

INTRODUCTION TO 3D PRINTING

A HAM RADIO PERSPECTIVE



SATURDAY FEBRUARY 4TH 10AM
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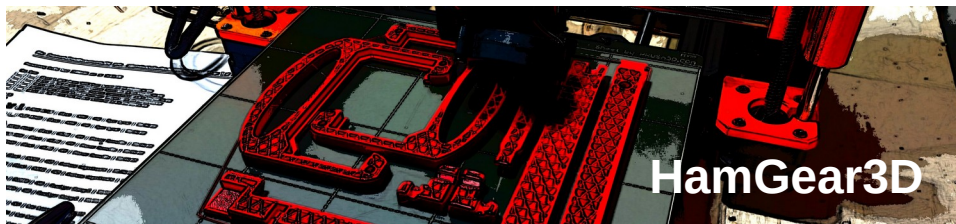
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Introduction

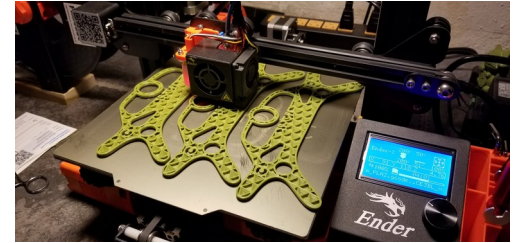
- **Your presenter: Mike Aiello, amateur callsign N2HTT**
I've been a licensed amateur for 26 years
I have run a small 3D printing business for the last 2+ years



- **Contact info**
You can reach me at n2htt.mike@gmail.com
Take a look at my blog at <https://n2htt.radio>
My ham radio accessory business is at <https://hamgear3d.com>
- **Don't worry about taking notes!**
These links to these slides and all references will be available at the end of the talk.

What We'll Cover Today

- **First, an overview of 3D printing for the hobbyist**
Great hobby on its own, complements other hobbies
Sometimes can turn into a business...
- **Then, a little introduction to Ham Radio**
For those not already engaged
- **Finally, why Ham Radio and 3D Printing?**
It's like peanut butter and jelly...



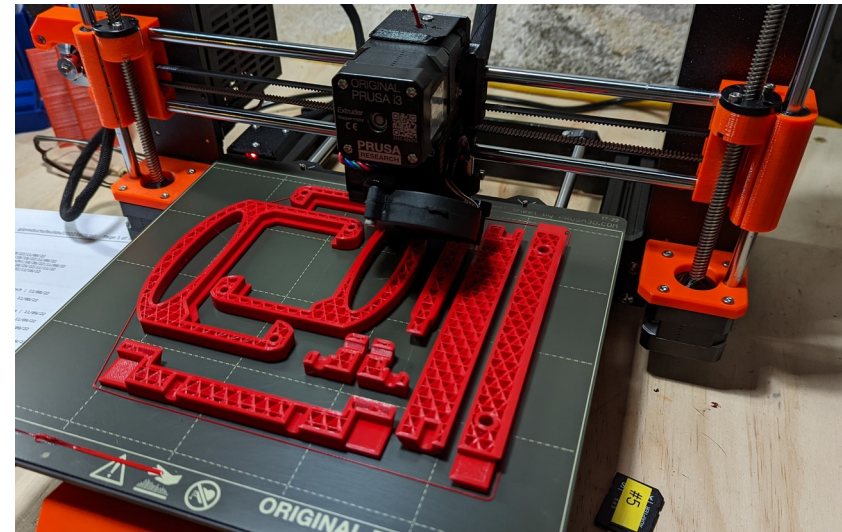
What is 3D Printing?

From Wikipedia:

“3D printing or additive manufacturing is the construction of a three-dimensional object from a CAD model or a digital 3D model.”

- Many kinds of 3D printing exist, but for the hobbyist, two predominate:
- SLA – Stereolithography, uses plastic resin hardened by exposure to light to create an object
- FDM – Fused deposition modeling, where a solid plastic is melted and extruded to form an object.

Both methods build up the solid object with successive layers of material.



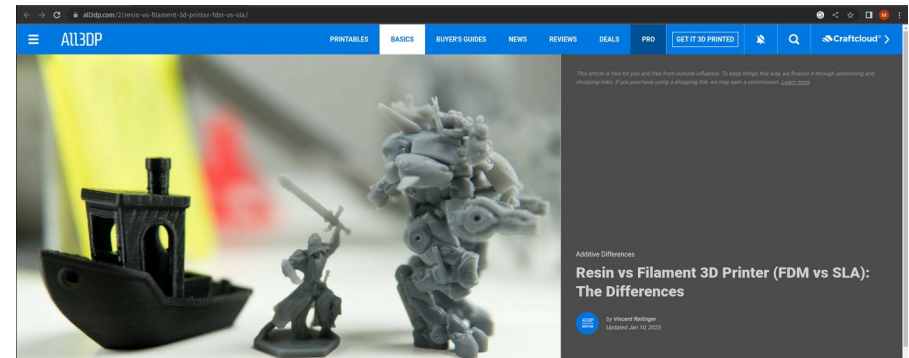
FDM vs. SLA

- **SLA**

- Uses liquid resin, a more expensive raw material
 - More difficult handling, maintenance
 - Better suited to dedicated workspace
 - But... potentially finer detail possible than FDM

- **FDM**

- Uses relatively inexpensive solid plastic filament
 - Can be used in the home with less concern (depends on filament though)



For the rest of this talk we will focus on FDM printing

Filament - the raw material of FDM

- **PLA (and variants)**

- Easiest to print

- Non-toxic

- Good strength and impact resistance

- Not suitable for use above 60 C (140 F)



- **PETG (think plastic water bottles)**

- A little more difficult to print

- Non-toxic

- Good strength and impact resistance

- Better heat resistance up to 70 C (160 F)



Filament . . .

- **ABS**

- Can be difficult to print, prone to warping

- Fumes are an issue

- Excellent strength and impact resistance

- Excellent heat resistance

- **Specialty Filaments**

- Can include wood, metal, carbon fiber, flexibles

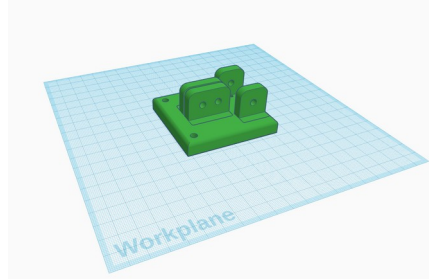
- Can be difficult to print, rough on the printer

- Desirable mainly for aesthetics



The Printing Process

- Create a design using software (or download a design)
- Convert design into instructions the printer understands (gcode)
- Send instructions to printer and print the design
 - SD or USB media
 - Computer connection (Octoprint, Pronterface)



```
M205 X8.00 Y8.00 Z0.40 E5.00 ;Setup Jerk
M220 S100 ;Reset Feedrate
M221 S100 ;Reset Flowrate

G28 ;Home
G29 ; BLTOUCH update mesh

G92 E0 ;Reset Extruder
G1 Z2.0 F3000 ;Move Z Axis up
G1 X10.1 Y20 Z0.28 F5000.0 ;Move to start position
G1 X10.1 Y200.0 Z0.28 F1500.0 E15 ;Draw the first line
G1 X10.4 Y200.0 Z0.28 F5000.0 ;Move to side a little
G1 X10.4 Y20 Z0.28 F1500.0 E30 ;Draw the second line
G92 E0 ;Reset Extruder
G1 Z2.0 F3000 ;Move Z Axis up
G92 E0
G92 E0
G1 F2700 E-6.5
;LAYER_COUNT:231
;LAYER:0
M107
G0 F6000 X87.21 Y44.885 Z0.2
;TYPE:SKIRT
G1 F2700 E0
G1 F720 X87.511 Y44.43 E0.02613
G1 X87.874 Y44.024 E0.05221
G1 X88.294 Y43.675 E0.07837
```

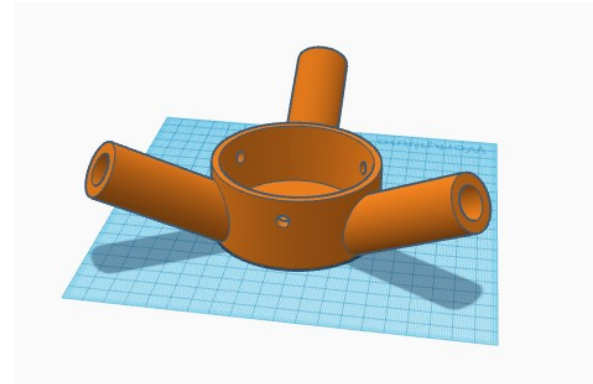
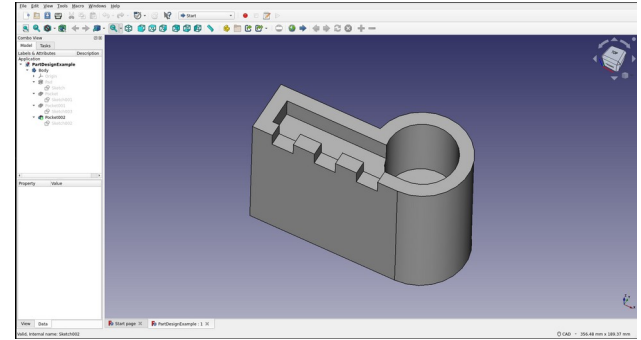
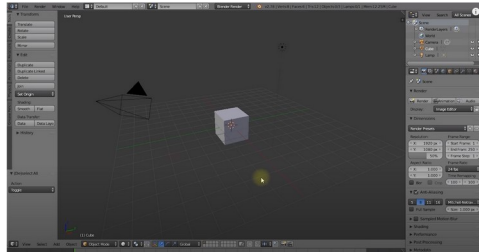


Three Kinds of Software You Need

- **3D Modeling Software – create a design**
Autodesk Fusion 360, OpenSCAD, FreeCAD
Work by extruding sketches into 3 space

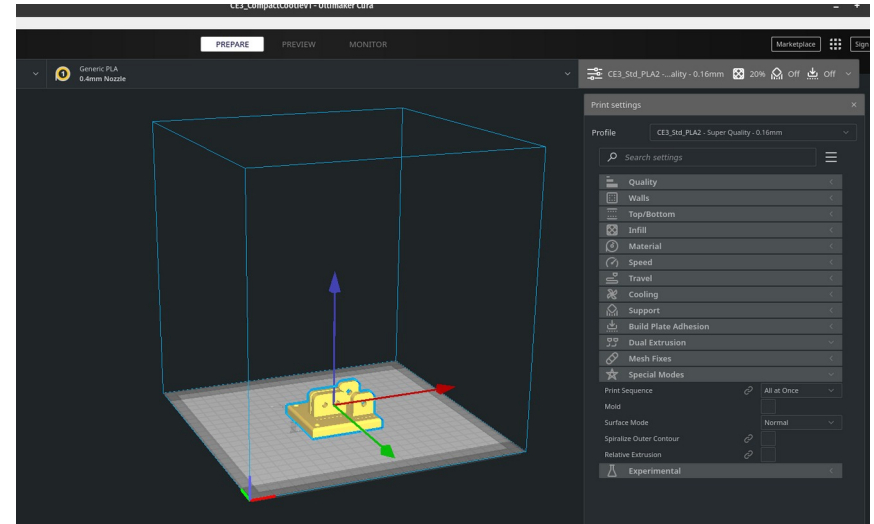
Blender
Free form modeling

TinkerCad
Browser based
Assemble 3D object out of basic 3D shapes
(cubes, spheres, etc.)



Three Kinds of Software . . .

- **Slicer – convert CAD model into “gcode”**
Free programs: Cura, Slic3r
Manufacturers’ programs: Prusa Slicer, MatterControl
- **Printer Firmware – runs the printer**
Manufacturer supplied
Community supported: Marlin



Anatomy of an FDM 3D Printer

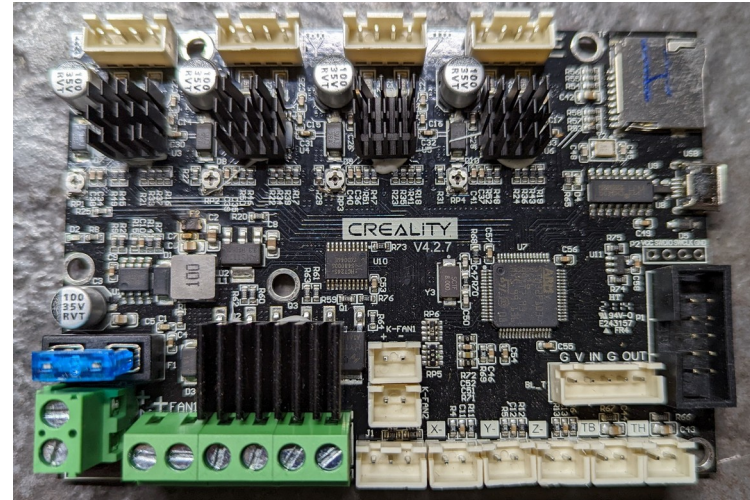
Frame



Power Supply



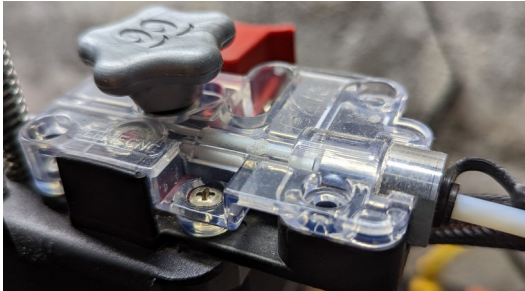
Microcomputer Control Board



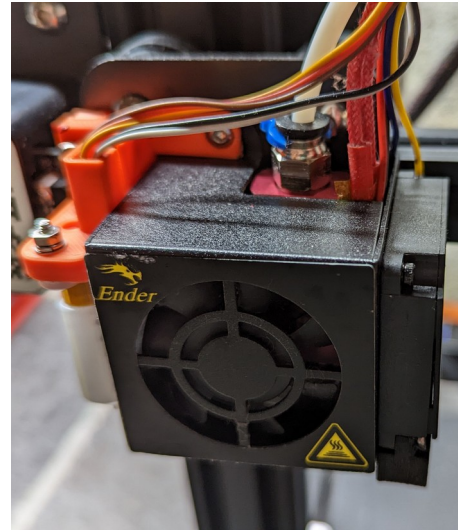
Anatomy . . .

Stepper Motors: X, Y, Z, Extruder
(some printers use different geometry)

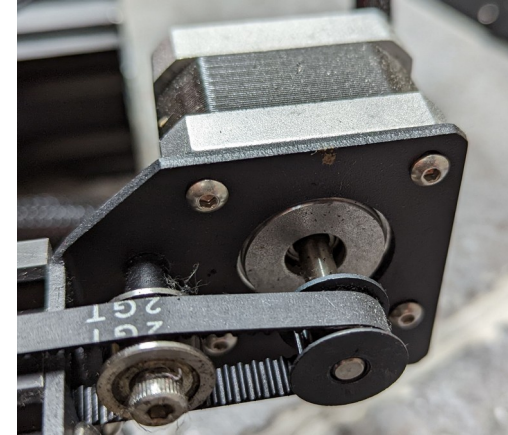
Extruder



Hot End



Print Bed



Basic Printing Tasks

- **Machine Calibration**

- Instructions provided by manufacturer

- Good way to get to know your printer

- **Bed Leveling**

- Misnomer – refers to constant distance of nozzle above bed

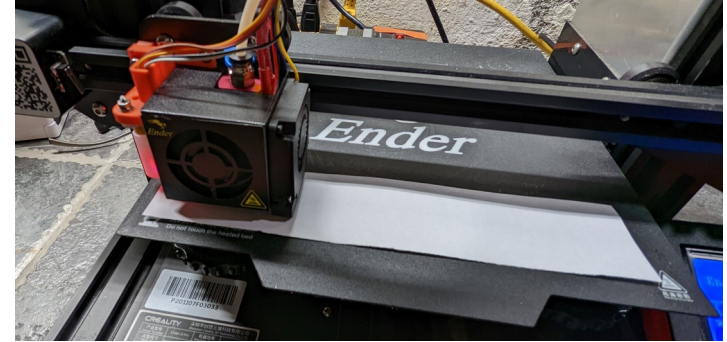
- Manual: Sheet of paper method

- Automatic: physical or induction probe

- **Z-Offset**

- Distance between actual and nominal nozzle height

- The amount of “squish” applied to the filament as it goes down



The First Layer

- **Provides the foundation for the entire print.**

If the first layer is not good, the print will eventually fail.

- **Bed Adhesion**

Bed is usually heated to insure first layer will stick

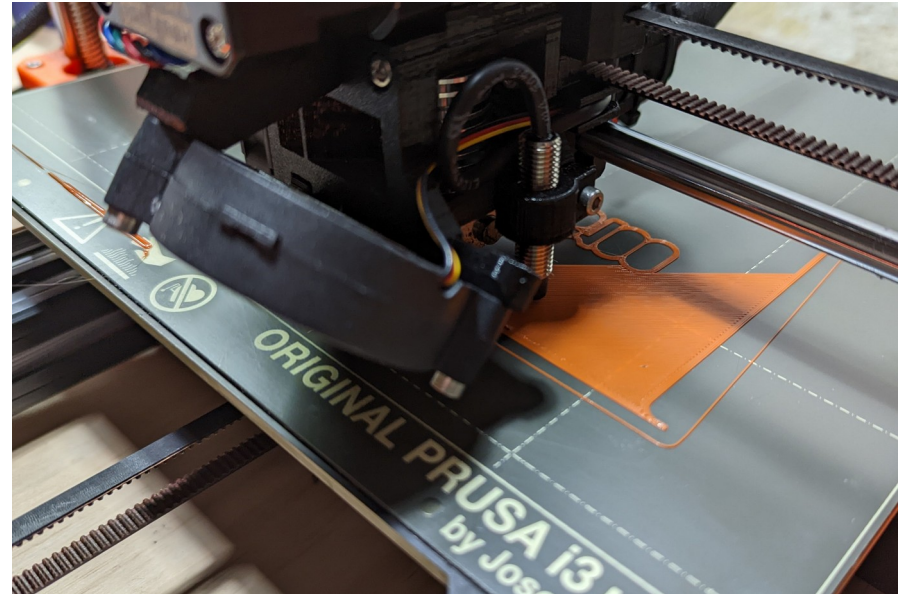
Some bed materials require addition of adhesives - glass

Some bed materials will adhere on their own: buildTack, PEI, garolite

- **Rafts and Brims**

For very tall prints, these add more surface in contact with the bed

Add time and material consumption



The Ham Radio Perspective?

- **What is ham radio? - Big question**

Licensed to communicate with other amateur operators

Modes of communication span voice and data to Morse Code

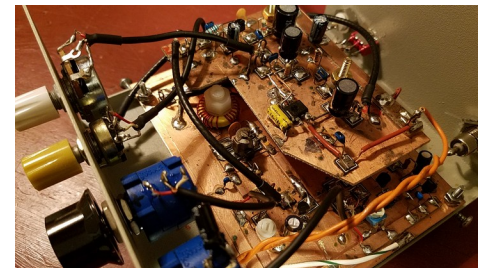
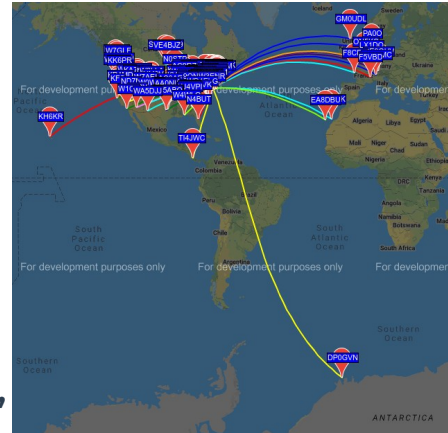
Participate in public service events and emergency communications

- **Activities**

Communicate world wide on short wave bands (HF, voice, data, CW),
locally on higher frequencies (VHF/UHF FM, repeaters)

Operate a permanent station (shack) or portable (POTA, SOTA)

Build your own equipment, from kits or from scratch (homebrew)



Ham Radio Applications

- Ham radio provides infinite opportunities for incorporating 3D printing

- Antennas

Coil forms

Dipole center and end insulators

End-fed wire antennas



- Cases and Enclosures

Kit built radios, power supplies, battery packs

Microphones, speakers

Protective frames for portable rigs



Ham Radio Applications . . .

- **Holders and Stands**

- HTs

- Rig stands

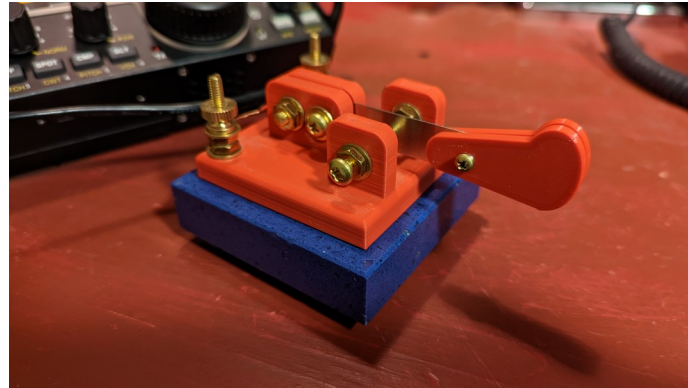
- Mounting brackets

- **Miscellaneous**

- Morse Code Keys

- Knobs

- Replacement of broken parts



Design Sources

- **File sharing sites**

Thingiverse.com, Printables.com, many others

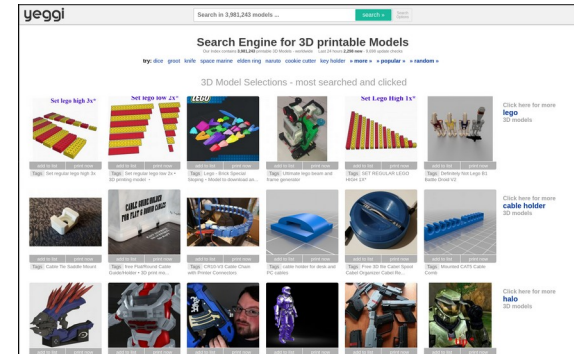
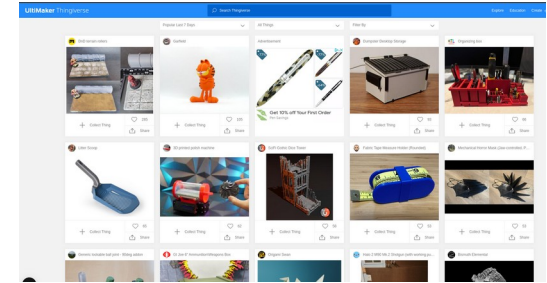
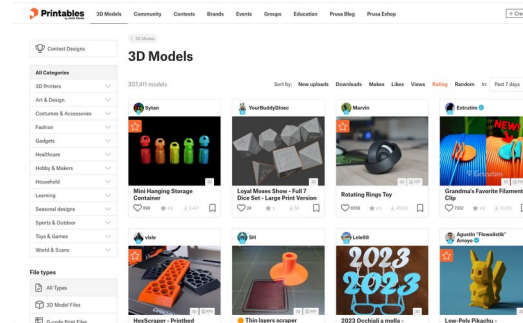
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Some sites provide designs for sale

yeggi.com – 3d design search engine

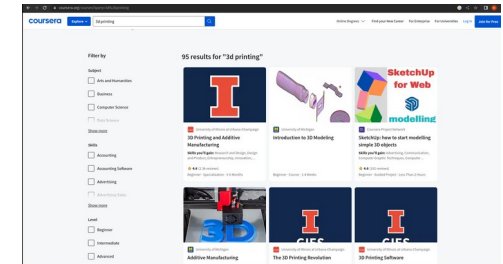
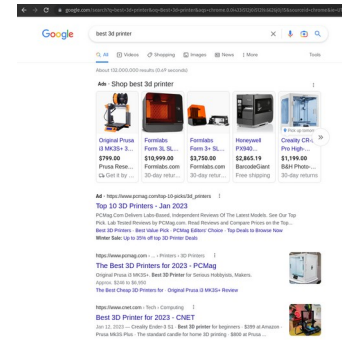
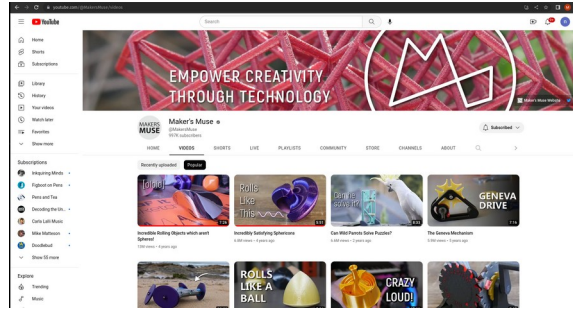
- **What if I don't own a 3D printer?**

Many sites have 3D printing services and will print a file for a fee



Online Resources

- Youtube
- Google it
- Online Courses
- My resource page with useful links:



<https://n2htt.radio/introduction-to-3d-printing-resource-page/>

Thank You!

Questions?

