3D Printing for Amateur Radio

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Overview

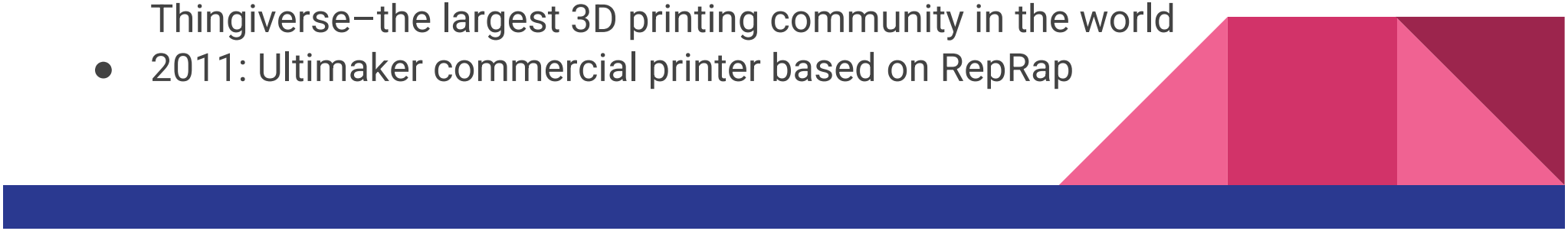
- History of 3D printing
- Printer types, vendors, methods and materials
- 3D project sources
- Creating / modifying projects (STL)
- Converting a project to printer code (Gcode)
- Best practices / lessons learned
- Example ham radio projects
- Q&A and additional resources

The birth of 3D printing: 1980s

- 1981:Dr. Hideo Kodama's rapid prototyping machines created parts layer by layer, using a resin polymerized by UV light
- 1986: first stereolithography patent (SLA) filed by Chuck Hull, "the inventor of 3D printing" who created and commercialized SLA and .stl - the most common 3D printing file type
- 1988: Carl Deckard licensed selective laser sintering (SLS) technology – another type of 3D printing that uses a laser to sinter powdered material into solid structures.
- 1989: Scott Crump patented fused deposition modeling (FDM) and founded Stratasys, one of the main players in the 3D printing industry to this day
- 1989: Chuck Hull's company, 3D Systems Corporation, released the SLA-1 3D printer

2000s: 3D printing takes off

- Additional companies were founded and material types developed in the 1990s but it wasn't until the early 2000s that things really took off
- 2005: Open source "RepRap" project created a 3D printer which became an inspiration for every low-cost 3D printer from that point on
  - 3D printer made of plastic parts that could be printed by the RepRap itself–owners of a RepRap could print another 3D printer – yielding "self-replicating" parts, tools, and designs.
- Mid 2000s: many of the 1980s FDM patents became public domain, fueling a surge of new printer manufacturers
- 2009: Makerbot introduces open-source "DIY" 3D printer kits and creates Thingiverse–the largest 3D printing community in the world
- 2011: Ultimaker commercial printer based on RepRap



3D printing today and in the future

- 3D printing is available from desktop “DIY” printers all the way to industrial and commercial printers–including concrete printers capable of printing buildings!
- The 3D printed mold and tool market was valued at $5.2 billion in 2020 – with growth projected to $21 billion by 2030
- End user parts market also projected to grow to $19B by 20390
- What’s next? AI? We will see….!

Major 3D printing types

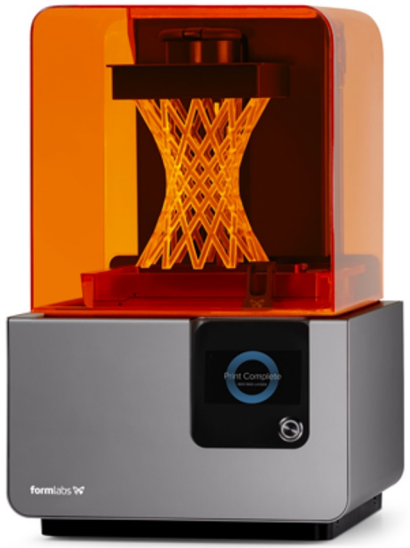
Fused Filament Fabrication (FFF) aka Fused Deposition Modeling (FDM) (most popular)

- Uses a continuous filament of a thermoplastic material, fed from a large spool through a moving, heated printer extruder head that is deposited on the growing work.
- The print head is moved in 2 dimensions under computer control to define the printed shape, and the work or the print head is moved vertically by a small amount to begin a new layer.

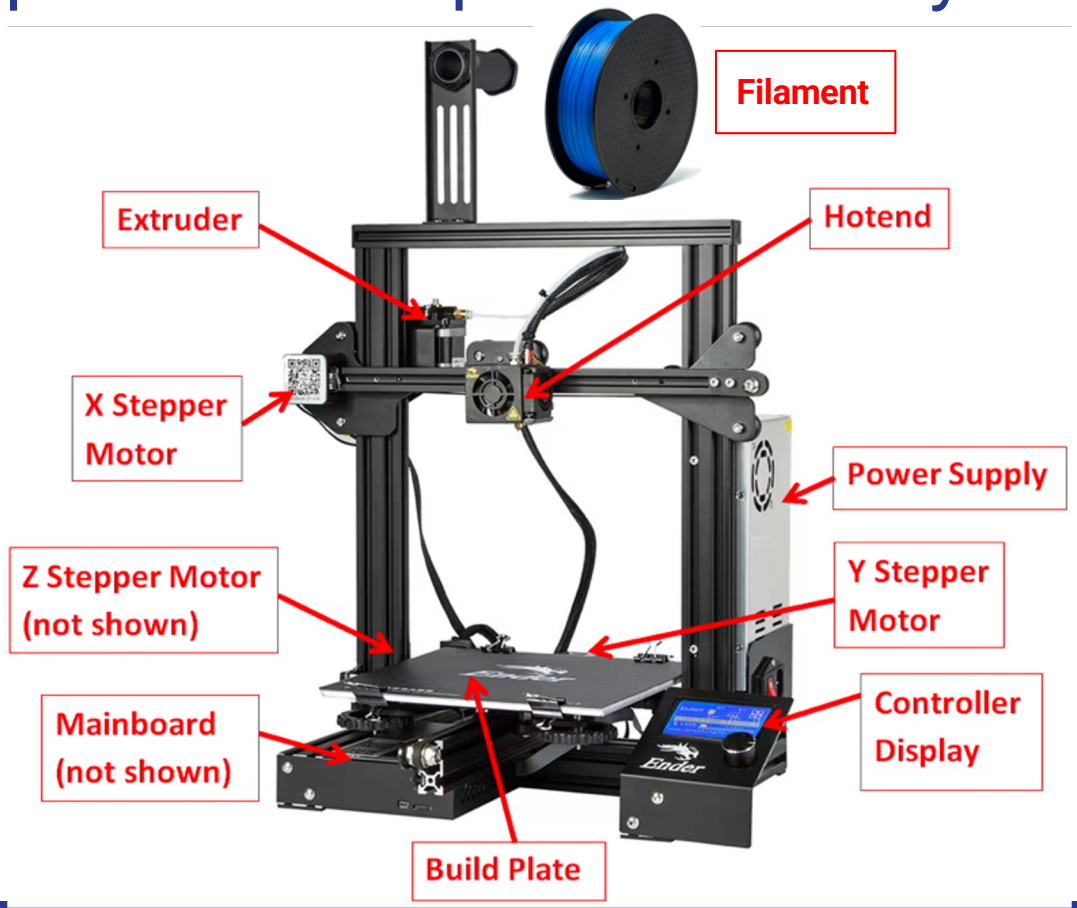
Major 3D printing types

Stereolithography (SLA)

- Focuses ultraviolet (UV) laser on to a vat of photopolymer resin to draw a pre-programmed design or shape on to the surface of the photopolymer vat.
- Photopolymers are sensitive to ultraviolet light, so the resin is photochemically solidified and forms a single layer of the desired 3D object.
- The build platform lowers one layer and a blade recoats the top of the tank with resin.
- Process is repeated for each layer of the design



Example home 3D printer: Creality Ender 3 Pro ($200)



Major home 3D printer manufacturers

- Creality
- Makerbot
- Prusa
- Stratasys
- Ultimaker

...and dozens more....!

3D printing filament types

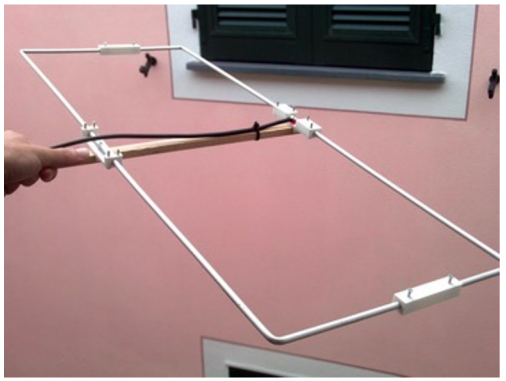
- PLA (Polylactic Acid) (a bioplastic made from corn!)
  - Most people start printing with PLA as it's forgiving and easy to use; low melting temp makes it prone to warping. PLA is brittle and doesn't flex well.
- PETG (Polyethylene terephthalate glycol-modified)
  - UV-resistant, trickier to print than PLA but easier than ABS; not prone to warping.
- ABS (Acrylonitrile Butadiene Styrene)
  - ABS is tricky to print (high melting temp) but produces strong prints that are impact resistant, wear resistant and can ensure high temps.. Typically requires a printing enclosure
- Polypropylene
  - Flexible with good impact and fatigue resistance; tricky to print and expensive
- Exotic materials
  - Metal-filled, wood-filled, carbon fiber-filled

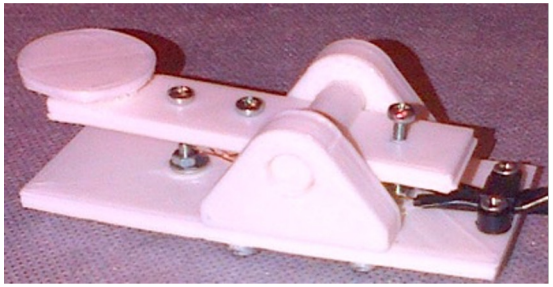
Great resource: https://www.simplify3d.com/resources/materials-guide/

Finding projects to print / modify

Free and paid sources:

- All3dp.com
- Cults3d.com
- Myminifactory.com
- Pinshape.com
- Printables.com
- Thangs.com
- Thingiverse.com

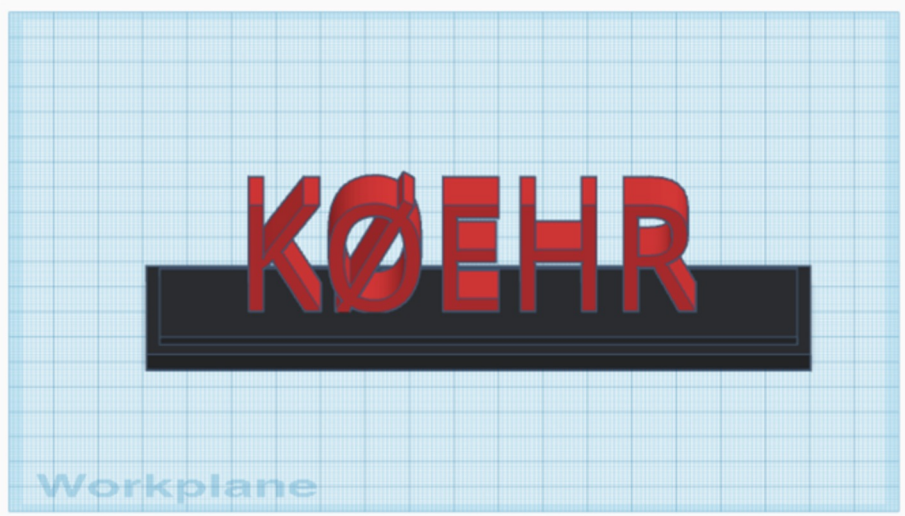




Creating and modifying 3D projects

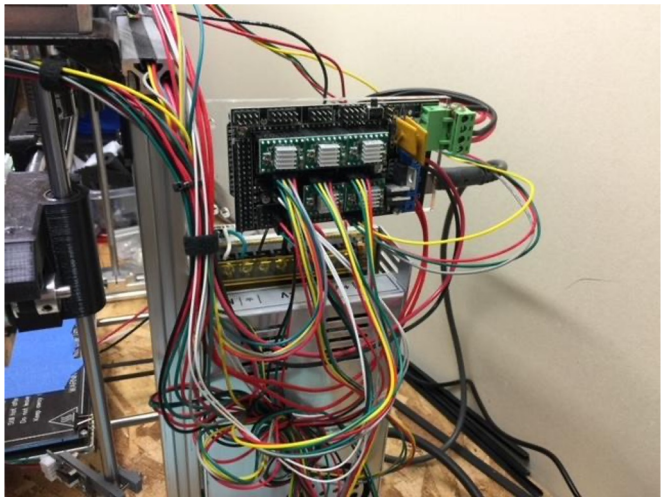
3D Computer Aided Design (CAD) allows you to create new or modify existing projects. Some are free and some are paid. Examples include:

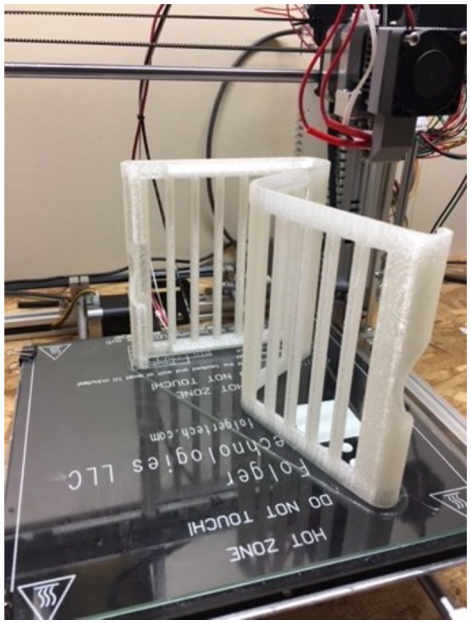
- AutoCAD
- Blender
- FreeCAD
- OpenSCAD
- Shapr3D
- Sketchup
- TinkerCAD



My experience with 3D printers

Started in 2015 with an inexpensive kit





Slicing: converting a project to Gcode

A slicer “*slices*” model into layers to be printed

Cura slicer - Creality & others - free

Prusa Slicer - free

Slic3er - Open Source Free

Simplify3D - Paid

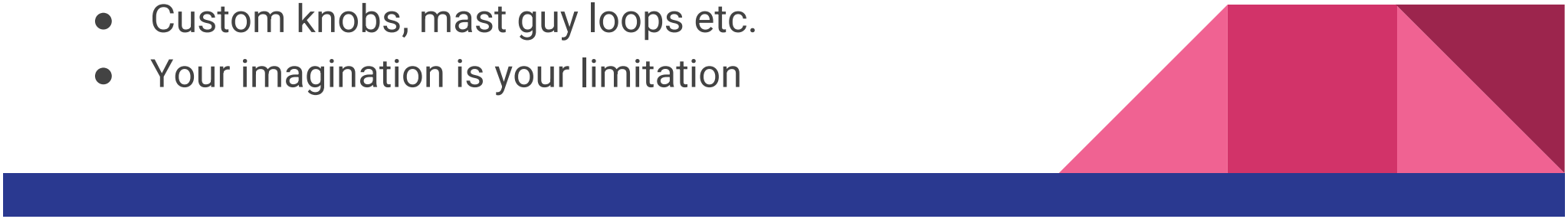
Demo - get file and prep for printing

Printables.com - K6ARK paddles

Creality Slicer - Slice file and save gcode

Example ham radio 3D printable projects

- Antennas / antenna parts
- Callsign plaques
- CW keys
- Go kit boxes
- Microphone clips
- Project boxes and cases
- Radio stands
- Wire antenna winders
- Custom knobs, mast guy loops etc.
- Your imagination is your limitation



Q&A / Conclusion

3D printing has gotten to be very popular

Easier than ever to 3D print, but still needs patience

Lots of support: forums, FaceBook groups & Youtube

Additional resources

Don’t want to buy your own 3D printer? Go to a local library or have it printed!

- Arapahoe County Library: https://arapahoelibraries.org/3d-printing/
- Denver Public Library ideaLAB: https://www.denverlibrary.org/idealab3D
- Denver 3D Print; https://denver3dprint.com/
- Shapeways: https://www.shapeways.com/
- Xometry (commercial 3D printing): https://www.xometry.com
- ..and many others