



3D Printing

Applied to Ham Radio

Sept 21, 2024

Duke City Hamfest, Albuquerque NM

Curt Laumann K7ZOO

Ron Jones K7RJ

Presenters Today



Ron Jones, K7RJ

It's hard to believe looking at him, but Ron has been a licensed ham radio operator for decades. Ron uses many different technologies to build radio gear: electronics, welding, and 3D printing. Ron has considerable experience in VHF/UHF operations.

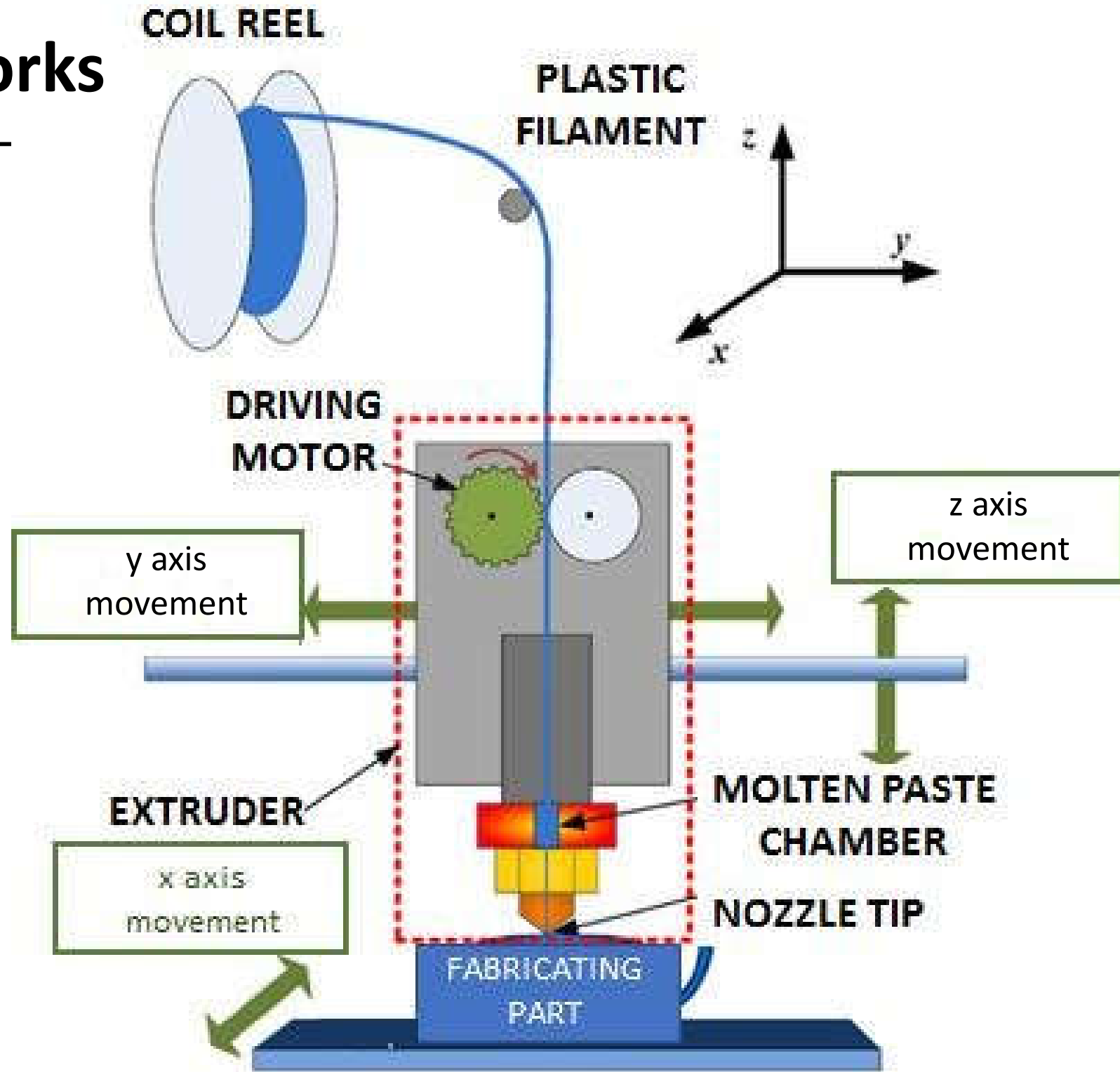
Curt Laumann, K7ZOO

Curt uses 3D printing to create 1000's of parts using a variety of materials. Over the last couple years Curt expanded his operation to 12 printers. Curt's ham radio experience includes almost every propagation mode except EME and aircraft scatter.

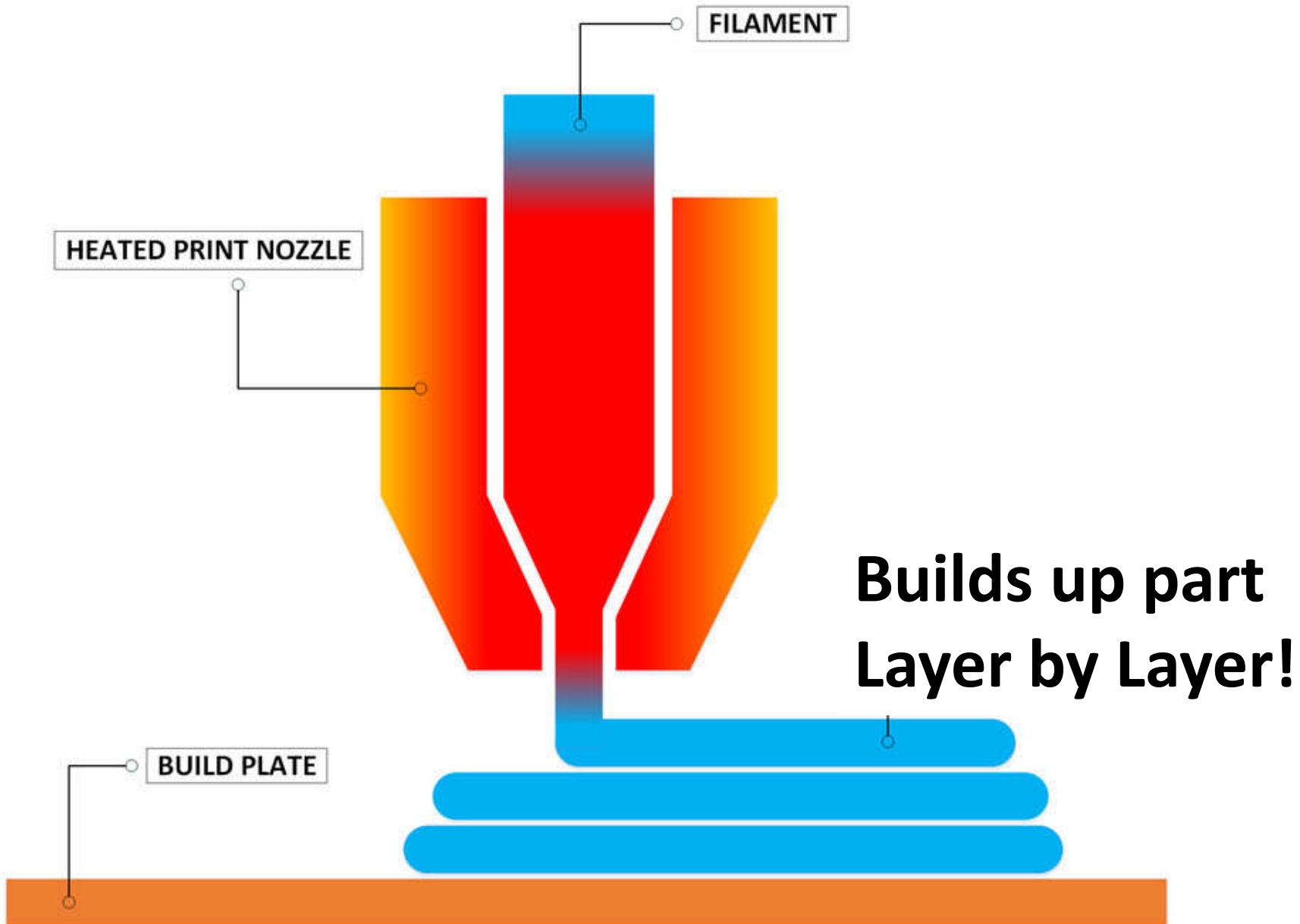


Let's cover how it works!

How It Works



How It Works





Questions?



This could be the End of Presentation

...but there is more 😊

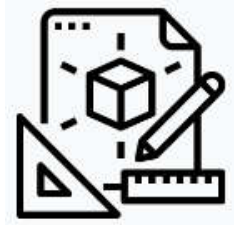
Goal of this presentation



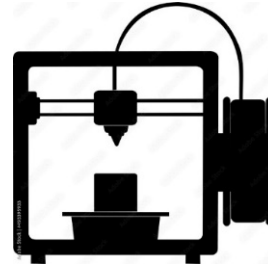
IDEA



DESIGN



3D PRINTER



HARDWARE



Show many examples!

Answering the question....

How can 3D printing augment my ham radio hobby?

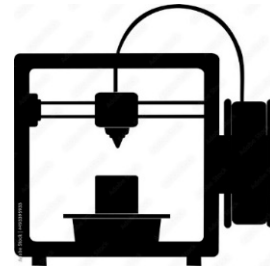
Process towards a 3D printed object



IDEA



DESIGN



PRINTER



HARDWARE



IDEA



Let's start with a **DISCLAIMER**

Sure, you can probably **PURCHASE** many items you could 3D print.

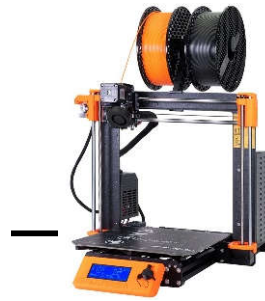
need a box? buy a box

BUT... it might be more satisfying to **DESIGN and PRINT** a

BOX WITH EXACTLY THE FEATURES YOU DESIRE!



IDEAS



Antennas

element holders, adapter to a tripod, spacers for gamma match

Organizing

Cable holders, multi-compartment box, labels

Building

Tools to assist and increase accuracy



Design



- With just a bit of mechanical skill YOU CAN design parts!
- There are MANY different design software platforms. Free ones:
 - **TinkerCAD**
 - Online design
 - Relatively simple parts
 - Short learning curve
 - **FreeCAD**
 - Free download
 - Simple to complex parts
 - Learning curve depends on the complexity of your design

FreeCAD example



FreeCAD 0.21.1

File Edit View Tools Macro Windows Help

Start

Combo View

Model Tasks

- LNK_MTR3B_V2_K7ZOO_2021_06_15_1
 - Fusion
 - Fillet001
 - Fillet001 (Meshed)

Property Value

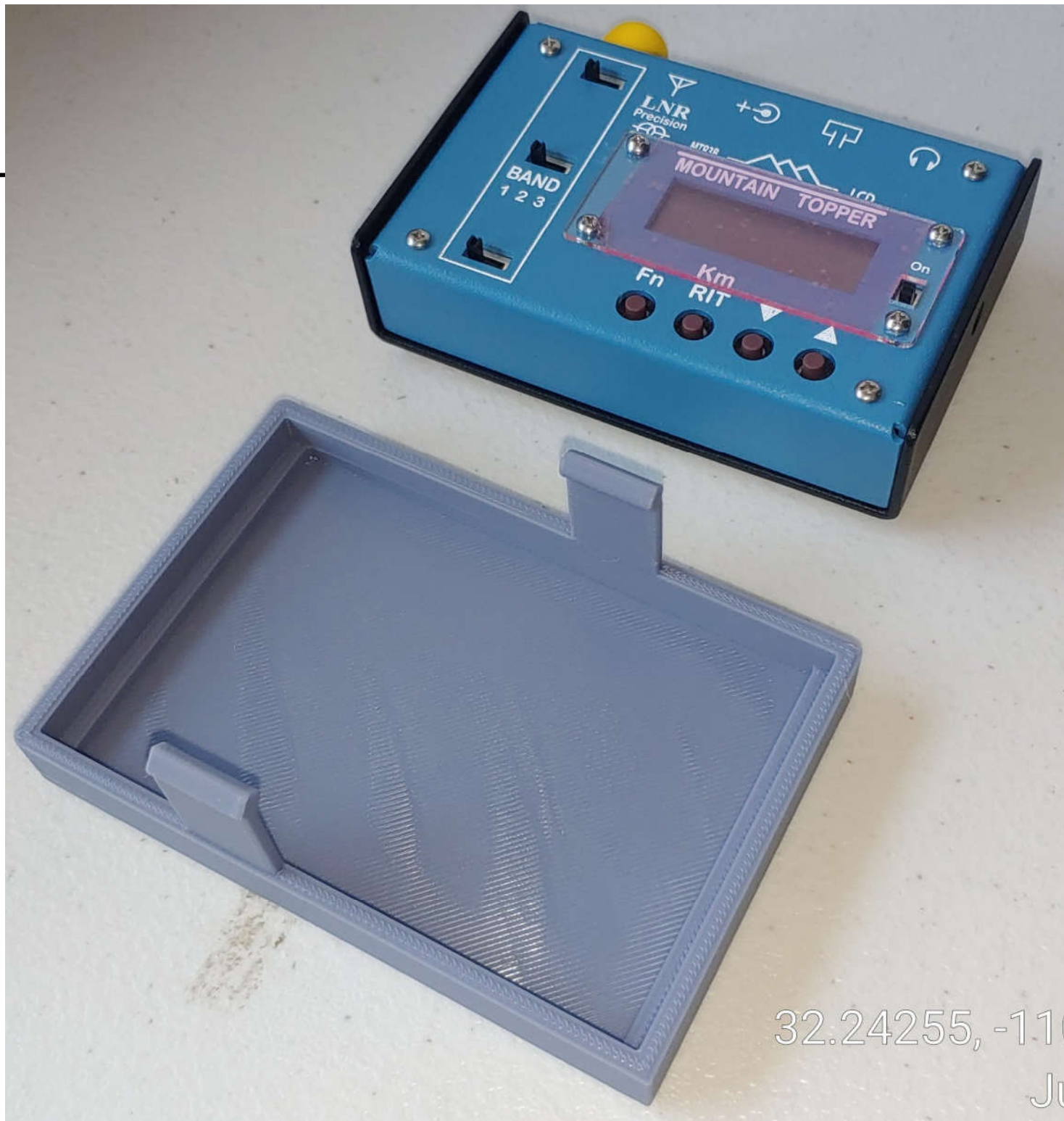
View 9/19/2024 9:47 PM

Start page LNK_MTR3B_V2_K7ZOO_2021_06_15_1200 : 1

Snap on cover for CW xcvr

FreeCAD

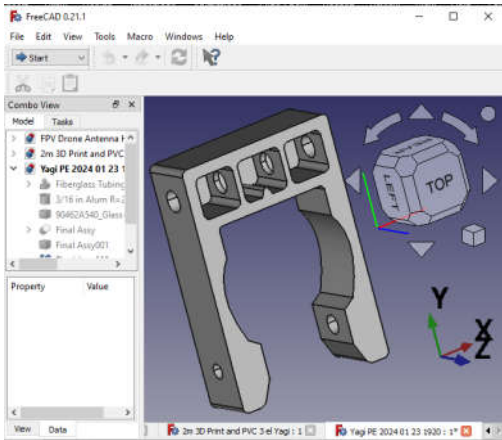
Snap on cover for CW xcvr



Bridge between Design and Printer



Mechanical Design



Line-by-line instructions for stepper motors

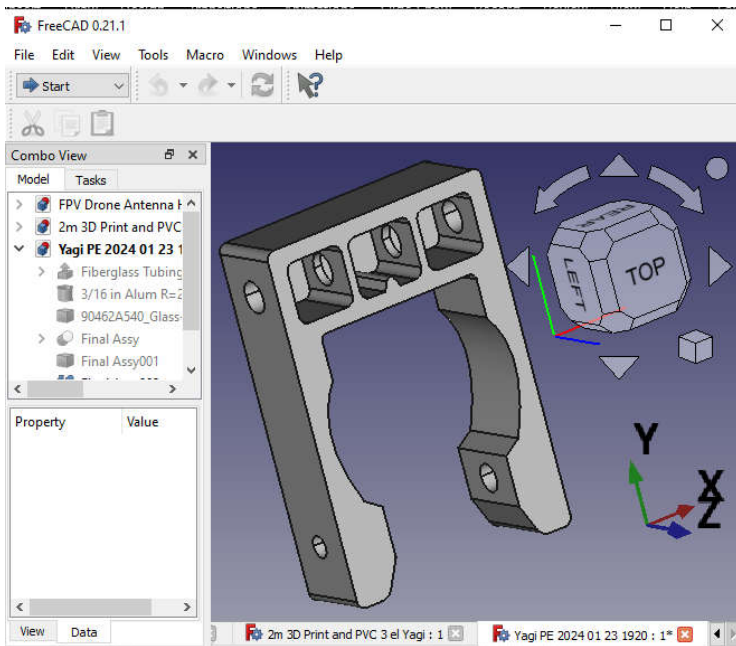
Need to convert a mechanical design into instructions for printer

```
G1 X115.428 Y139.015 E.00353  
G1 X115.184 Y138.637 E.01413  
G1 X114.934 Y138.447 E.00984  
G1 X114.636 Y138.329 E.01004  
G1 X114.325 Y138.297 E.00979  
G1 X114.026 Y138.347 E.0095  
G1 X113.744 Y138.477 E.00974  
G1 X113.586 Y138.607 E.00642  
G1 X113.476 Y138.583 E.00353  
G1 X113.223 Y138.195 E.0145  
G1 X112.981 Y138.013 E.00949  
G1 X112.692 Y137.898 E.00974  
G1 X112.383 Y137.864 E.00977  
G1 X112.075 Y137.914 E.00977
```

Bridge between Design and Printer



Mechanical Design



Line-by-line instructions for stepper motors

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G1 X112.692 Y137.898 E.00974
G1 X112.383 Y137.864 E.00977
G1 X112.075 Y137.914 E.00977
```

“Slicer” software is used to convert your mechanical design into line-by-line instructions

Slicer Software



- **CURA**

- Free
- Written by volunteers
- Very popular

- **PRUSASLICER**

- Free
- Written by Prusa company
- Also very popular

- **Both work well**
- **Many begin with Cura**
- **Later jump to Prusaslicer**

Slicer Software



Gear Shaft 20 ea 05h40m 2024 04 11 1455 ECAP.715513.001 Gvnt-zaglushka - PrusaSlicer-2.8.0 based on Slic3r

Menu | **Plater** | Print Settings | Filaments | Printers | Enter a search term | Expert mode | Log in

Print settings:
0.30mm DRAFT (modified)
Filament: Overture3D Easy PLA - K7Z00 (modified)
Printer: Original Prusa i3 MK3S & MK3S+ (modified)
Supports: None
Infill: 25% | Brim:

Name		Editing
Instance 6	<input type="radio"/>	<input type="checkbox"/>
Instance 7	<input type="radio"/>	<input type="checkbox"/>
Instance 8	<input type="radio"/>	<input type="checkbox"/>
Instance 9	<input type="radio"/>	<input type="checkbox"/>
Instance 10	<input type="radio"/>	<input type="checkbox"/>
Instance 11	<input type="radio"/>	<input type="checkbox"/>
Instance 12	<input type="radio"/>	<input type="checkbox"/>
Instance 13	<input type="radio"/>	<input type="checkbox"/>
Instance 14	<input type="radio"/>	<input type="checkbox"/>
Instance 15	<input type="radio"/>	<input type="checkbox"/>
Instance 16	<input type="radio"/>	<input type="checkbox"/>
Instance 17	<input type="radio"/>	<input type="checkbox"/>
Instance 18	<input type="radio"/>	<input type="checkbox"/>
Instance 19	<input type="radio"/>	<input type="checkbox"/>
Instance 20	<input type="radio"/>	<input type="checkbox"/>

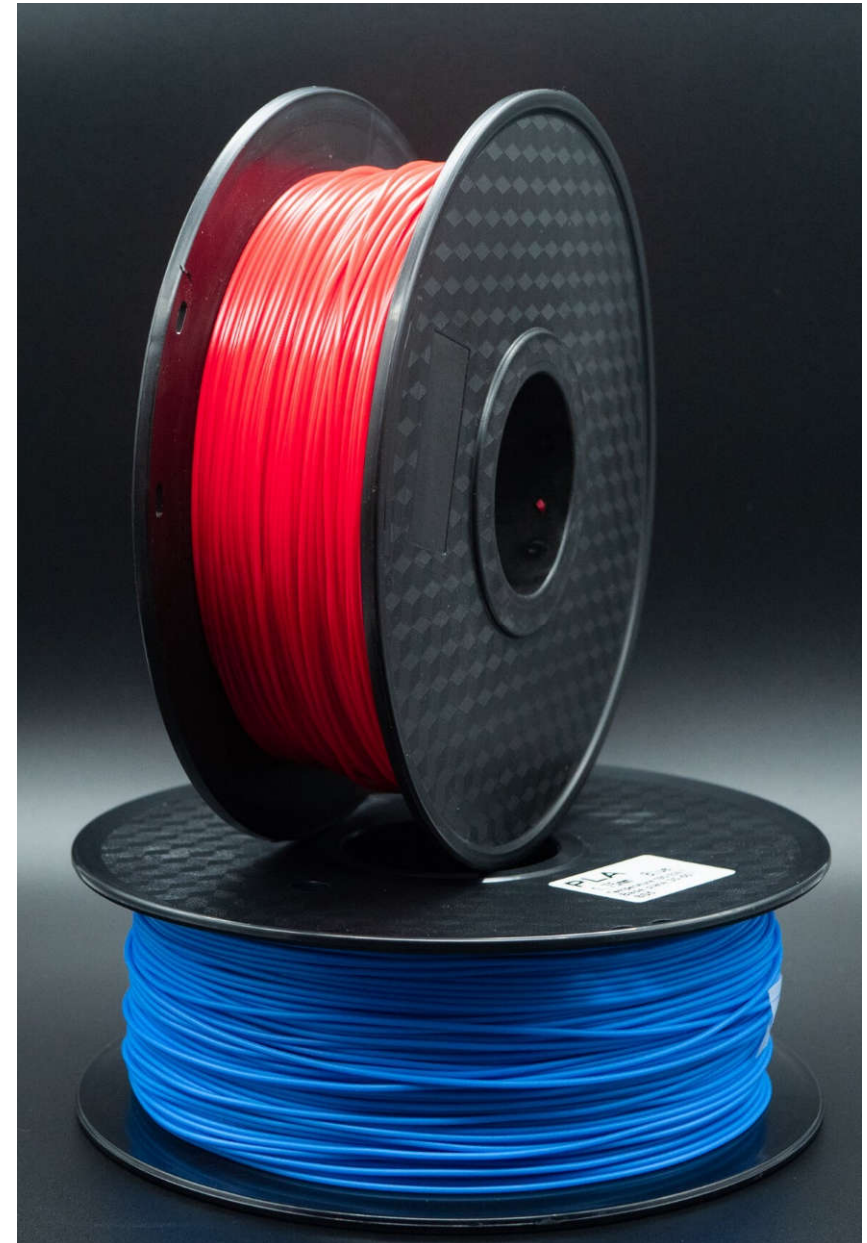
Object manipulation
X Y Z
Translate: mm
Slice now

Filament



- Comes in spools of 1 kg
- Any color of the rainbow!
- 1.75 mm diameter
- Cost: \$12 to \$25 per spool
- One spool will likely serve you for many months

- Of course, there are a variety of material types for different applications! (next page)



Filament Material for Ham Radio



PLA	Start with this material! Very easy to print Indoor use only
PETG	Requires higher temps A bit more challenging to print Outdoor use
ASA <i>(like ABS)</i>	Very strong; excellent for outdoors
TPU	Flexible! Good for knobs

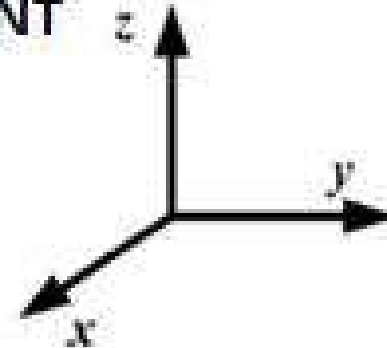
PLA and PETG for 99% of ham radio parts

How It Works

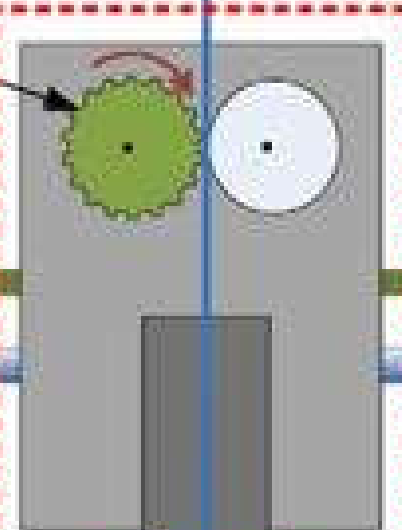
COIL REEL



PLASTIC FILAMENT



DRIVING MOTOR



QUESTIONS?

y axis movement

z axis movement

EXTRUDER

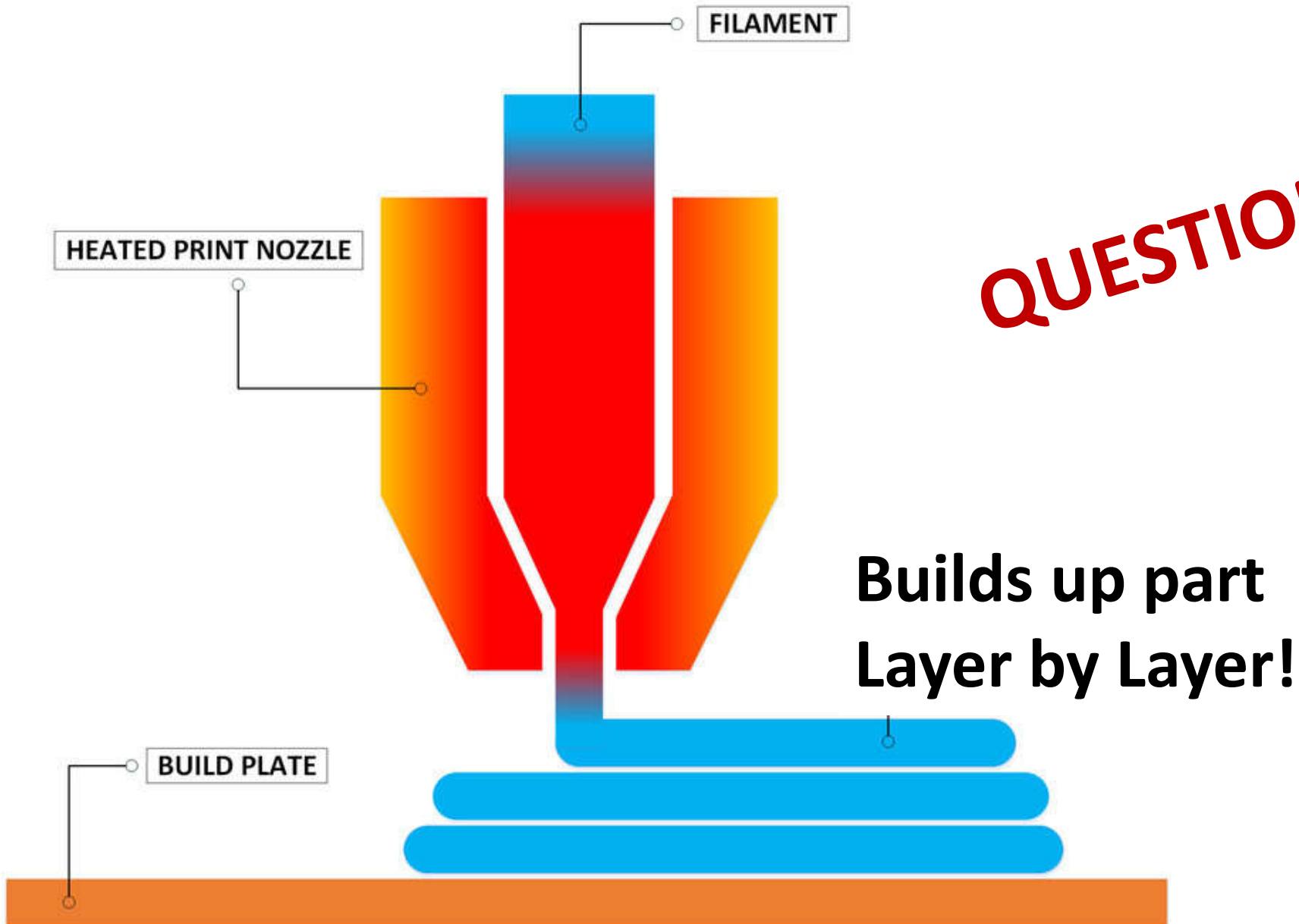
MOLTEN PASTE CHAMBER

x axis movement

NOZZLE TIP

FABRICATING PART

How It Works

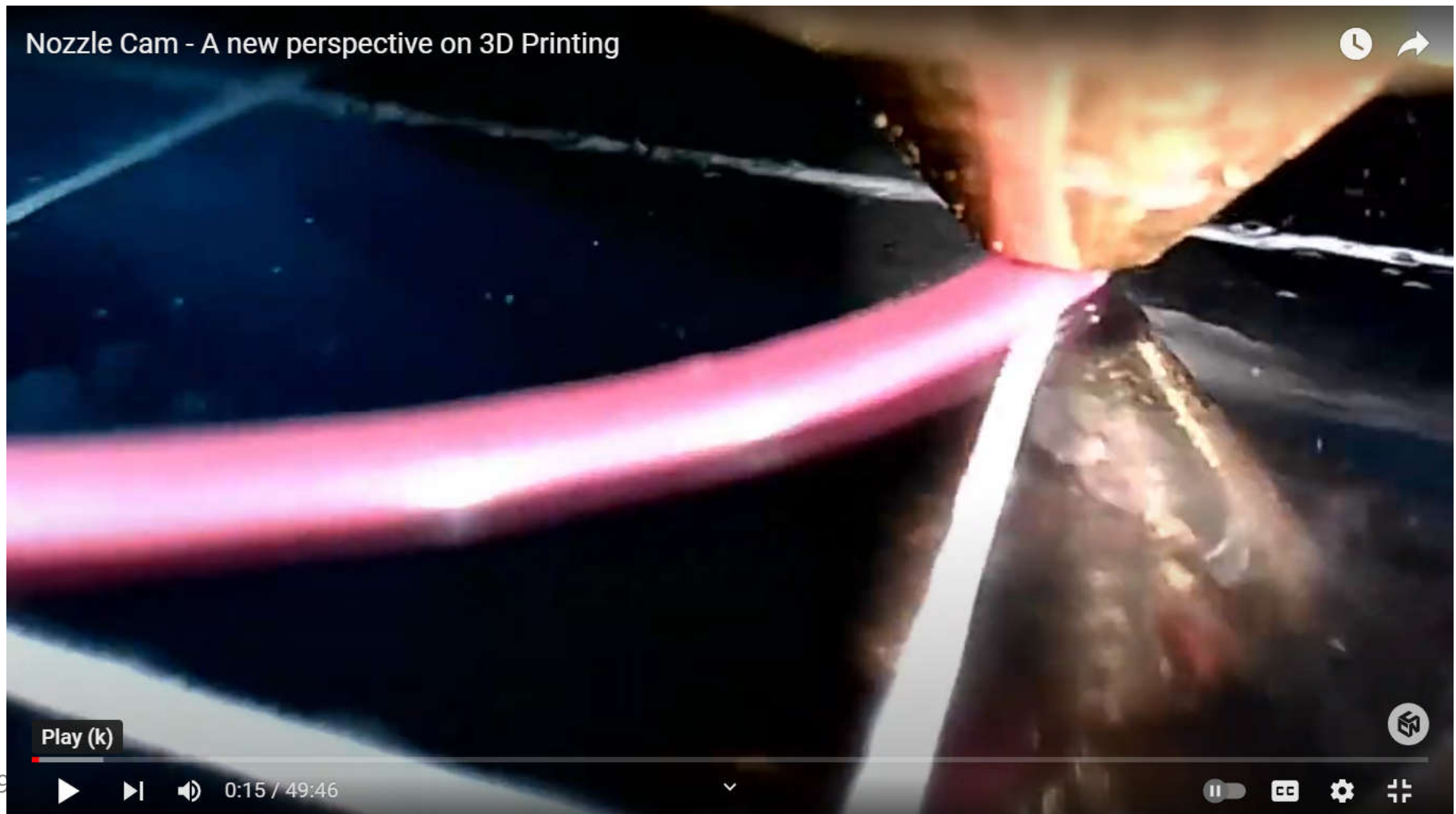


QUESTIONS?

How do 3D printers actually create parts



- Video of close up of filament being deposited
- <https://www.youtube.com/watch?v=MZROg5rd6AM>



Purchase recommendation



- **Reputable brand**
- **Auto leveling** ...*you don't want to spend your life twisting knobs to level the plate!*
- **PEI printing plate**... *this is the modern technology, allows easy release of parts after printing*
- **Direct Drive**... *higher temperature for PETG makes direct drive a requirement*

Printer Recommendation

Manuf: Elegoo

Model: **Neptune 3 Pro**

Autolevel – YES

PEI Plate – YES

Direct Drive – YES

\$160



Filament recommendation



- The market is HUGE
- Many manufacturers of filament
- Competition is fierce
- After using about a dozen different brands, I settled on

Overture 3D

- **Wide range of colors and materials**
- Almost always in stock
- **Competitive price** (not the cheapest, though)
- **VERY consistent quality** (never got a **wet roll**)
- Cardboard spool is the best – storage holes for tail; scale to estimate remaining stock

Overture3D – many material types



PLA

- PLA
- PLA Filament
- Matte PLA Filament
- Easy PLA Filament
- PLA Pro Filament
- Super PLA Plus Filament
- Turbo PLA High Speed Filament
- 2KG PLA Filament
- 3KG PLA Filament

PLA special

- Specialty PLA
- Rock PLA Filament
- Glow PLA
- Shimmer PLA Filament
- Silk PLA
- Silk PLA Dual Colors
- Matte PLA Dual Colors
- Air PLA Filament

PETG

- PETG
- PETG Filament
- Rock PETG Filament
- PETG Transparent Filament
- PETG Filament 2pack
- PETG Filament 6pack

TPU

- TPU
- TPU Filament
- High Speed TPU Filament

Engineering

- ENGINEERING
- PC Professional Filament
- PC Professional Transparent
- ASA Filament
- ABS Filament
- Easy Nylon Filament
- Carbon Fiber Filament

Overture3D – many colors



typical price: \$29.99

prime Two-Day
FREE Returns

Color: Fresh Red



Brand	OVERTURE
Material	Polylactic Acid
Color	Fresh Red
Item Weight	1 Kilograms
Item Diameter	1.75 Millimeters



EXAMPLES

FROM K7RJ

Cable Organization



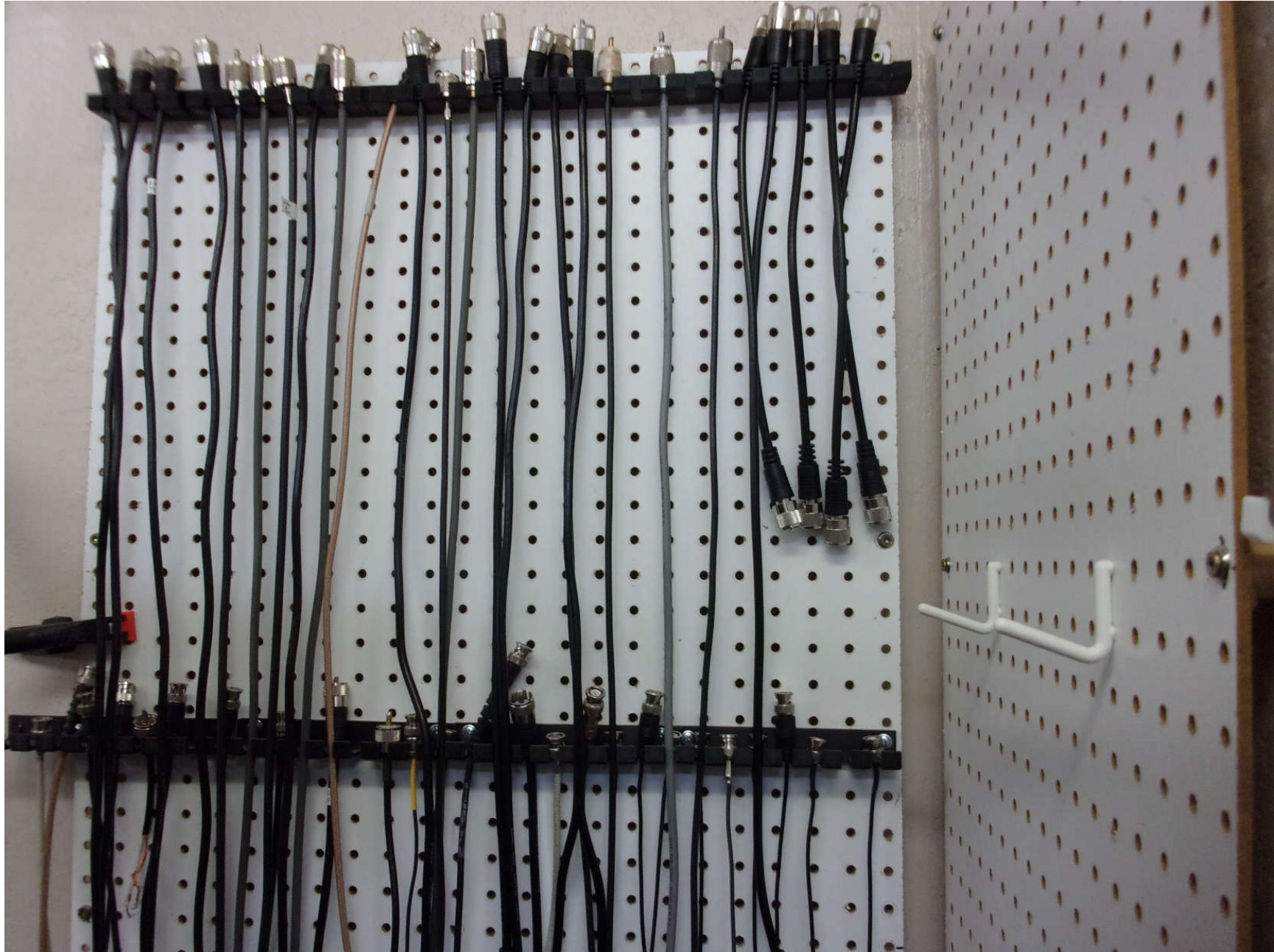
Cable Organization



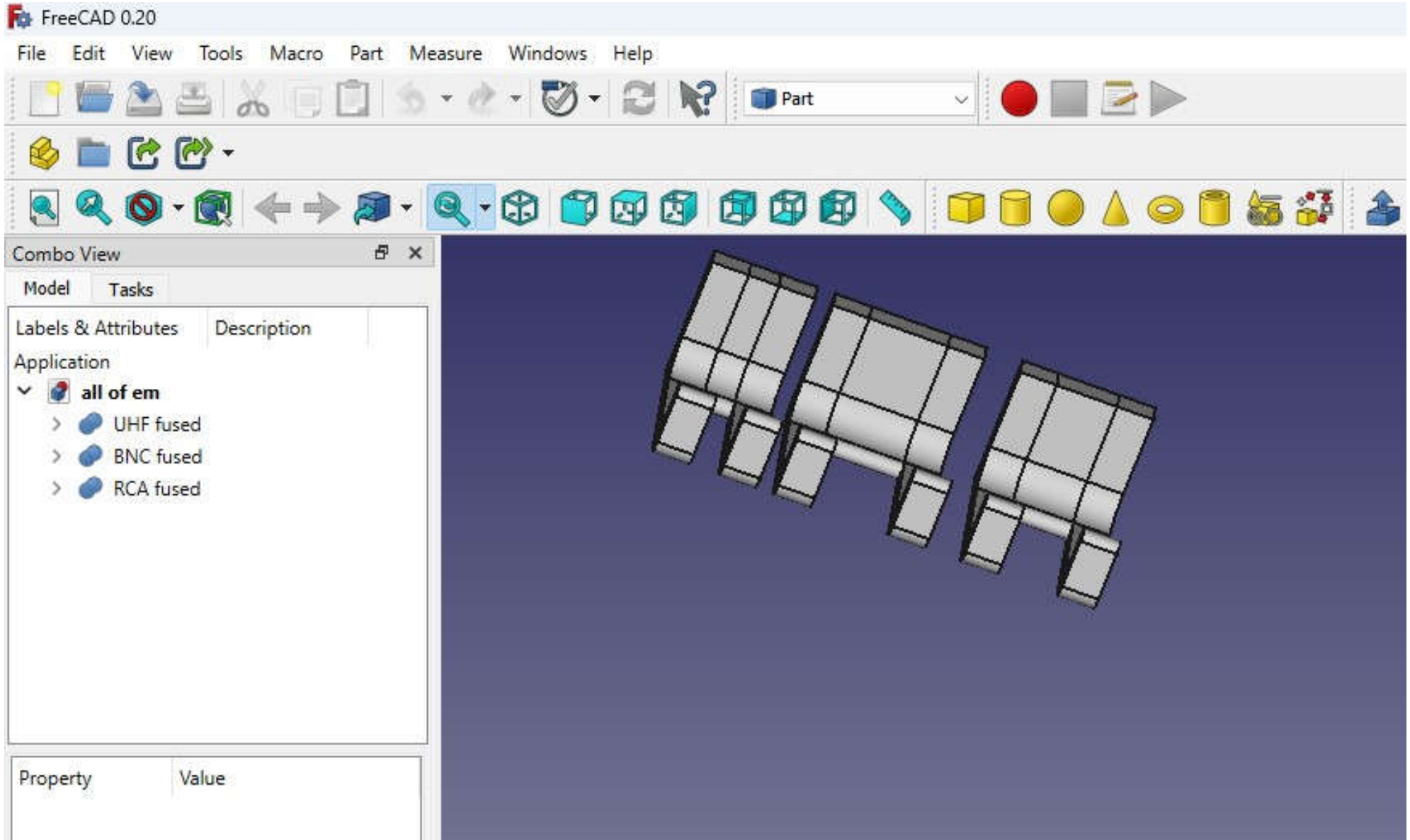
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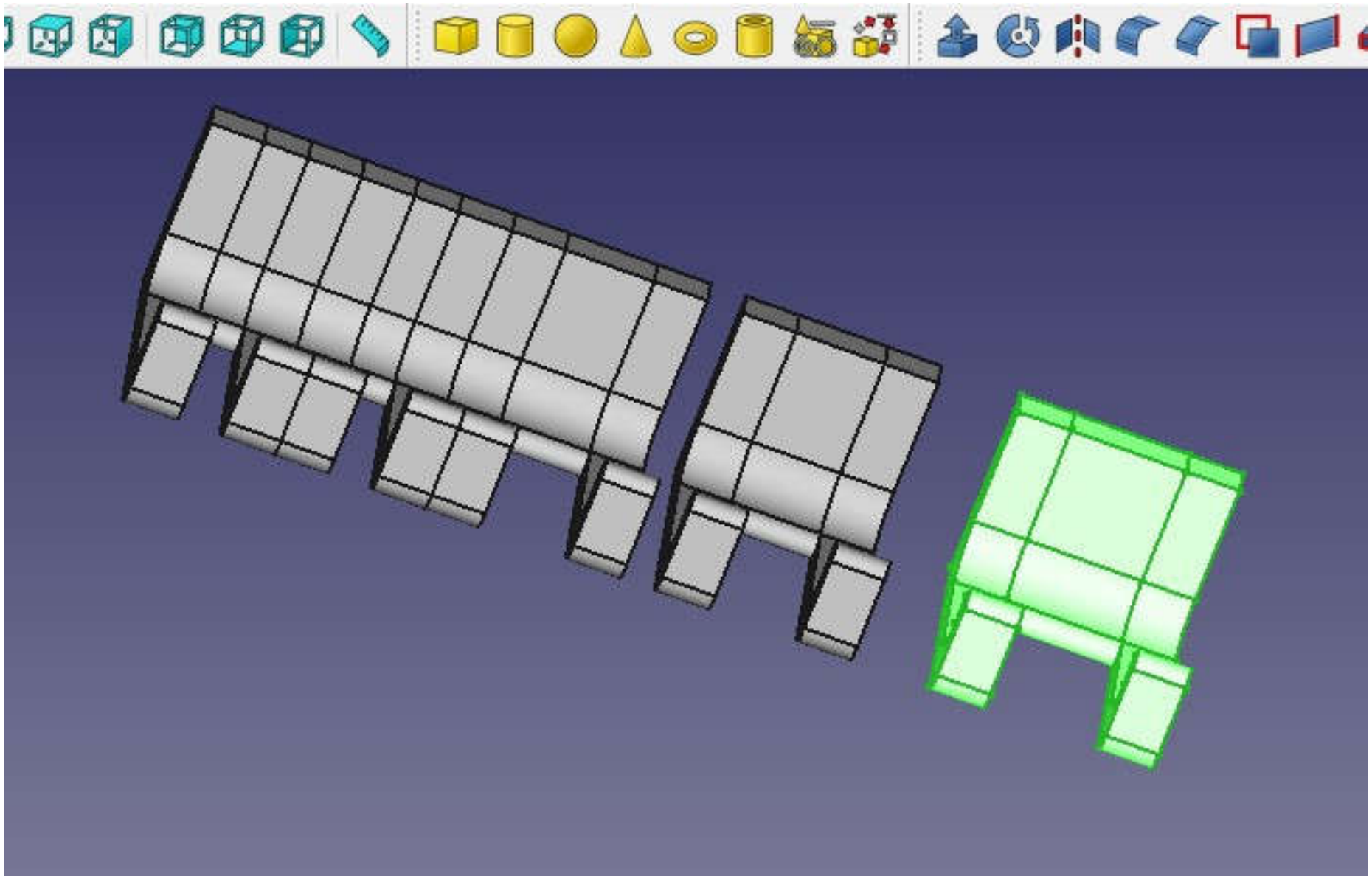
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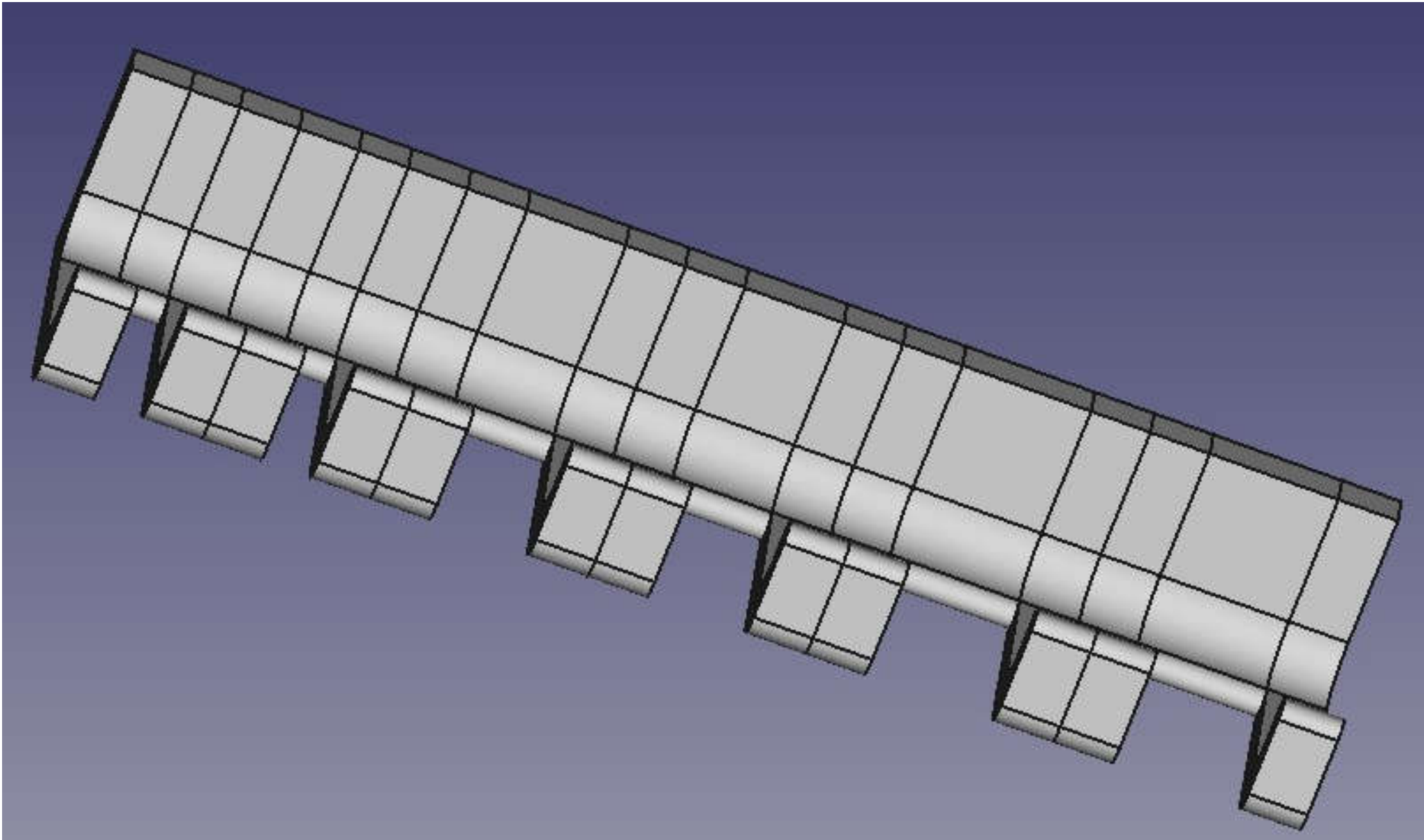
Cable Organization



Cable Organization



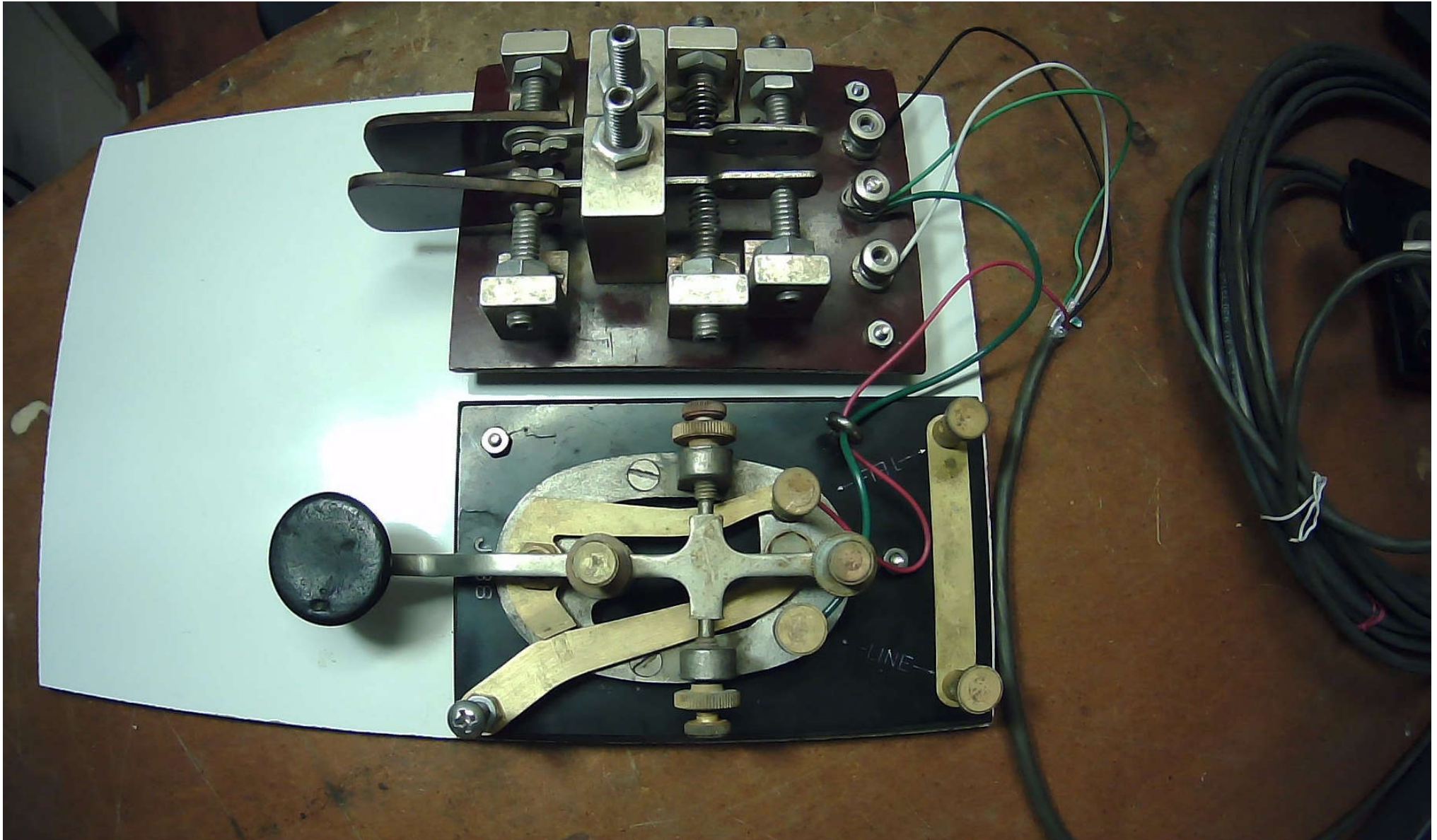
Cable Organization



Cable Organization



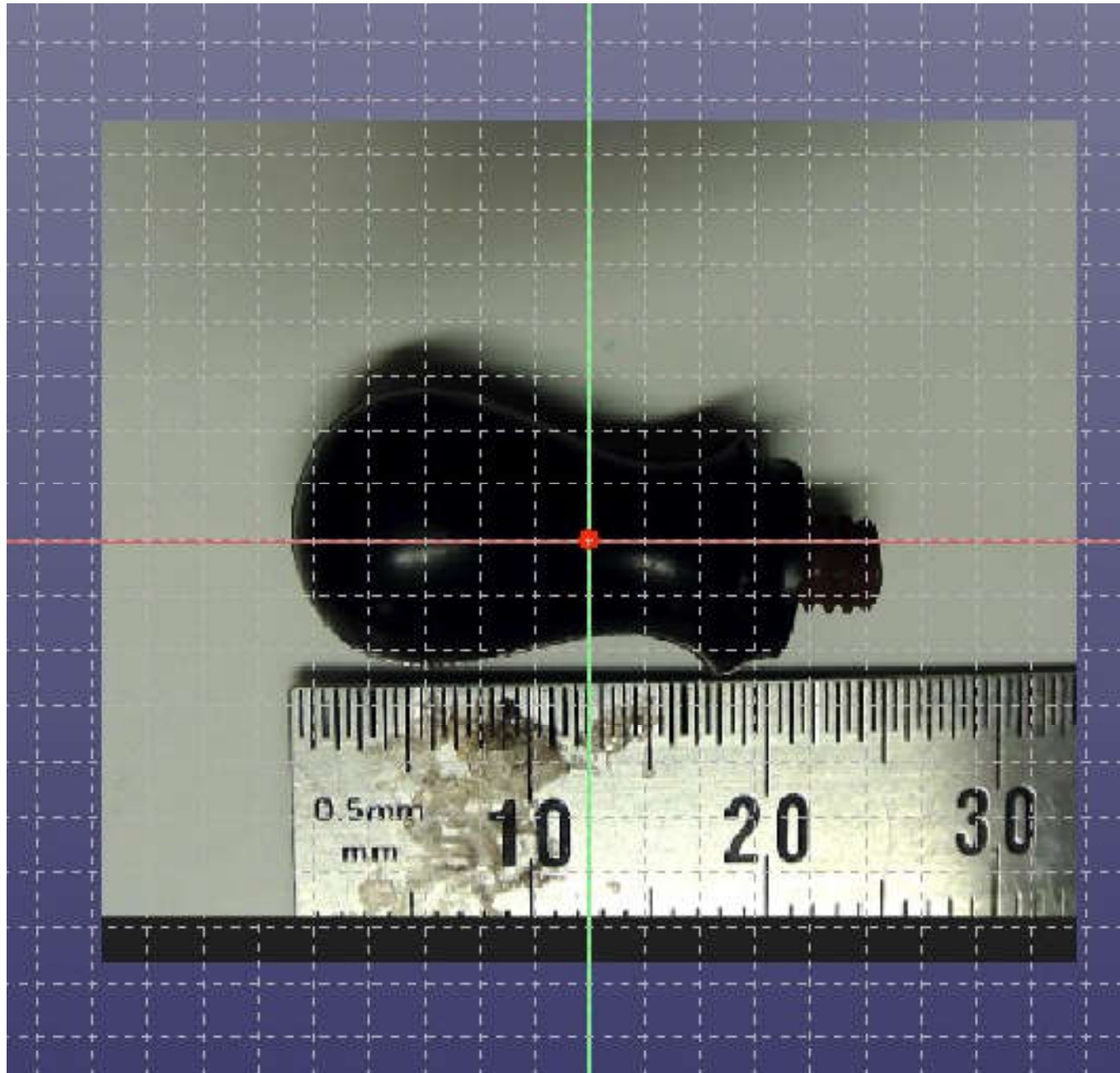
Custom Knobs



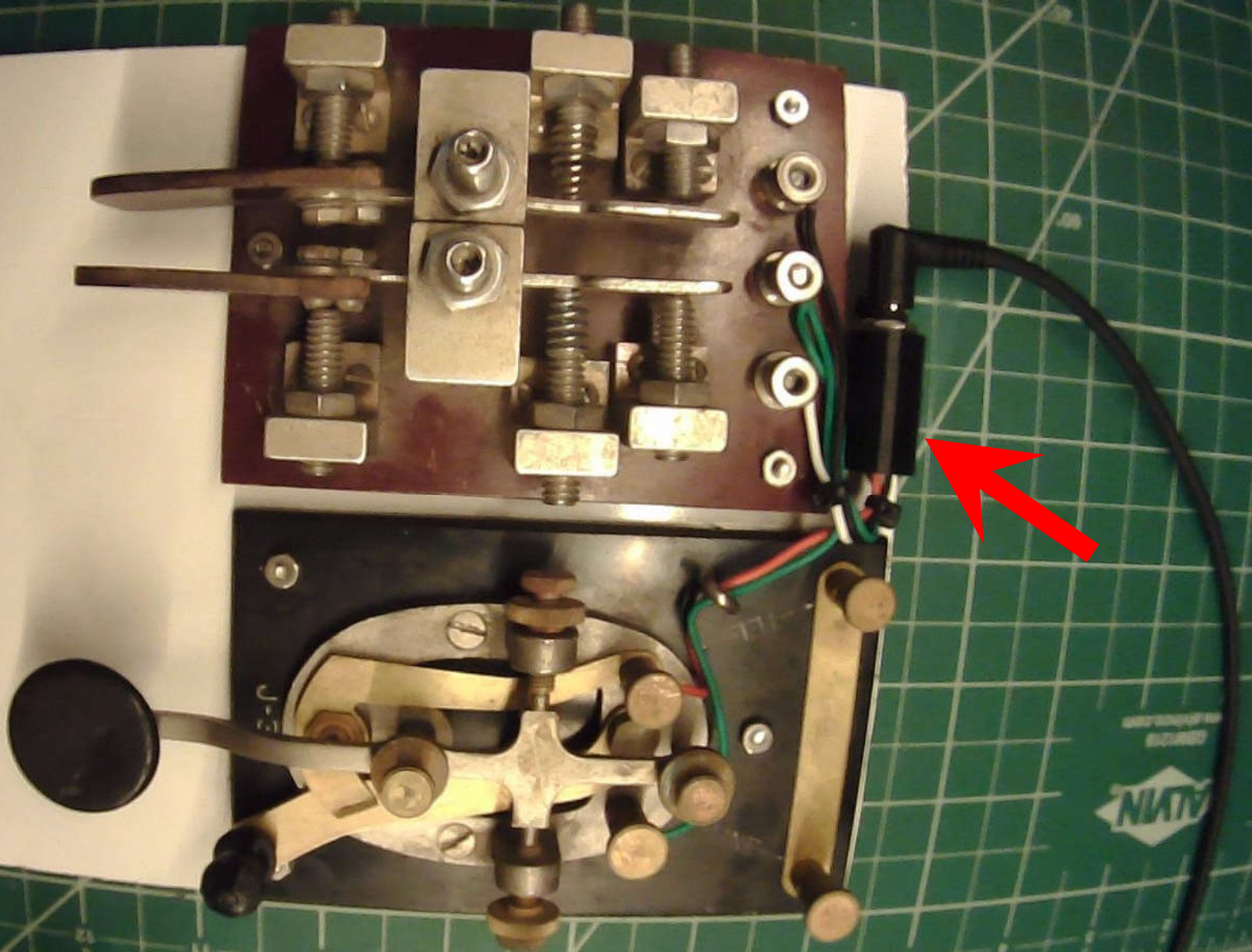
Custom Knobs



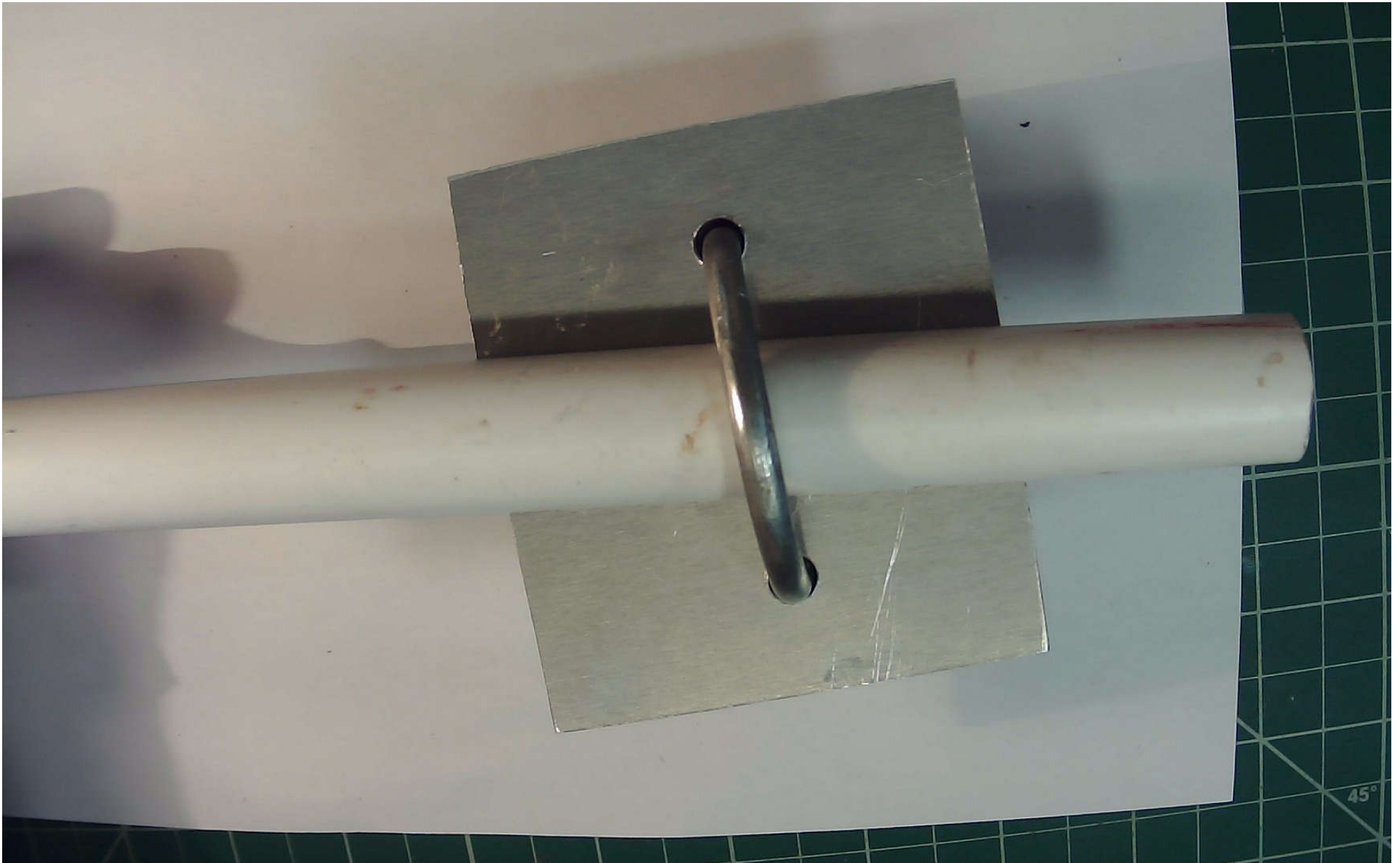
Custom Knobs



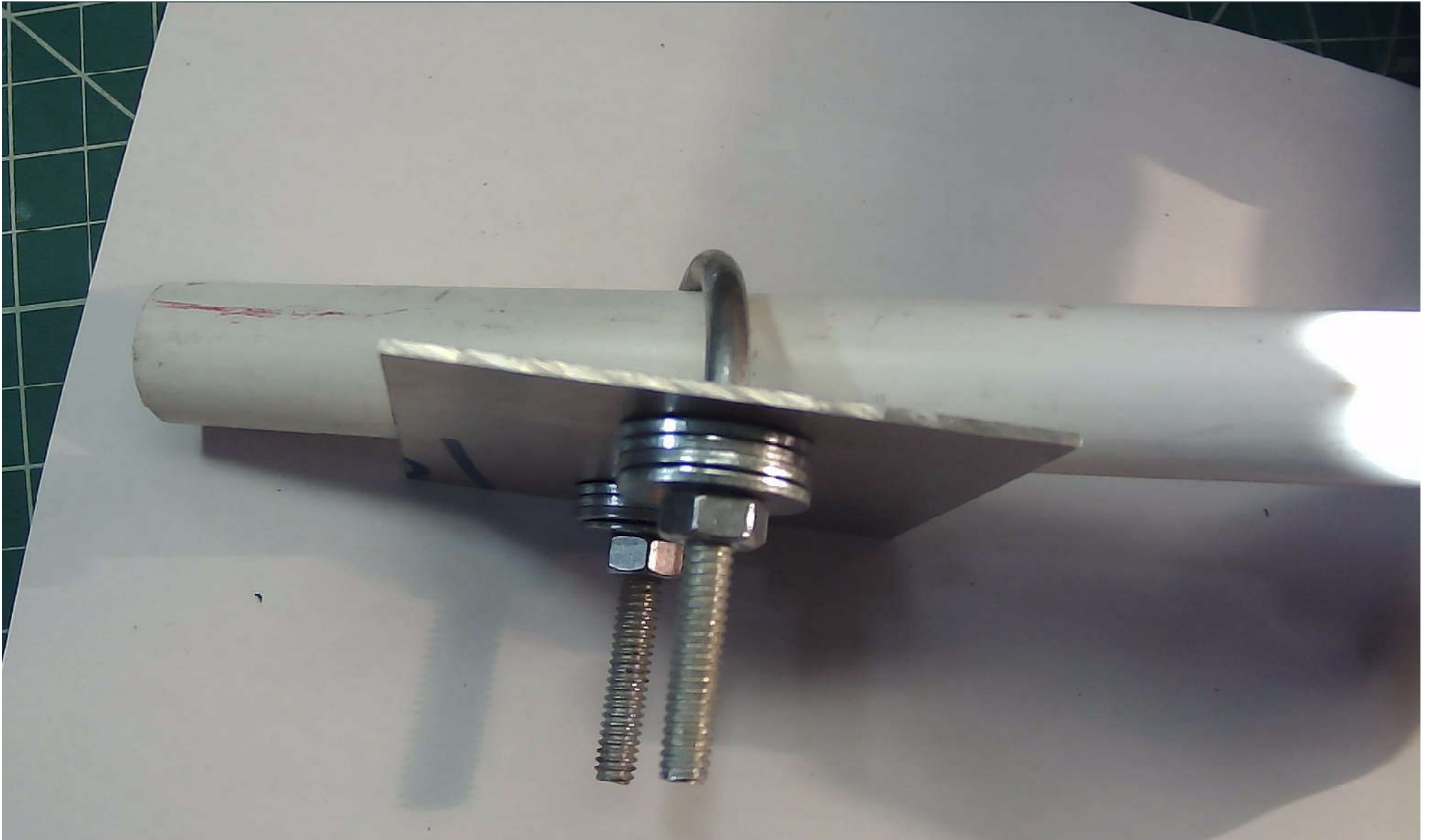
Custom Female Connector



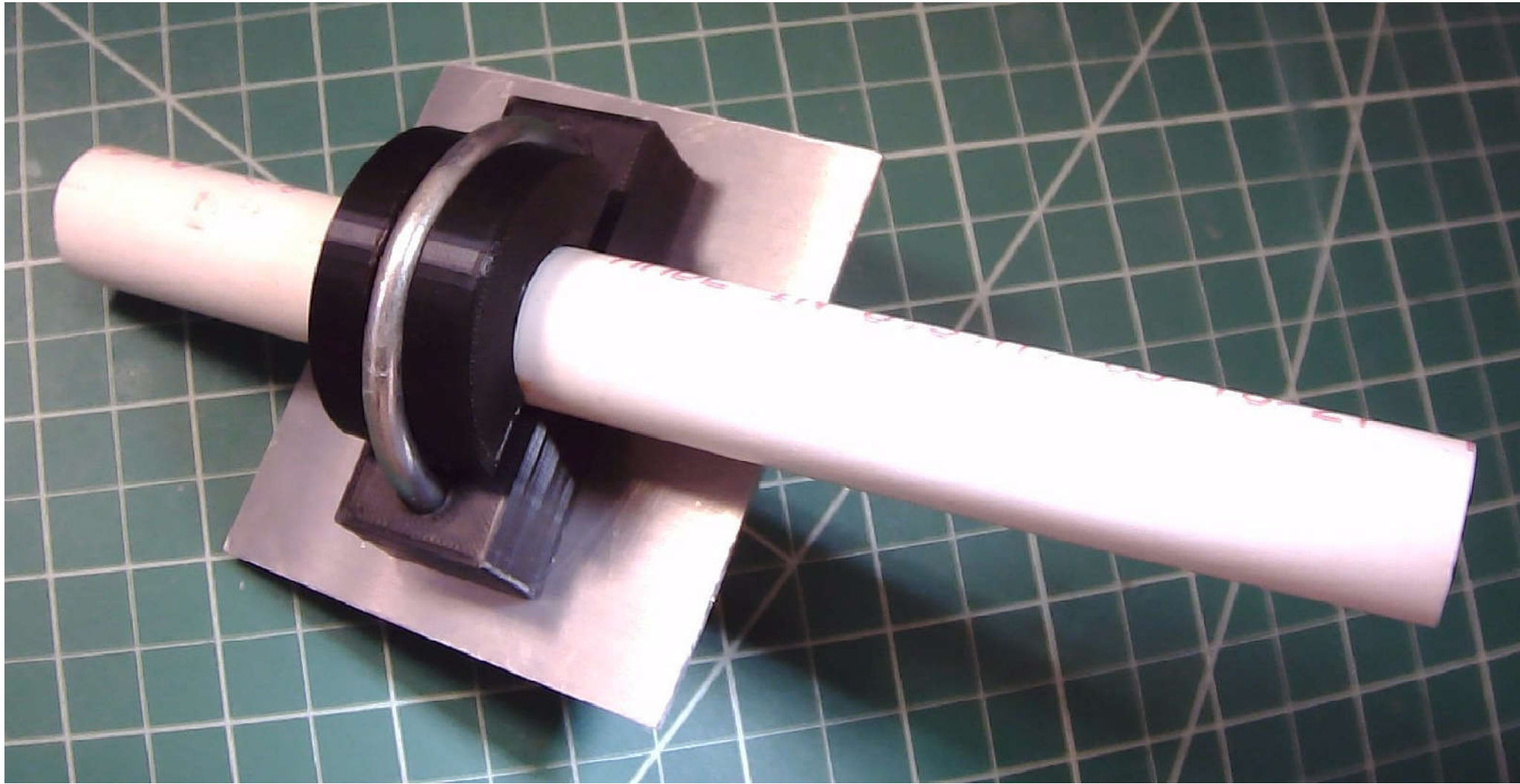
U-Bolt Enhancement



U-Bolt Enhancement



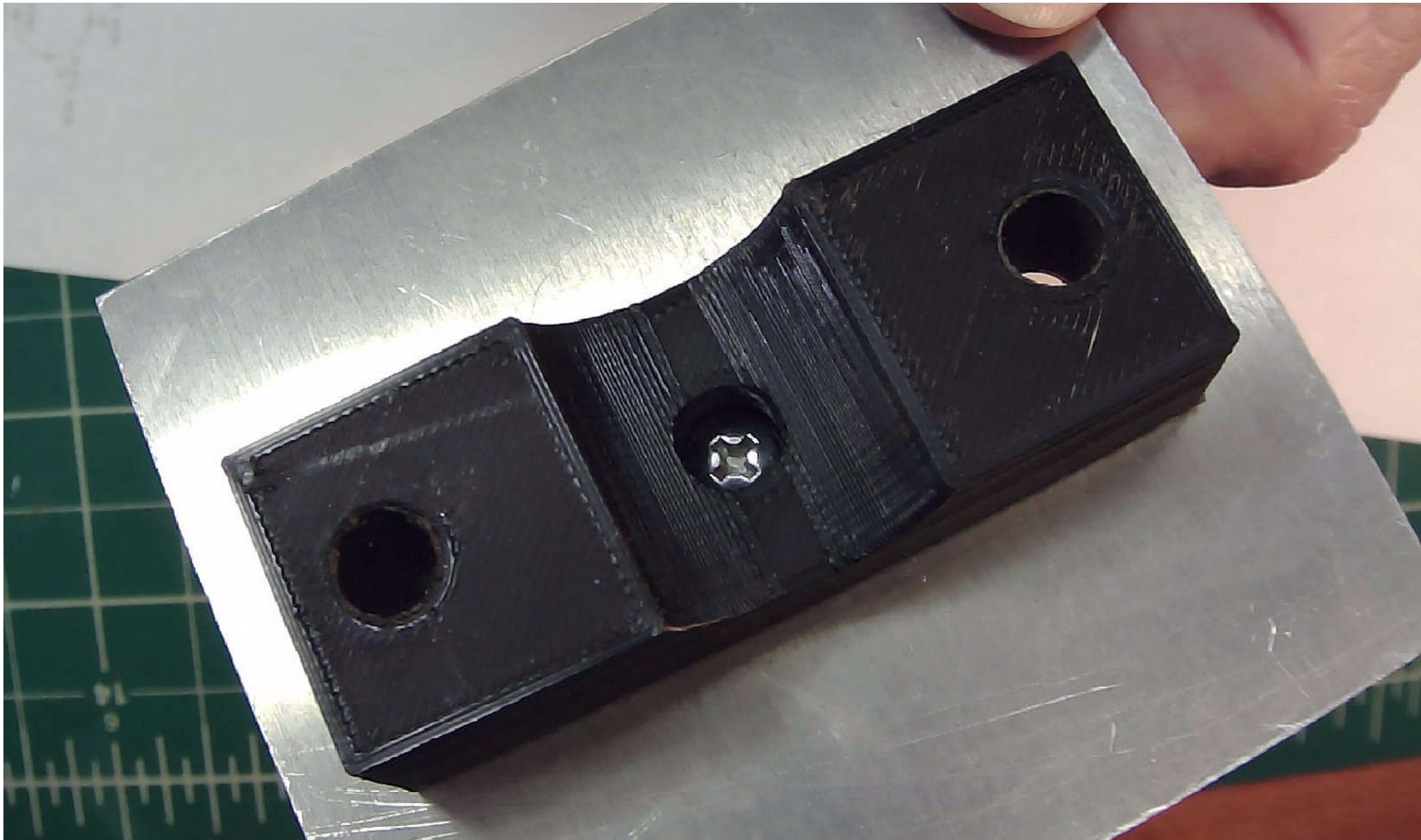
U-Bolt Enhancement



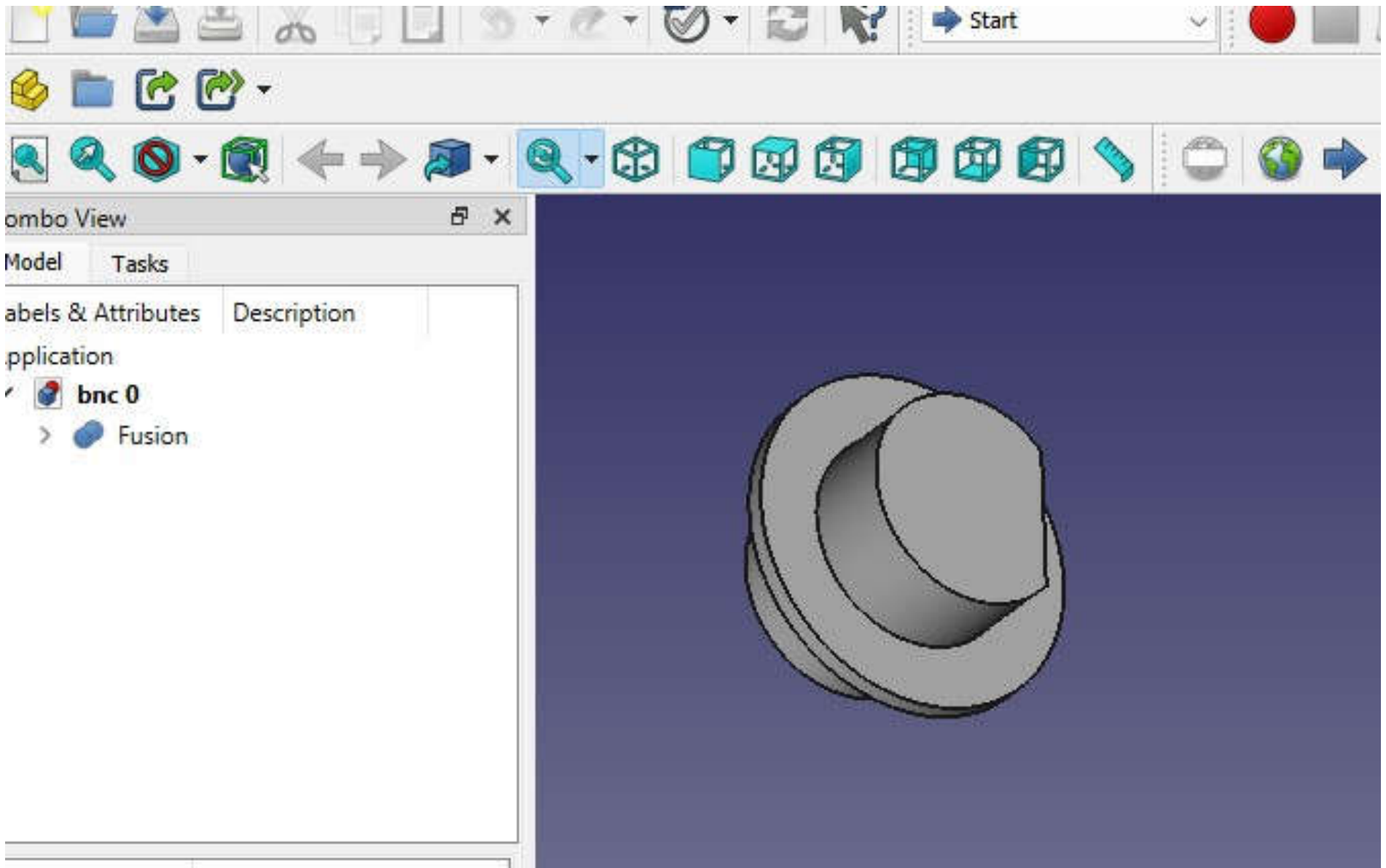
U-Bolt Enhancement



U-Bolt Enhancement



Connector template: use when designing box



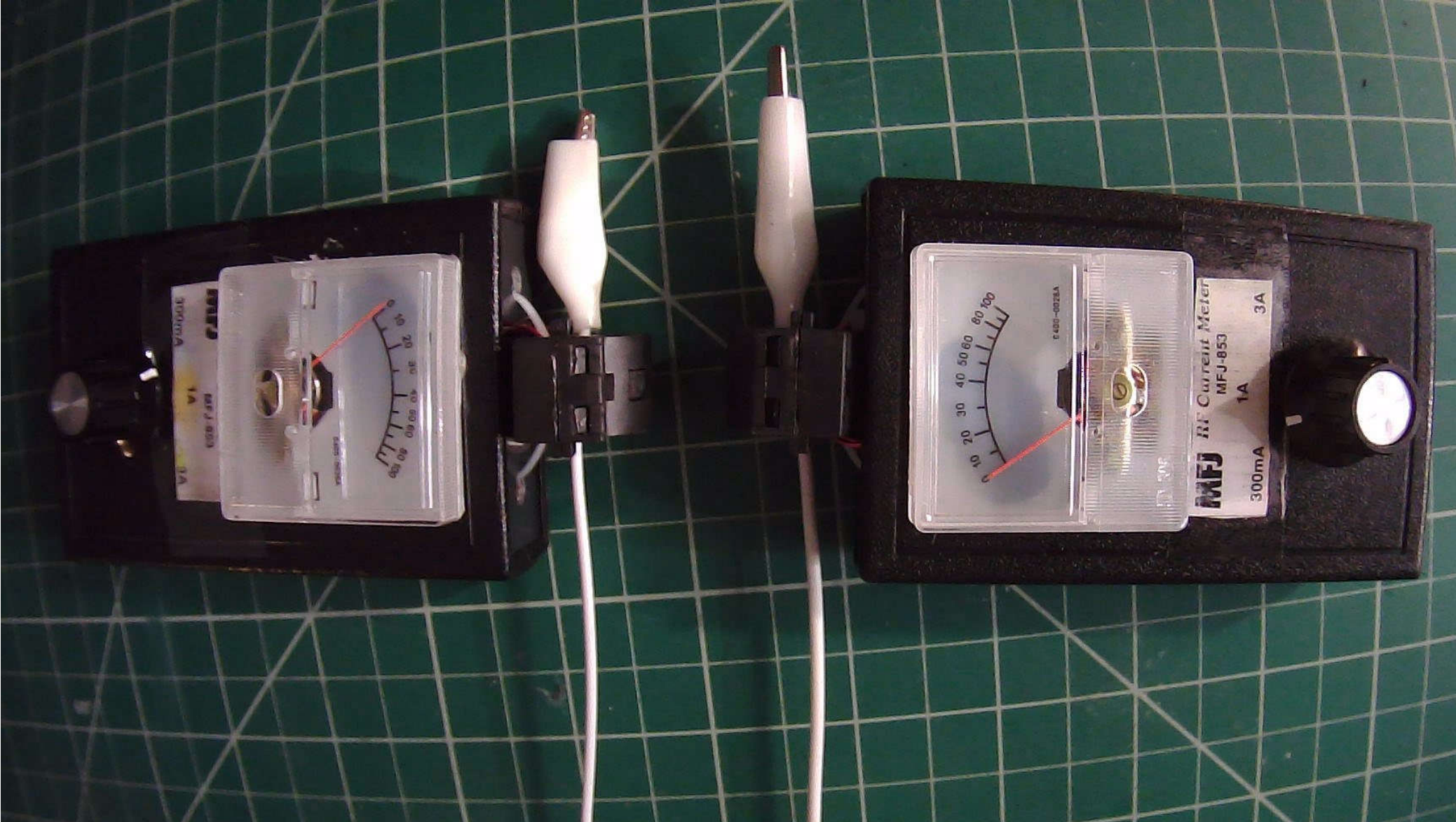
Connector template: use when designing box



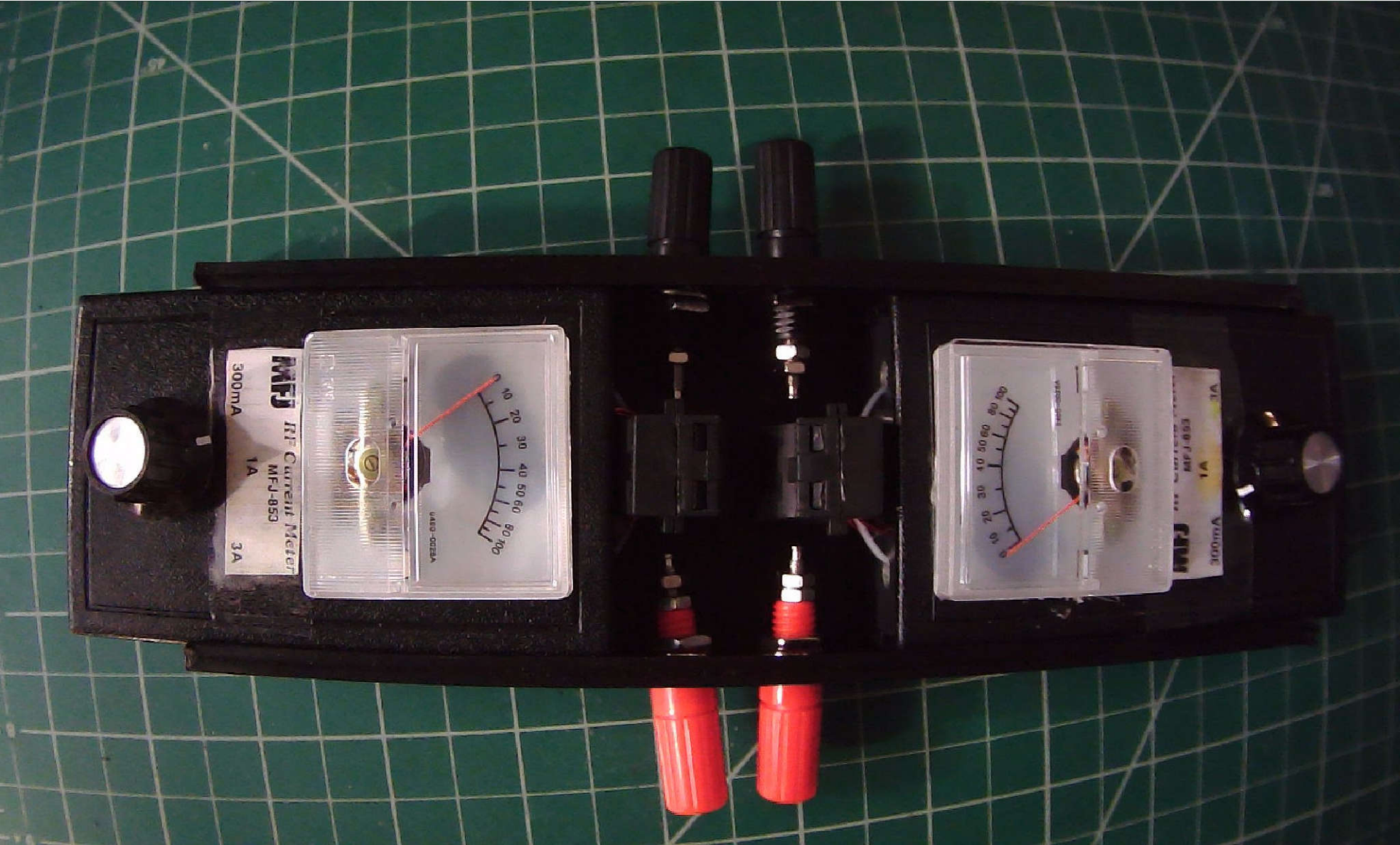
Enhancing Test Equipment



Enhancing Test Equipment



Enhancing Test Equipment



Attaching to an Outdoor Mast



Attaching to an Outdoor Mast



Speaker Stand



Speaker Stand



Hanging Bracket



Custom Knobs



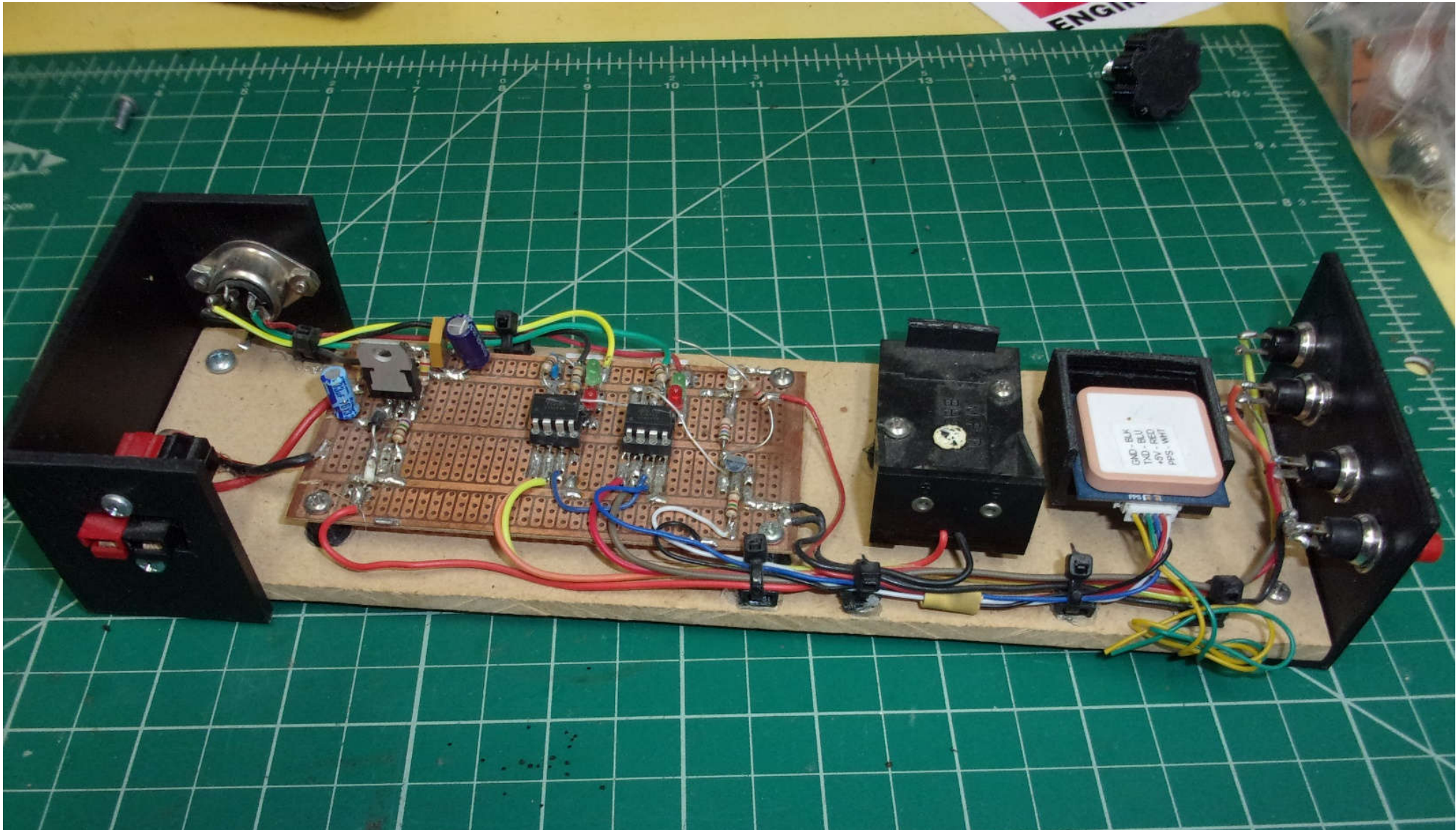
Custom Project Box



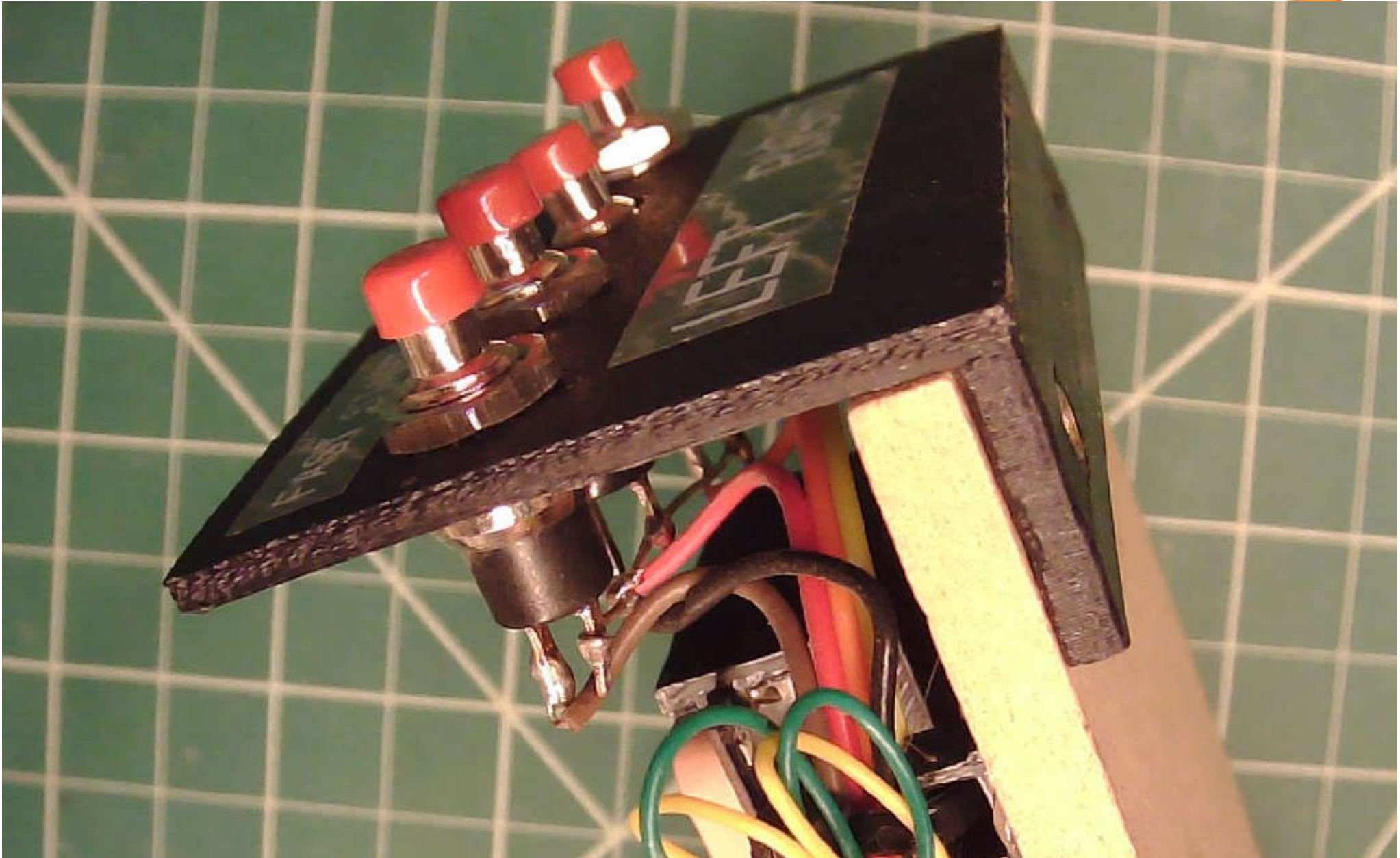
Custom Project Box



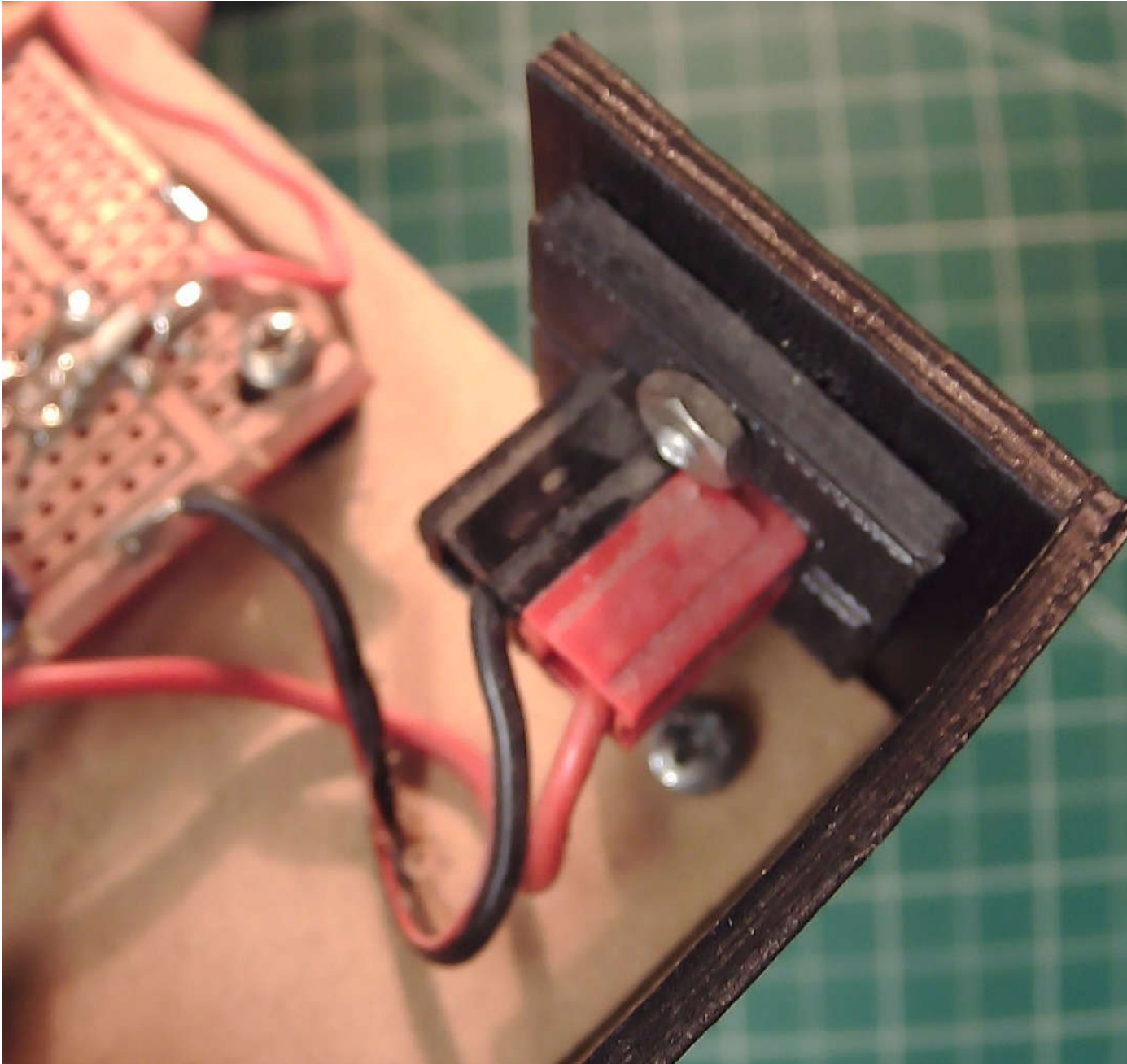
Custom Project Box



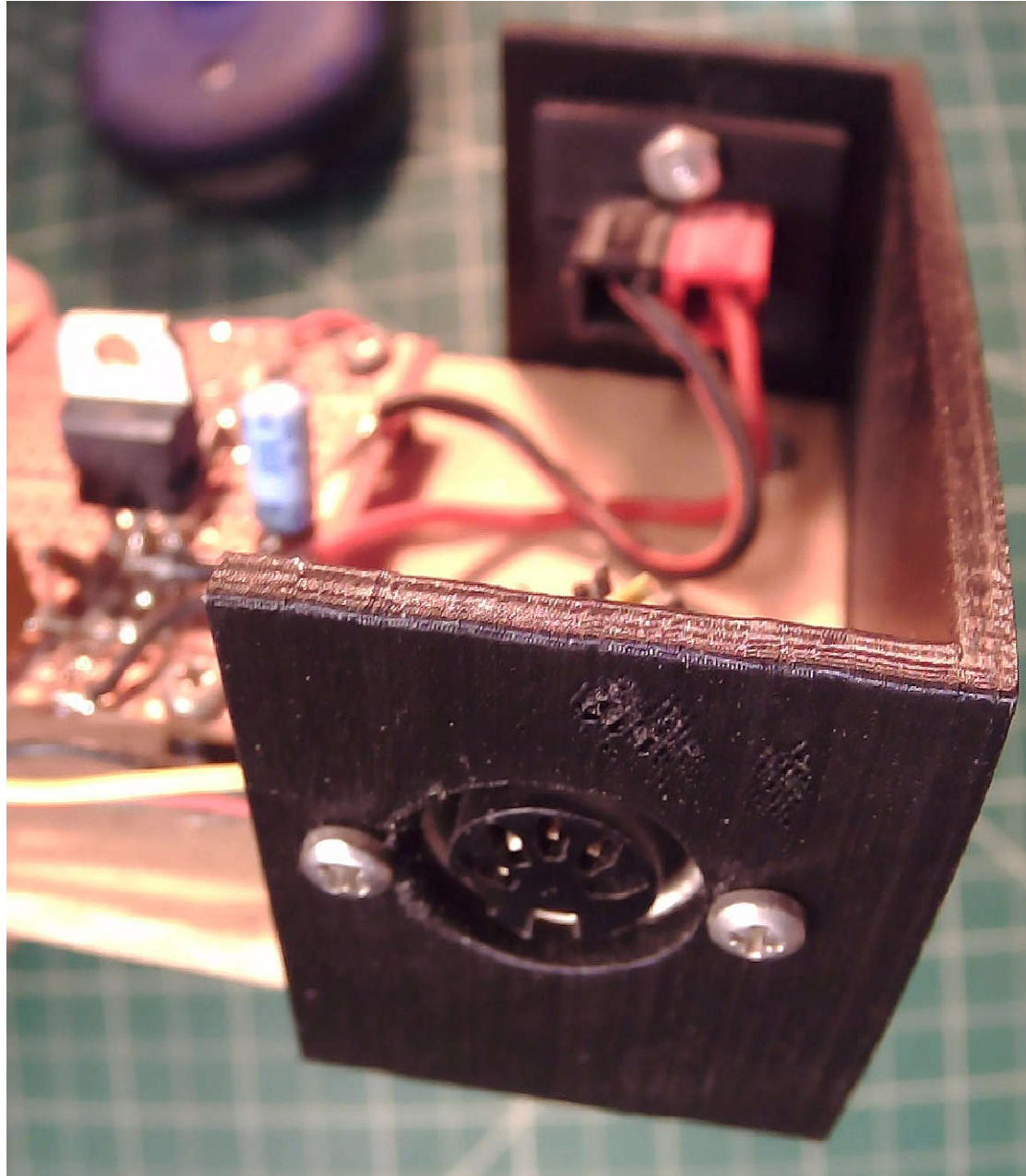
Custom Project Box



Custom Project Box



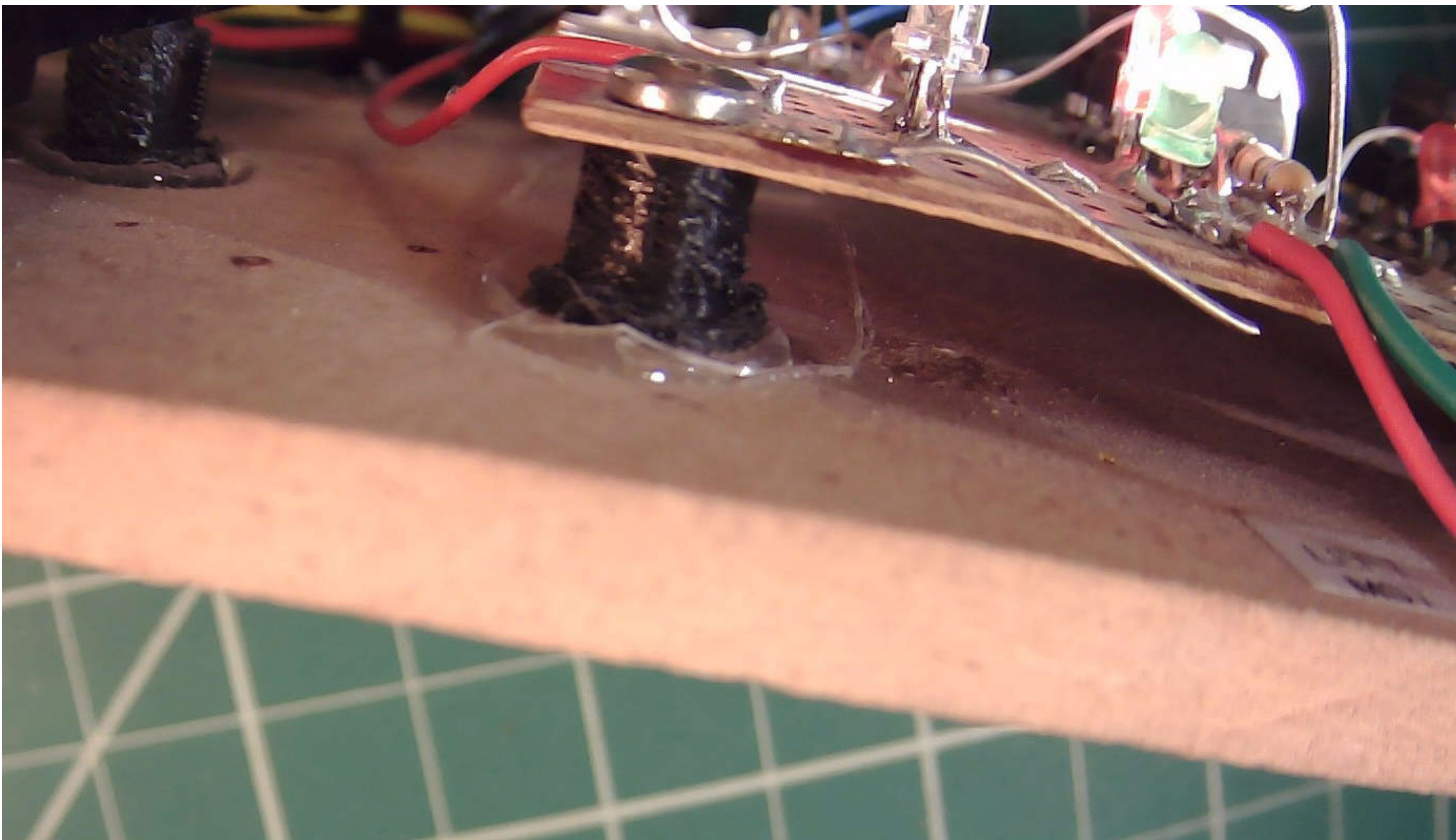
Custom Project Box



Custom Project Box



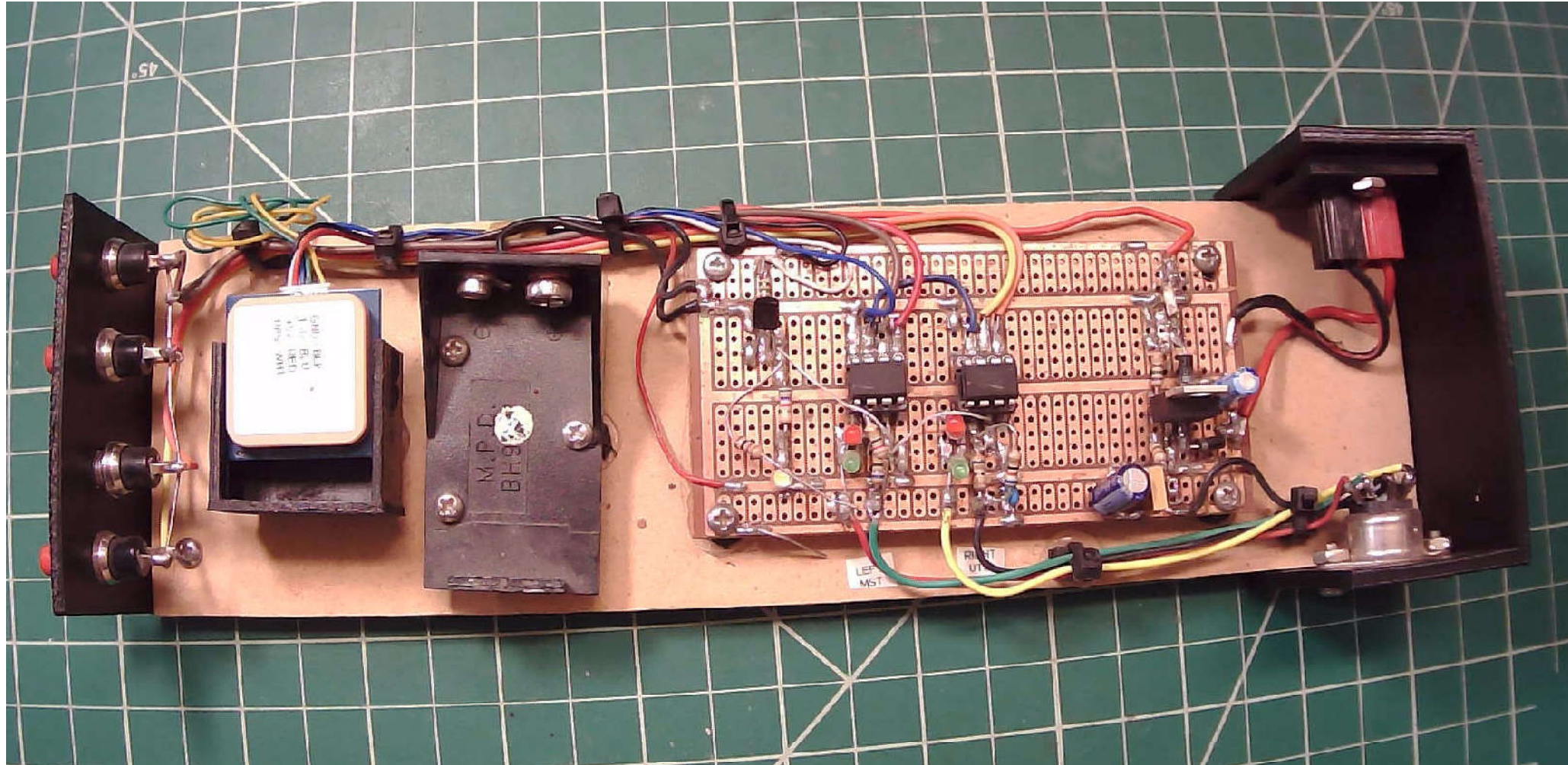
Custom Project Box



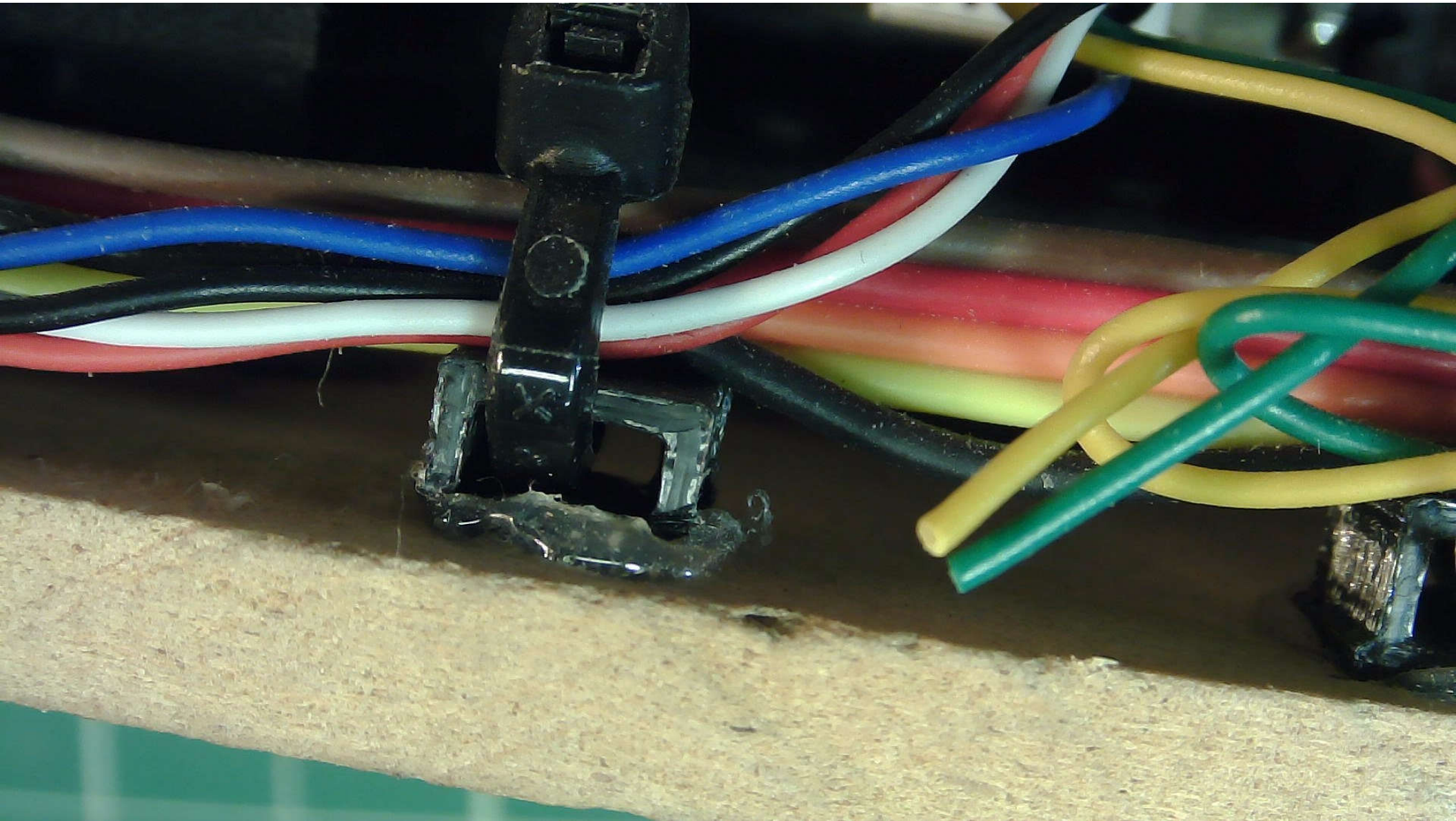
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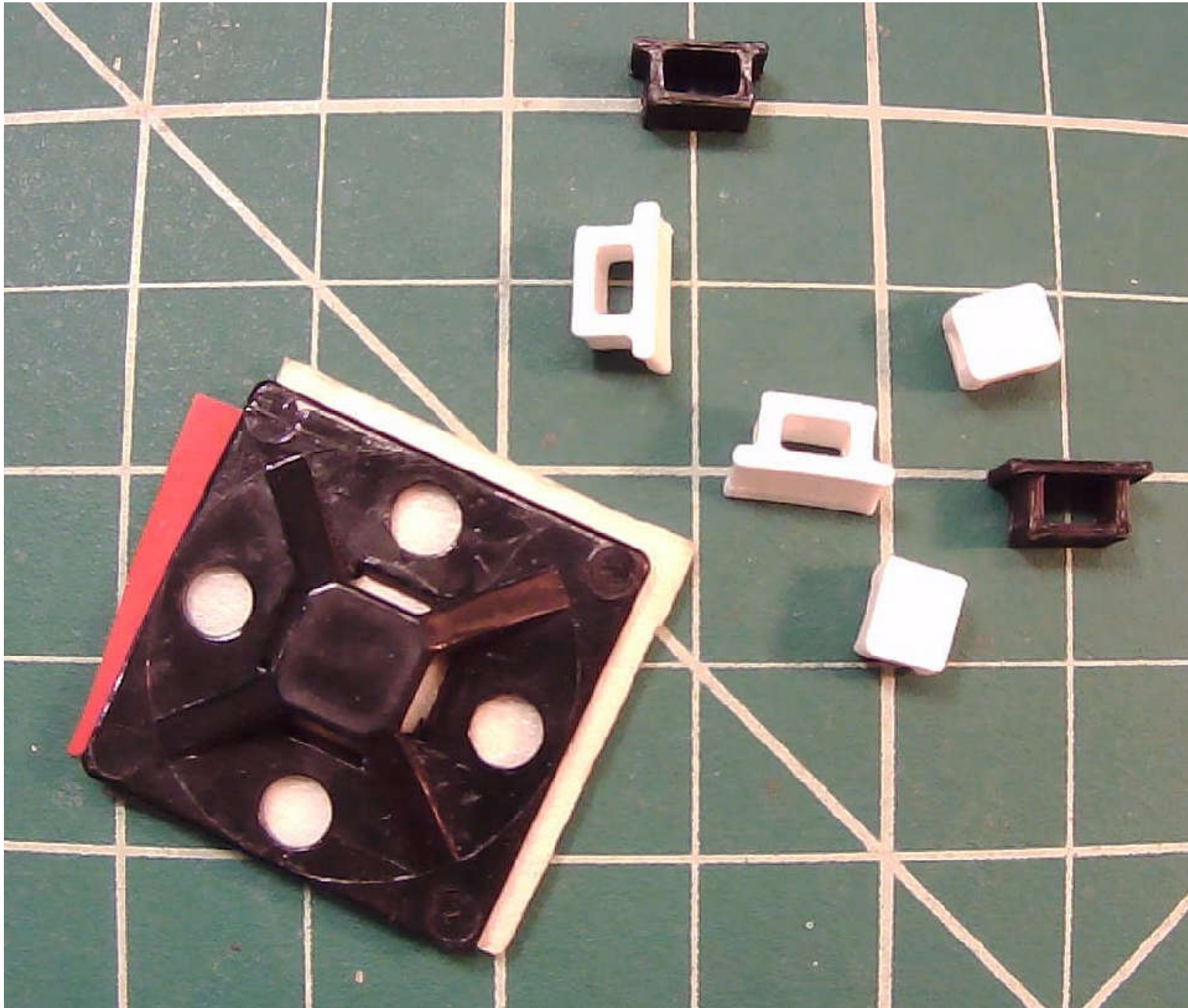
Custom Project Box



Cable Management



Cable Management



Wine Rack





Comments or Questions please!