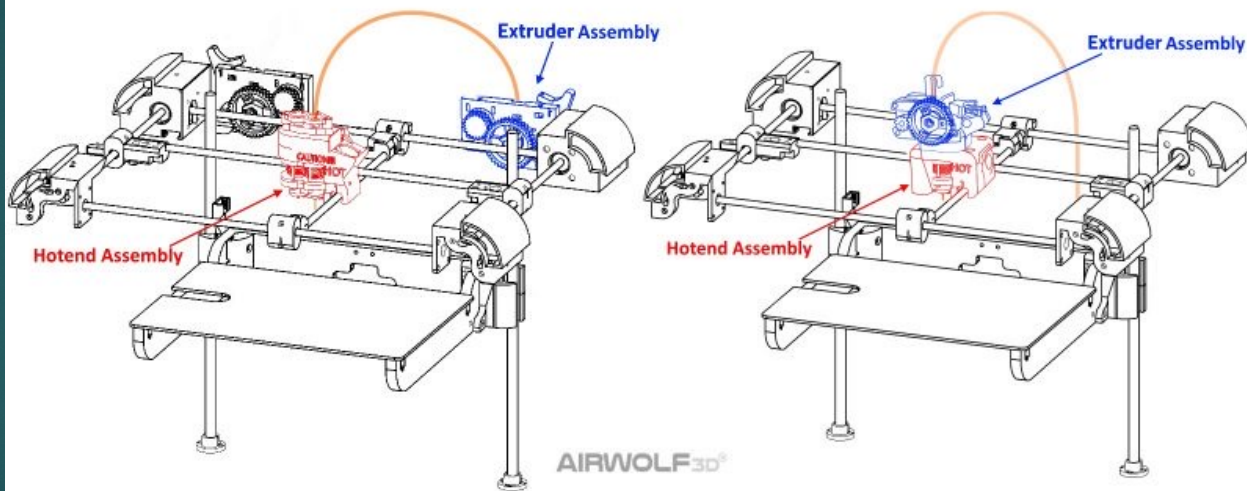


Extruder

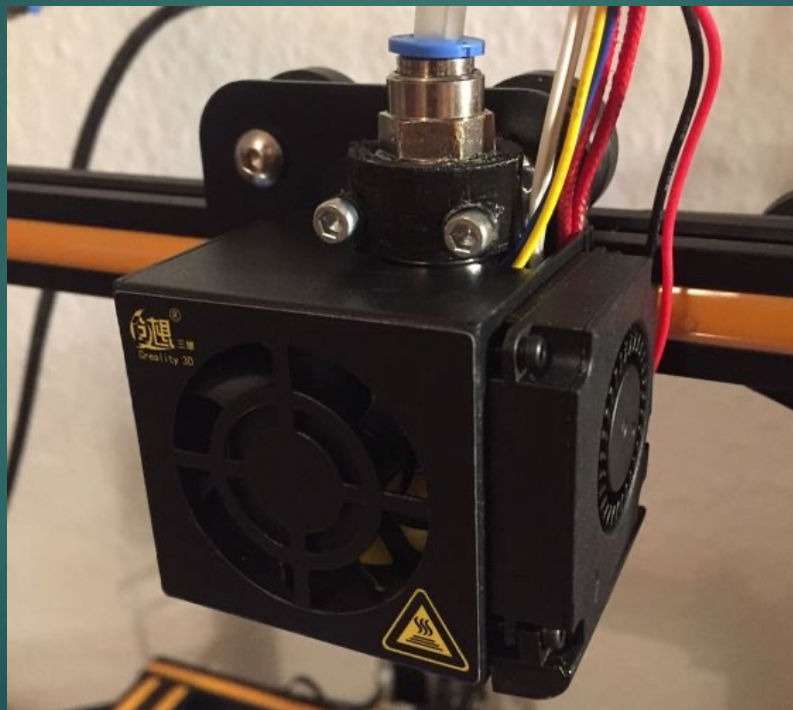


Bowden vs Direct Drive

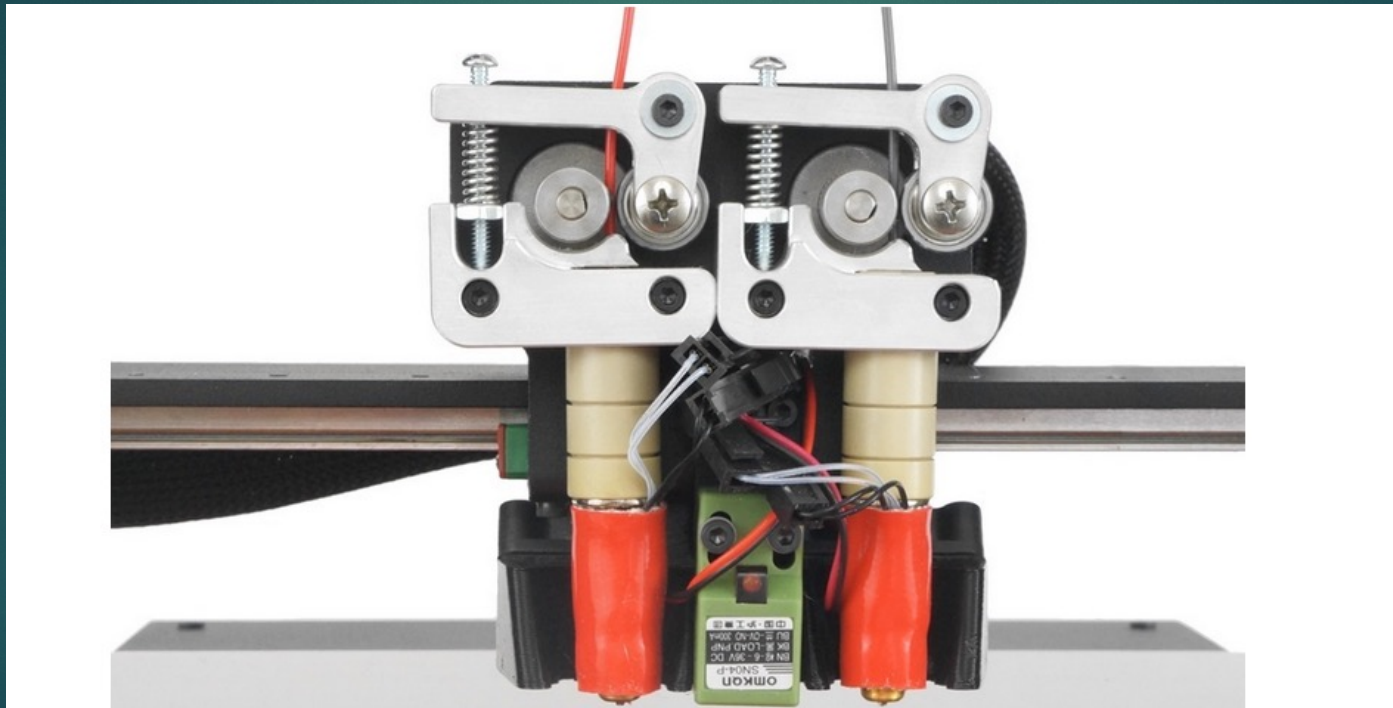
Bowden VS Direct Drive



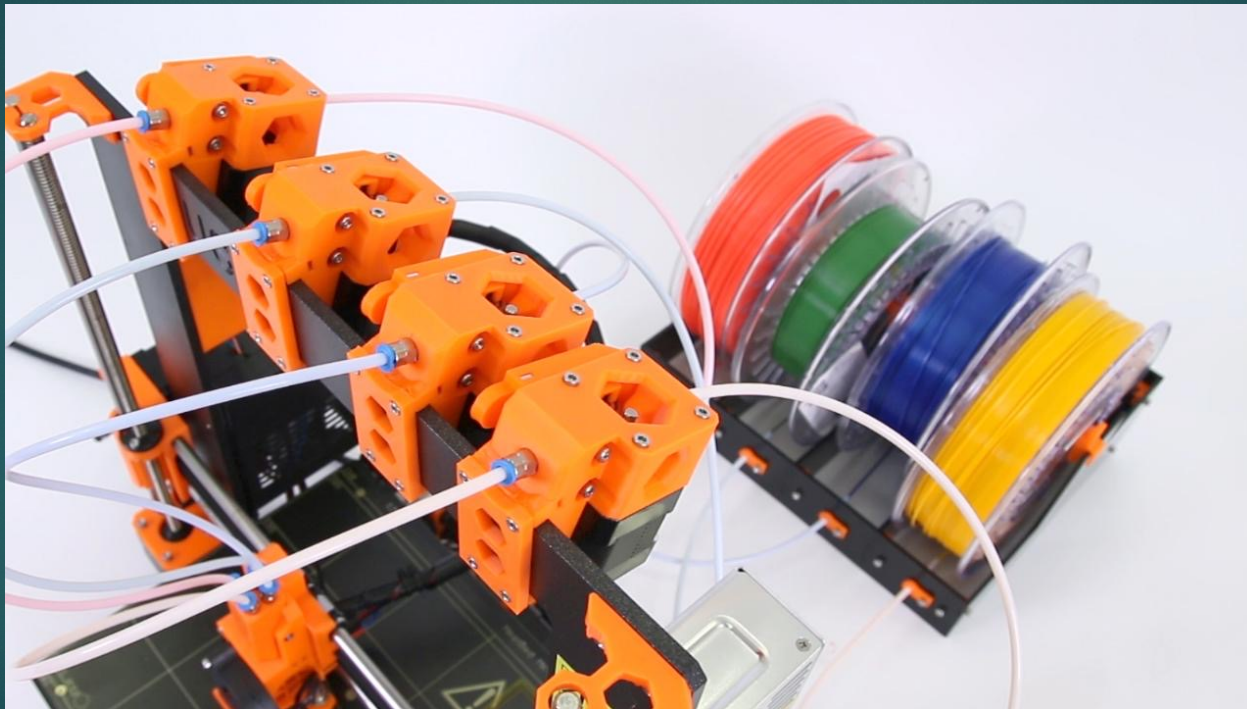
Single Head



MultiHead or ...



Single Head Multithread



or spliced filament



4 separate colors
of filaments in

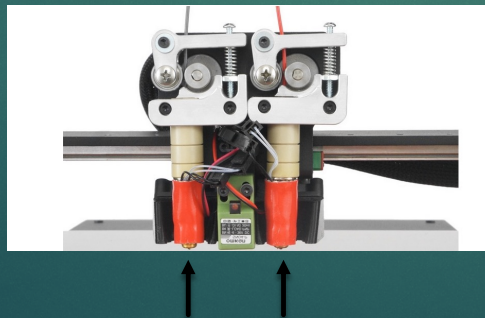
"Magic"

1 multi-color
filament out

MultiHead Issues

Physics

- ▶ Increased Mass
- ▶ Aligning Head Level of all heads is critical
- ▶ Reduced print area due to the side-by-side heads



Spliced Filament Issues

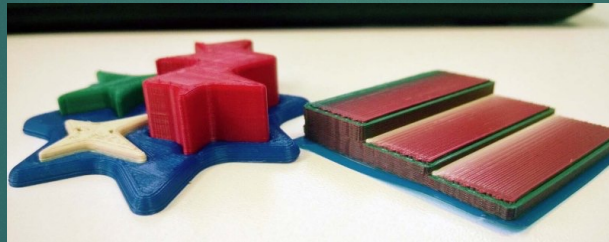
Synchronization

- ▶ Syncing filament transitions (linear) with changes in filament layer / objects

Single Head, Multifilament Issues

Waste Towers

- Uses extra filament to purge nozzle between filament changes



Materials

- ▶ PLA
- ▶ ABS
- ▶ Nylon
- ▶ PETG
- ▶ TPU
- ▶ Carbon Fiber
- ▶ Wood infused
- ▶ Metal infused

Slicer Settings

- ▶ Nozzle Temp
- ▶ Bed Temp
- ▶ Layer Height
- ▶ Support
- ▶ Bed Adhesion
- ▶ Infill
- ▶ + over 100 others

Slicer Demo

► Cura 4.12

What should I buy?

- ▶ Like many things in life, it depends
- ▶ My recommendation for an inexpensive FDM printer
 - ▶ 220 x 220 print bed
 - ▶ Heated print bed
 - ▶ Huge installed user base (i.e. great online support)
 - ▶ Mods (think hot rodding your Chevy)
- ▶ Creality Ender 3 : \$189 Amazon
- ▶ Creality Ender 3 v2 (enhanced from original): \$279 Amazon

Online Resources

- ▶ Things to Print

- ▶ <https://www.thingiverse.com/>
- ▶ <https://www.myminifactory.com/>

- ▶ Troubleshooting

- ▶ <https://www.matterhackers.com/articles/3d-printer-troubleshooting-guide>

- ▶ General Info

- ▶ <https://all3dp.com/>

- ▶ Webcasts

- ▶ Makers Muse - <https://www.youtube.com/channel/UCxQbYGpbdrh-b2ND-Aflybq>
- ▶ Thomas Sanladerer - <https://www.youtube.com/user/ThomasSanladerer>
- ▶ Teaching Tech - <https://www.youtube.com/channel/UCbgBDBrwsikmtoLqtpc59Bw>
- ▶ 3D Printing Nerd - https://www.youtube.com/channel/UC_7aK9PpYTqt08ERh1MewlQ