3D Printing for Ham Radio

Tim Deagan KJ8U

AUSTIN
TEXAS
KJ8U

Should You Care About 3D Printing as a Ham?

Are you a:

- **MAKER HAM** - likes to build kits and antennas, design components, upgrade and tweak gear == **YES, 3D PRINTING IS FOR YOU**

- **SOCIAL HAM** - Equipment is just a tool for connecting with other Hams == **PROBABLY NOT, 3D PRINTING IS MORE FIDDLY BITS**

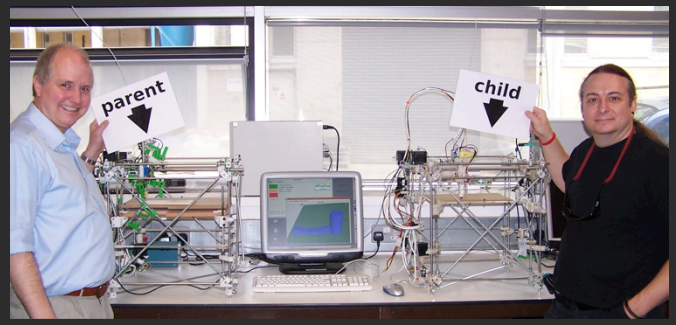
Why did 3D printing explode in the last 10 years?

Patents:

"3D printing has been around for about 30 years, which means that some of the earliest patents in this space are fond memories. From 2002 to 2014, about 225 early 3D printing patents expired. About 16 key patents relating to 3D printing processes called Material Extrusion, Powder Bed Fusion, and Vat Photopolymerization expired in 2013-14. This means that 3D printing technology that is at least 20 years old is now available for anyone to use." *John F. Hornick, 2016, https://www.finnegan.com/en/insights/articles/how-patents-die-expiring-3d-printing-patents.html*

RepRap (**Rep**licating **Rap**id-Prototyper):

In 2008, Adrian Bowyer and Vik Oliver used an open-source design 3D printer to successfully print all the (unique) parts to make a copy of itself. *https://reprap.org/wiki/About*

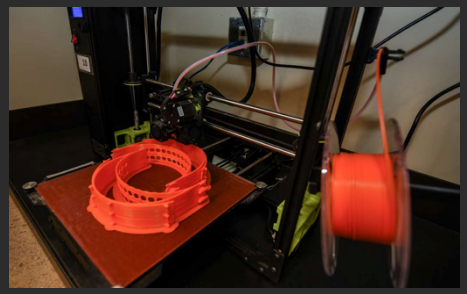


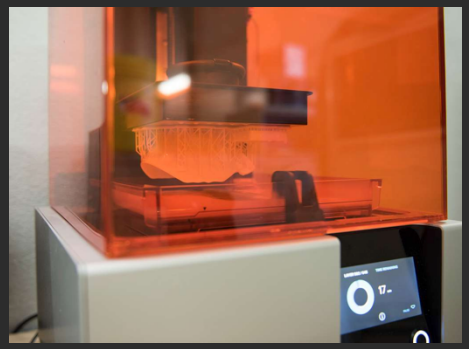
Common 3D Printing Methods
(aka Additive Manufacturing)

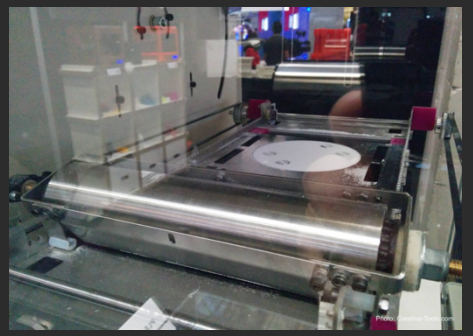
FDM (Fused Deposition Modelling) - Spools of plastic filament melted and applied to successive layers. What most people think of as a '3D Printer'

Resin - Photopolymer resin cured by UV light in successive layers

Laser Sintering/Melting - Commercial process using lasers to harden successive layers of powder (including plastic, ceramic, metal)





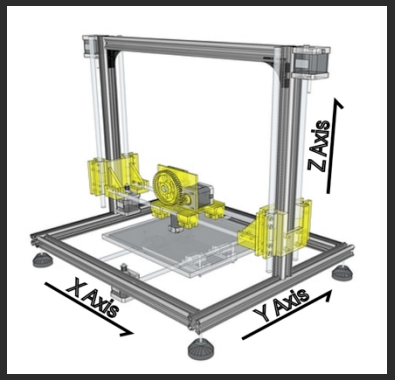


Essential Anatomy of a 3D Printer

Cartesian Movement

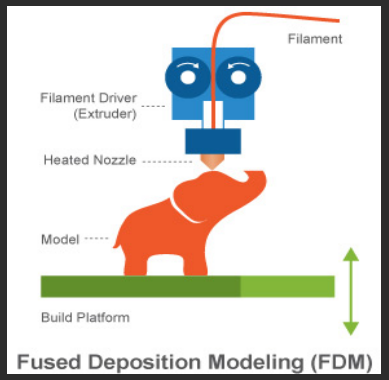
(X-Y-Z)

Stepper Motors



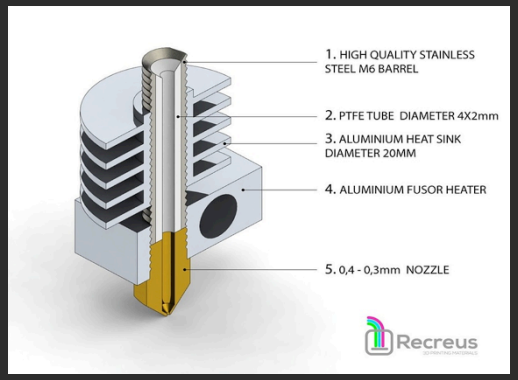
Filament Extruder

Stepper Motor



Hot End

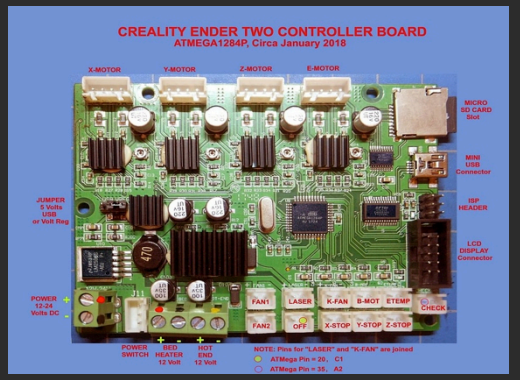
Heater Block



Controller Board

Microcontroller

Motor Drivers



3D Printing Costs

Printer

Creality: $170 - $250

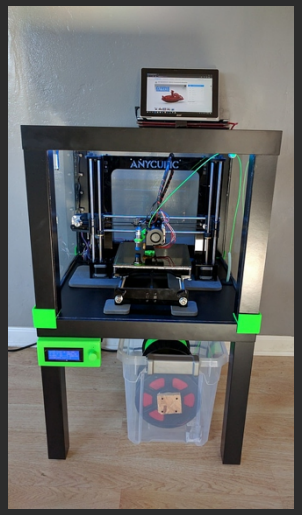
Prusa: $430 - $1099

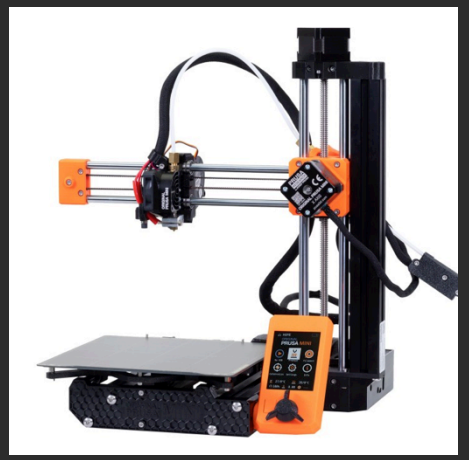
Filament

1 kg Spool: $20 - $50

Enclosure

$0 - $200



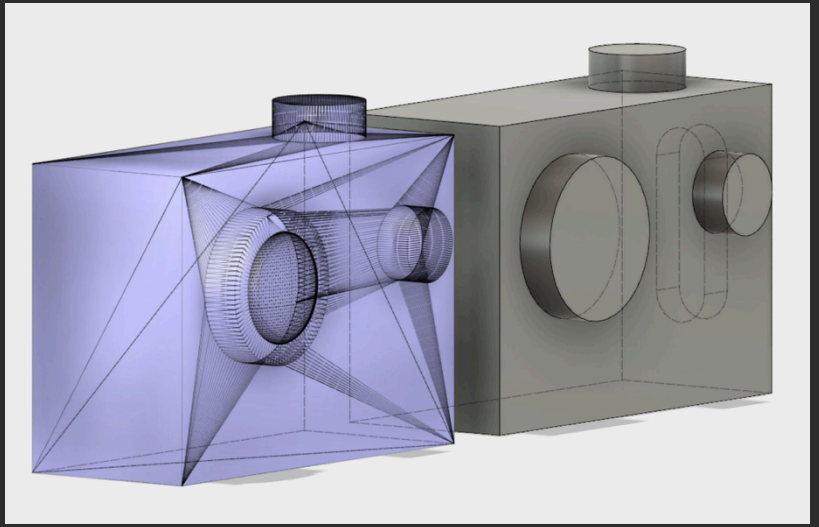


The 3D Printing Process

Model - Slice - Print

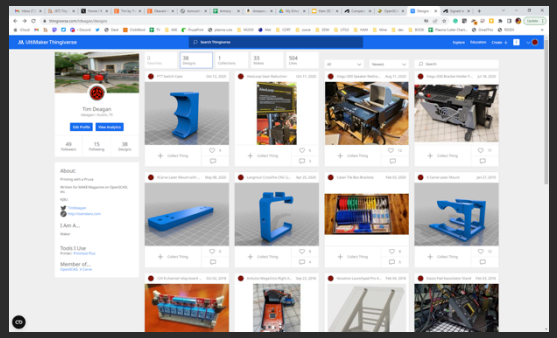
The Toolchain - Modelling (the process)

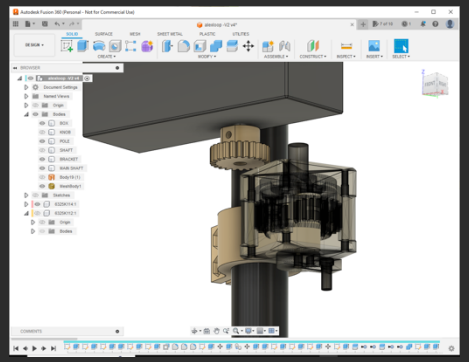
- Creating a 3D model
  - **Constructive Solid Geometry**: Edit shapes, e.g. Cubes, Spheres, Cones, etc., to form a model
    - OBJ, STEP, etc.
  - **Mesh Modelling**: Edit surface polygons to form a model
    - STL, 3MF, etc
  - Procedural Modelling: Edit text (code) to generate a model
    - SCAD

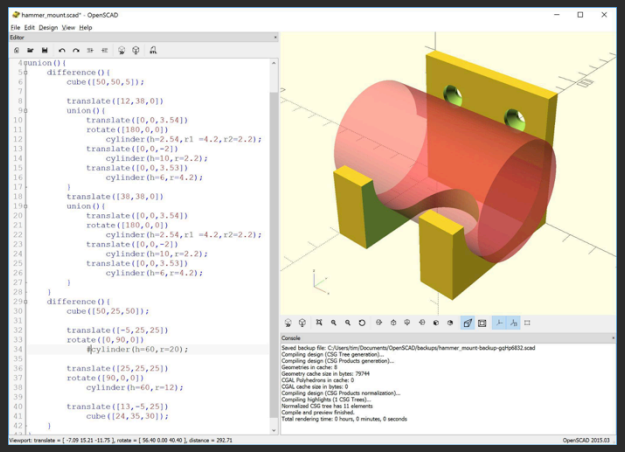


The Toolchain - Modelling (the tools)

- Pre-built Models
  - https://www.thingiverse.com/
  - https://sketchfab.com/
- Parametric Models
  - https://www.thingiverse.com/tag:parametric
- CAD Modelling
  - Tinkercad - https://www.tinkercad.com/
  - Fusion 360 - https://www.autodesk.com/products/fusion-360/personal
  - OpenSCAD - https://openscad.org/

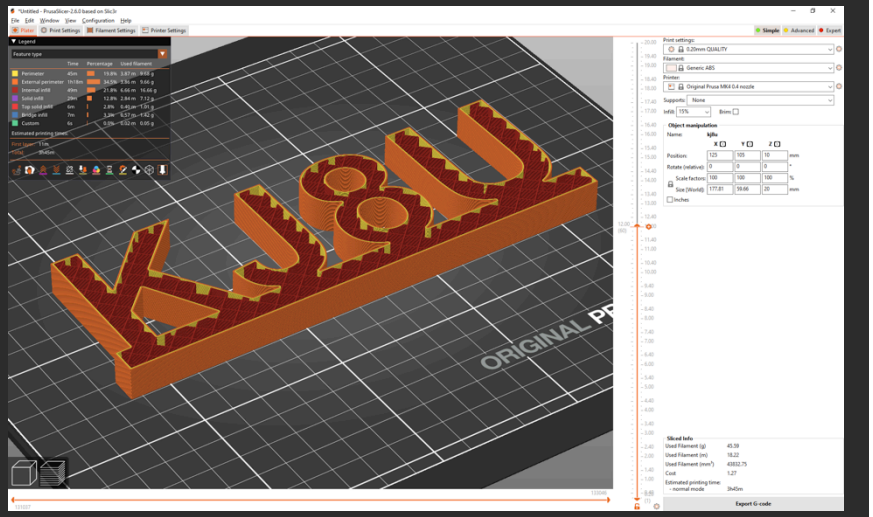






The Toolchain - Slicing (the process)

- “Slicing” is the process of turning a 3D model into a series of 2D layers.
  - **Shells** - How to configure the outer layers
  - **Infill** - How to pack the innards
  - **Bridging** - How to cross gaps
  - **Supports** - How to handle overhangs
  - **Brims** - How to add material to assure adherence to the printing bed
  - **Speeds, Feeds, Temps** - How to control the filament extrusion



- Generates a tool path, typically GCODE

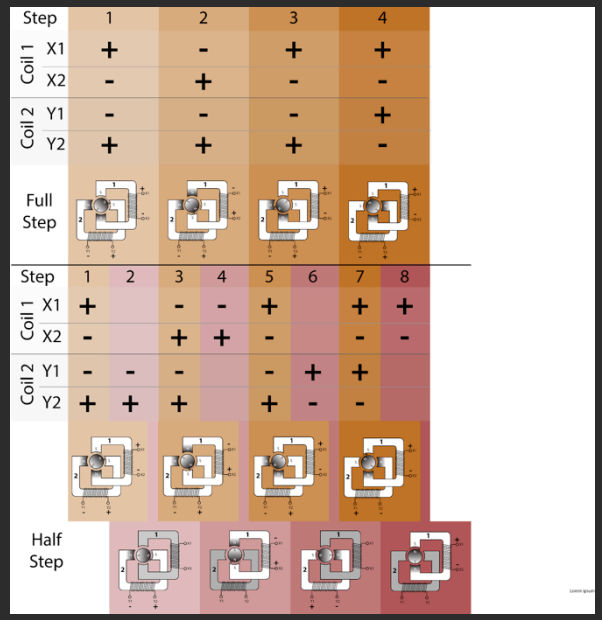
The Toolchain - Slicing (the tools)

- **Big List:** https://all3dp.com/1/best-3d-slicer-software-3d-printer/
- **PrusaSlicer (fork of Slic3r):** https://www.prusa3d.com/page/prusaslicer_424/
- **Ulitmaker Cura:** https://ultimaker.com/software/ultimaker-cura/

The Toolchain - Printing (the process)

- **Controller SW** feeds GCODE commands to the printer's firmware
  - https://reprap.org/wiki/List_of_Firmware
- **Firmware** converts GCODE to STEP & DIRECTION for stepper motors
- **Motor Controllers** provide power to stepper motor coils in the appropriate sequence to create motion

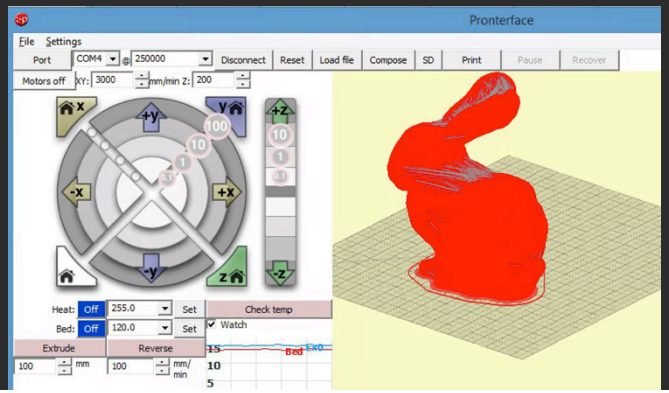
```
G21 ; set units to millimeters
G90 ; use absolute coordinates
M83 ; use relative distances for extrusion
G1 E-0.80000 F2100.00000
G1 Z0.200 F7200.000
G1 X109.754 Y91.987 F7200.000
G1 E0.80000 F2100.00000
M204 S1000
G1 F2100
G1 X109.834 Y91.498 E0.01553
G1 X110.000 Y91.031 E0.01553
G1 X110.249 Y90.598 E0.01566
```

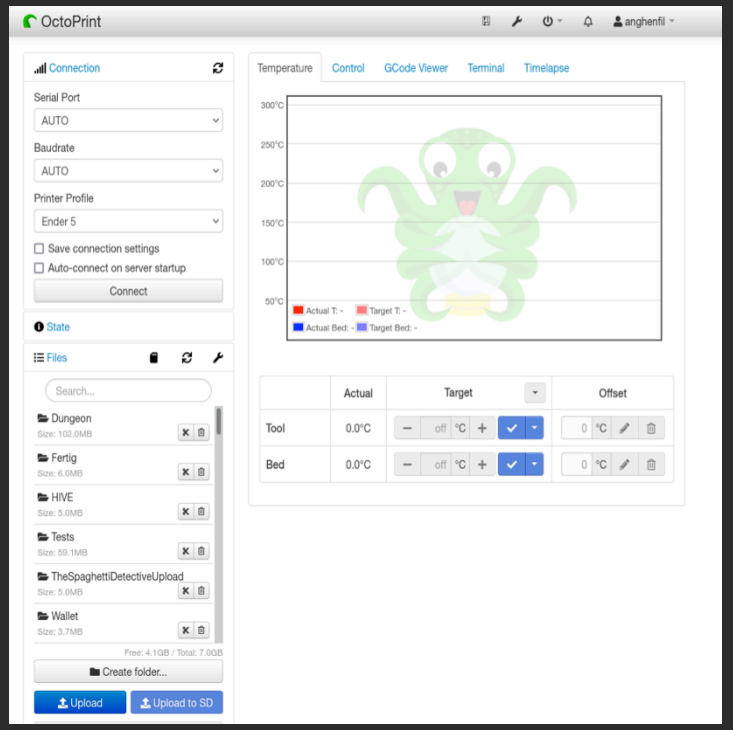


The Toolchain - Printing (the tools)

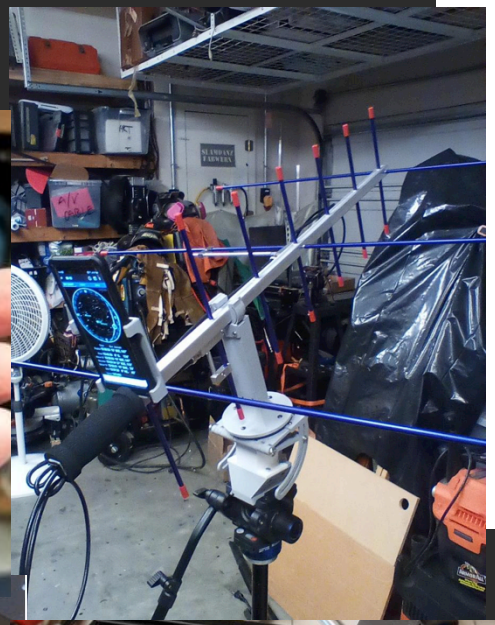
- Direct from the Slicer Software
- On an SD card in the printer
- Controller Software
  - Printrun
  - Octoprint
  - https://all3dp.com/2/best-octoprint-alternatives/

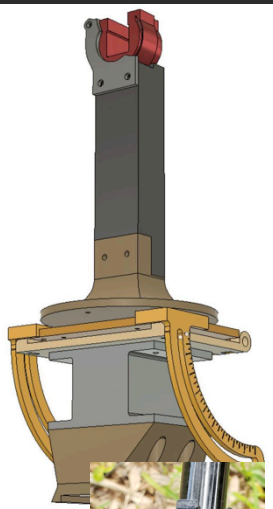
  Pronterface also mentioned. Ed.

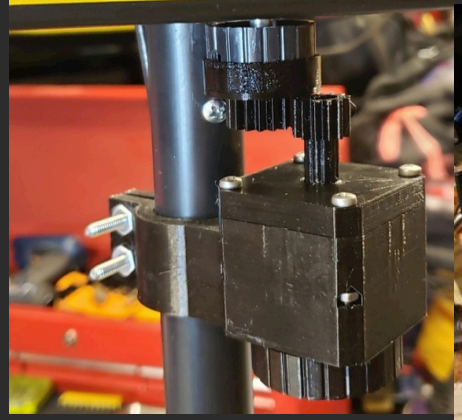




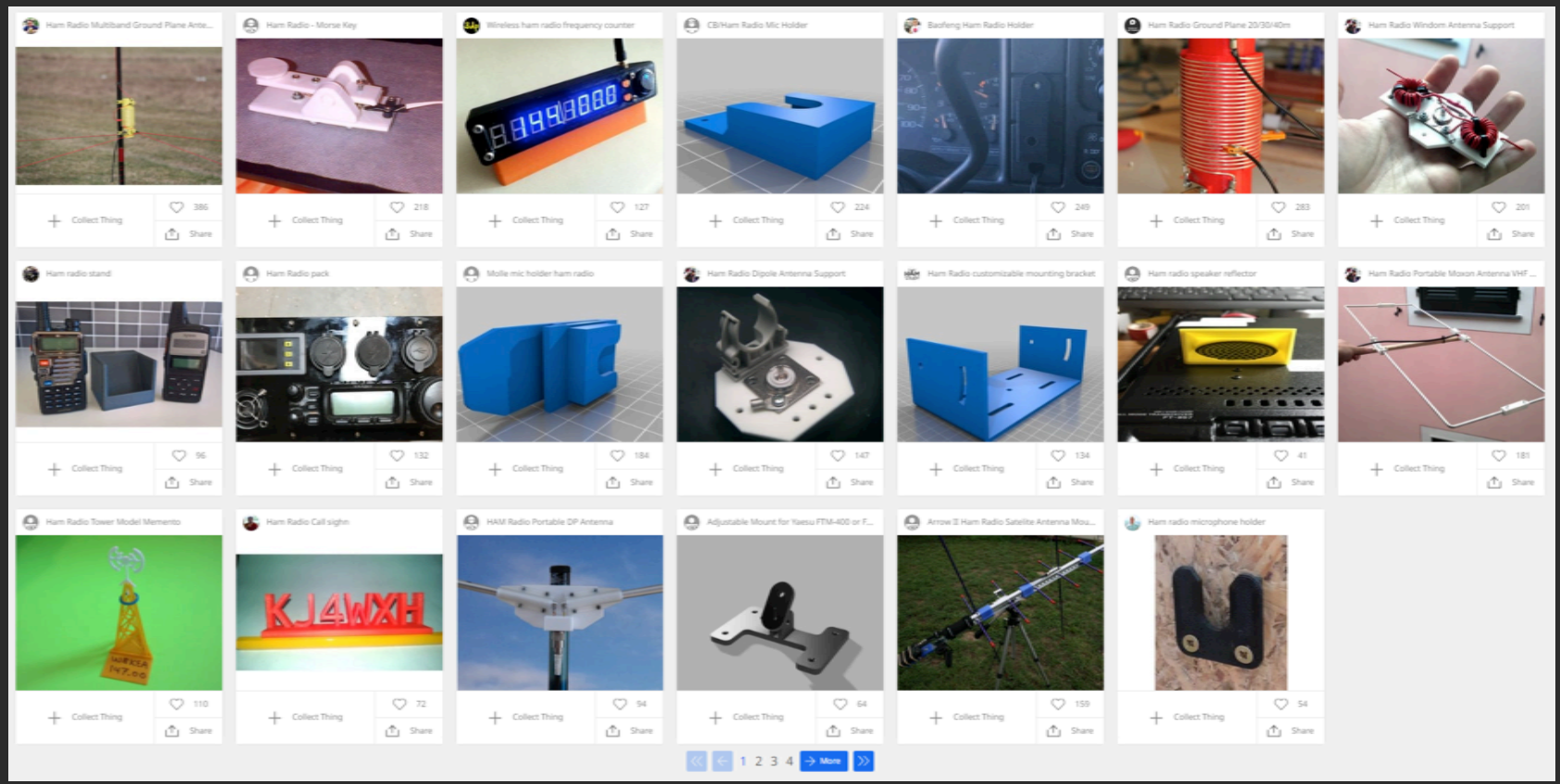
Ideas for Ham Radio







Ideas for Ham Radio



Questions?

73

KJ8U Clear