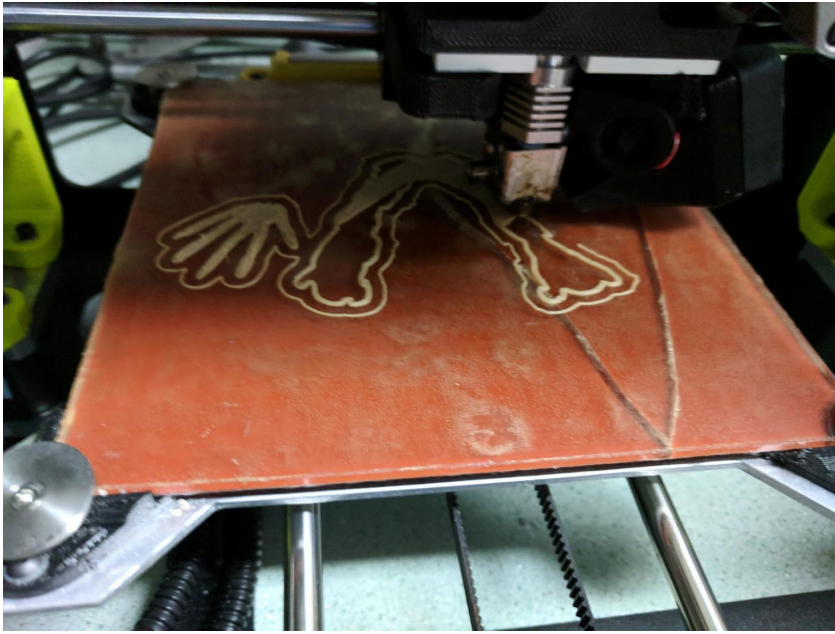


A row of five white 3D printed ship models, likely frigates, arranged on a light-colored wooden surface. The models are shown from a side-on perspective, increasing in size from left to right. Each model features a complex superstructure with multiple masts, radar domes, and gun mounts. The background is slightly blurred, showing a white bowl and some cables.

# 3D Printing

Adina Scott  
USAP

RVTEC 2021



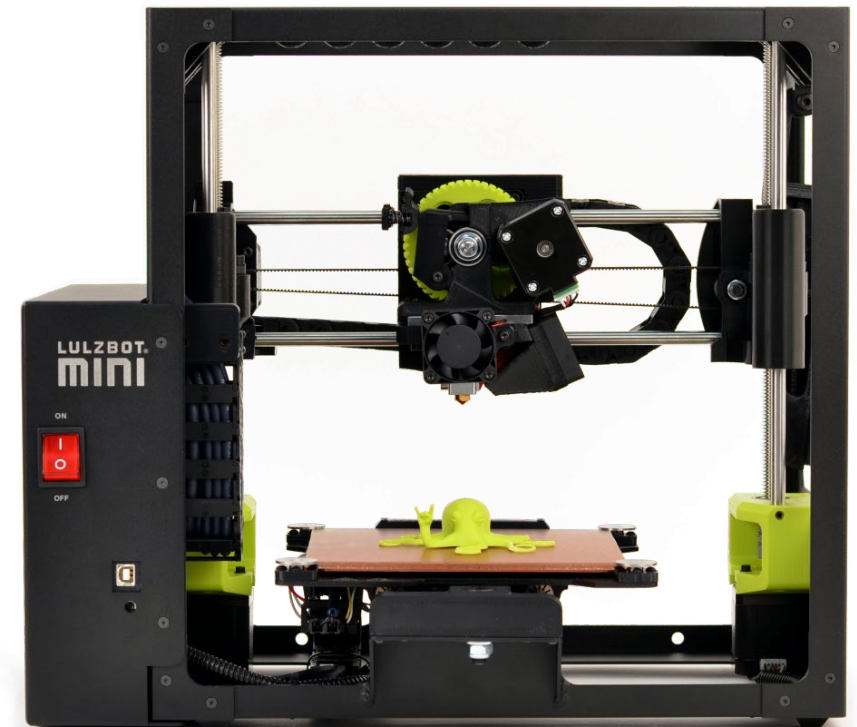
## Layer by layer additive fabrication process

Plastic filament is heated and extruded  
Extruder and bed move relative to each other





Nathaniel B Palmer  
Lulzbot Taz 5



Laurence M Gould  
Lulzbot Taz Mini

### Features/considerations

- Print volume
- Print Speed
- Compatible Materials
- Auto bed leveling
- Performance with boat motion
- Ease of repair
- Documentation/support
- Ease of use

\*\* Not intended as a particular product endorsement  
We have been happy with these but have not played  
with other models recently

# Applications

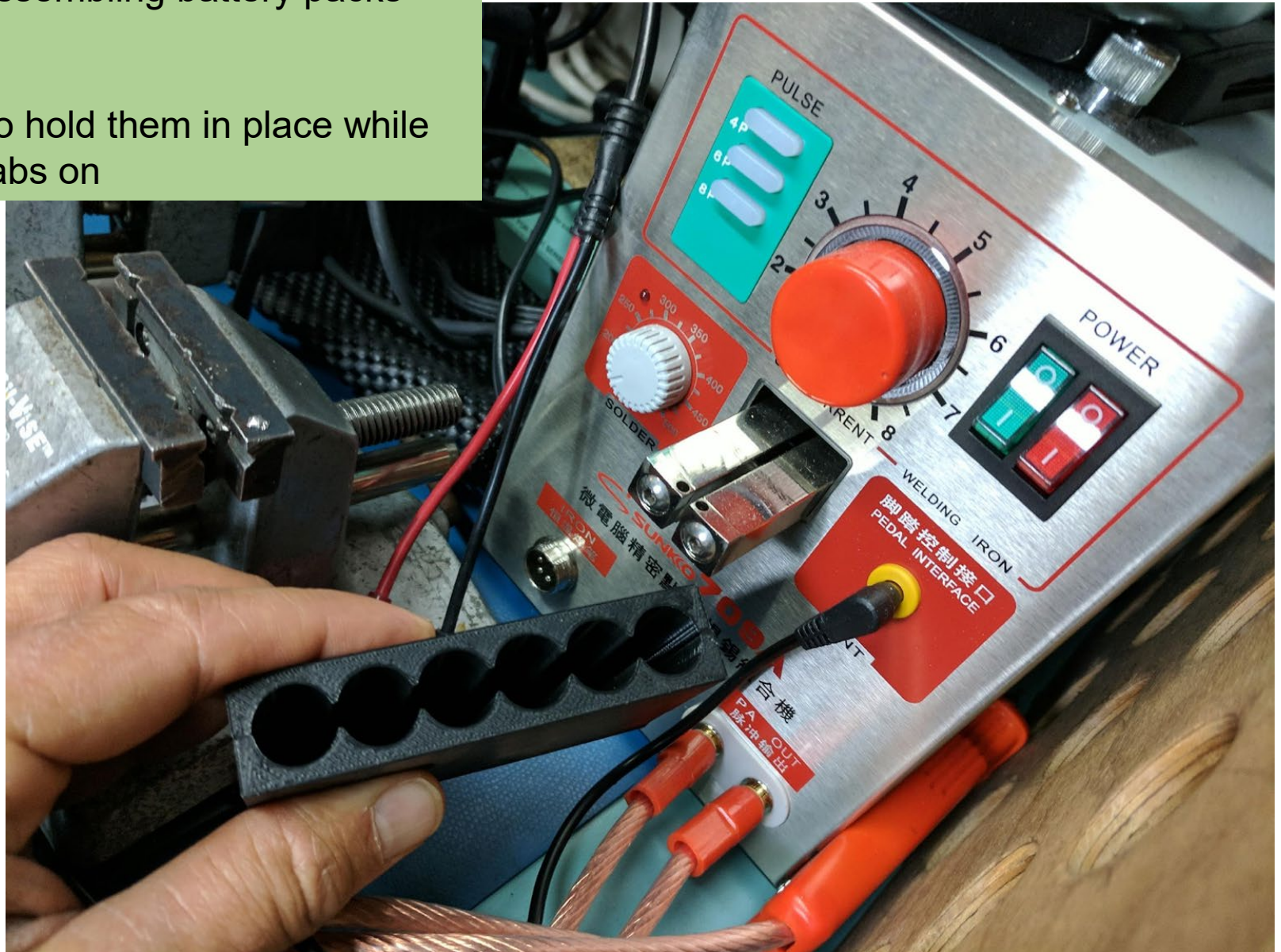
- Mounting Brackets
- Enclosures
- Mounting Blocks
- Repair and replace plastic components
- Morale
- ...

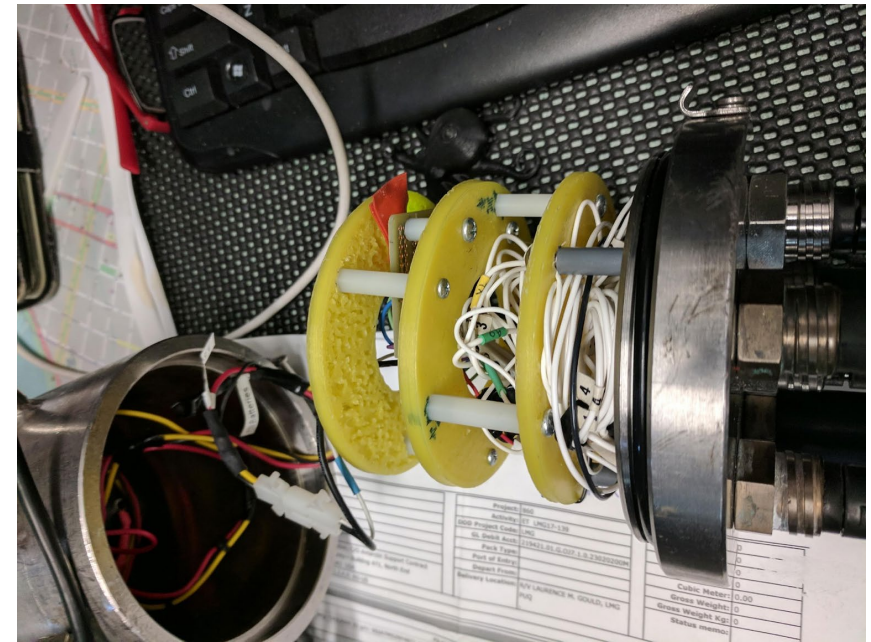
## Problem

Batteries are cylindrical – they like to roll away when assembling battery packs

## Solution

Make a tray to hold them in place while welding the tabs on





### Problem

Pressure vessels are usually cylindrical and the attachment points are on the lid  
Components need to be precisely positioned in order to work correctly

### Solution

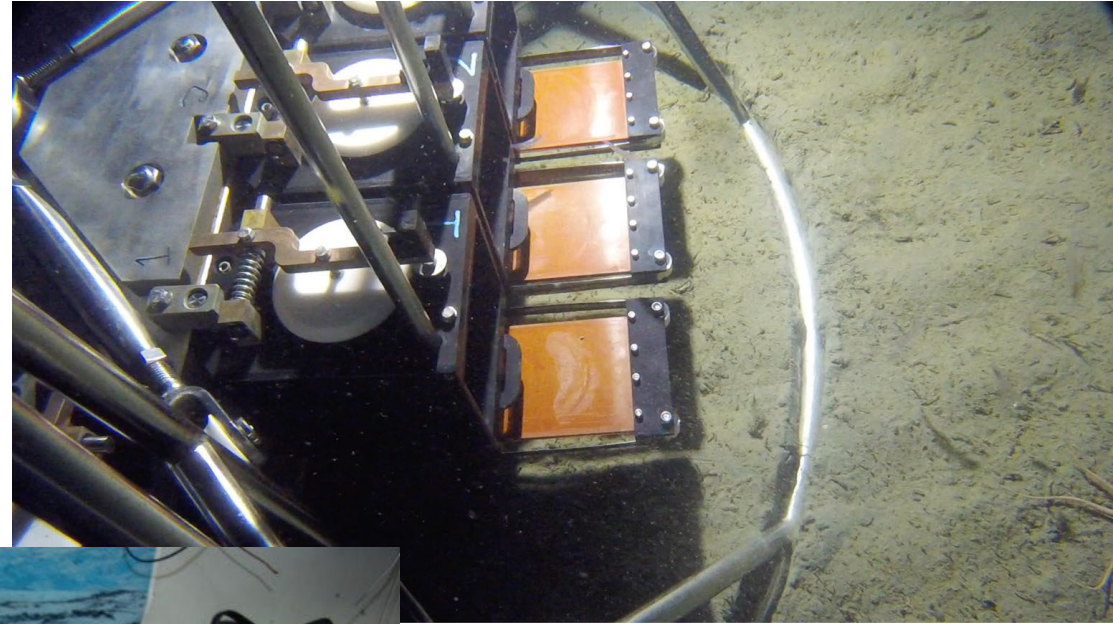
Sweet mounting bracket goodness



Repurposed Deep Sea and Light housing to hold Go-Pro

Repurposed various housings to hold motion sensors for monitoring equipment deployment

Repurposed old TDR housing to add instrumentation to OIS camera



Versatile

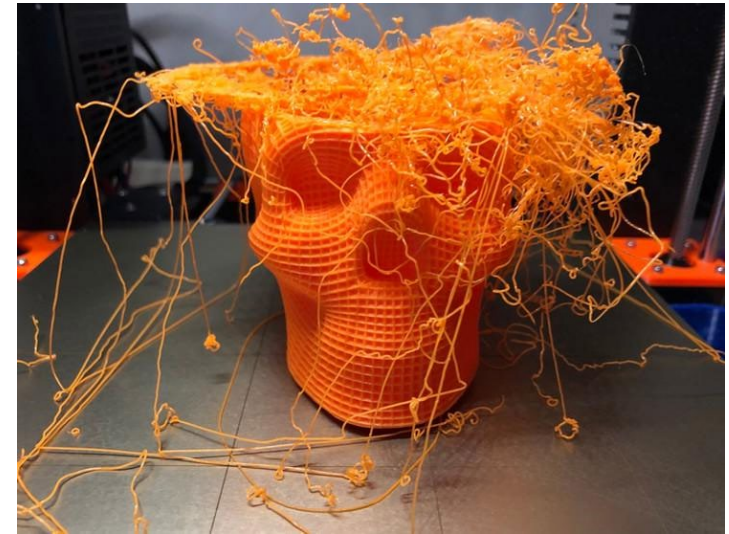
Generate arbitrary shapes

Choice of materials (as long as it's mostly plastic)

Repositories of models

Low waste (once you're good at it)

Small footprint

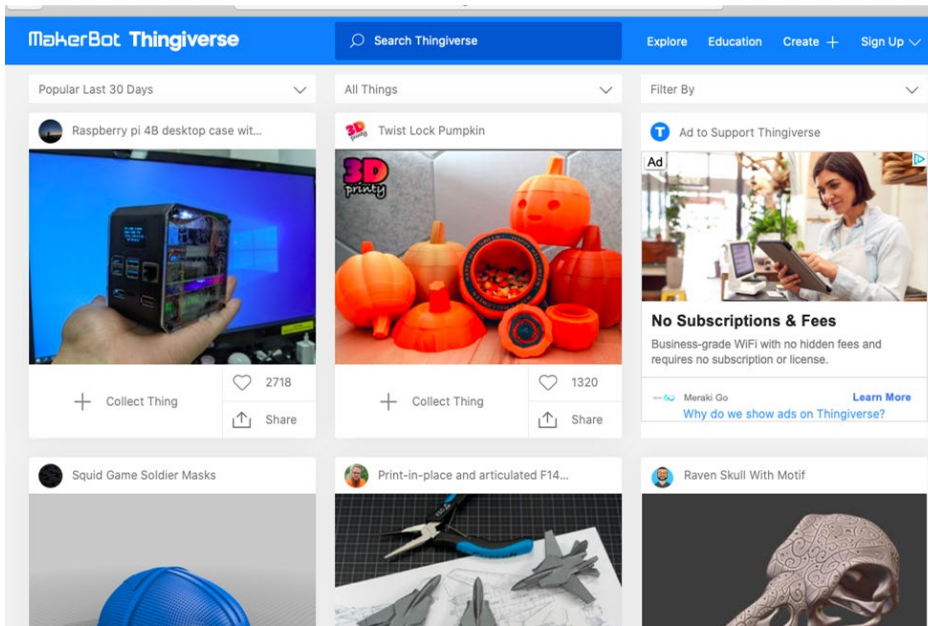


Slow

Some geometries are difficult or impossible

Need CAD skills/tools

Finicky



Like most tools there are applications for which 3D Printing is great but it is not a panacea



# Material



- Ease of use
  - Printing Temp
  - Thermal Expansion
  - Extrusion
  - Adhesion
  - Outgassing
- Mechanical
  - Hardness
  - Strength (tensile, compressive)
  - Brittleness
- Environmental
  - UV
  - Water
- Chemical
  - Ketones
  - Common organic solvents
- Aesthetic
- Environmental
- Special properties

- ABS
- PLA
- Nylon
- PETG
- PC
- Delrin
- Proprietary
- Flexible
- Extruder cleaning
- Sacrificial
- PEEK
- ...
- Specialty (mostly PLA composites)
  - Conductive
  - Magnetic
  - Wood/bamboo
  - Metals

Choice of material depends on application

Details of print process and finishing depend on material

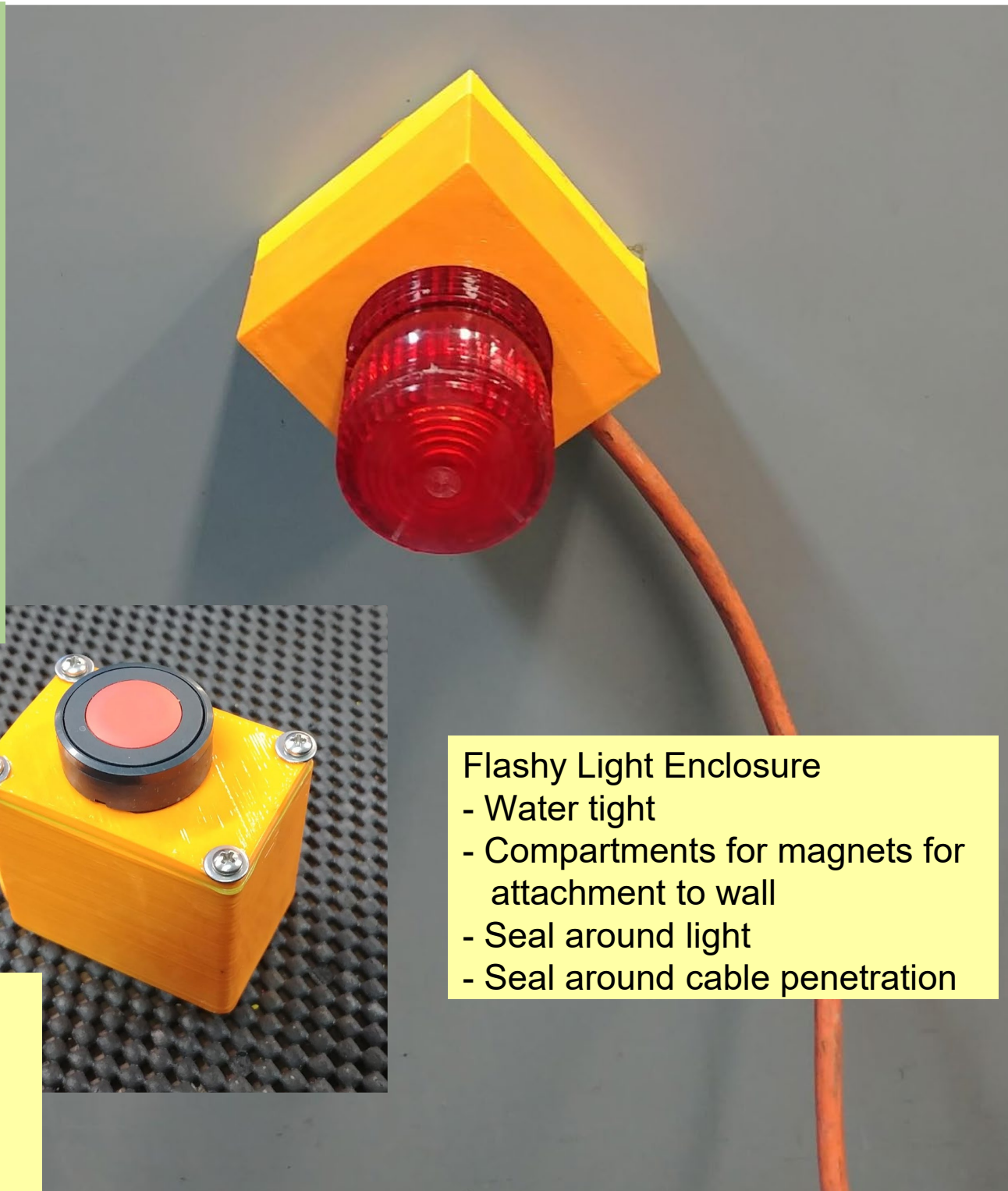
# Towed Echosounder

## Problem

Deck personnel need to be able to shut off pinging to pull transducers out of the water to avoid ice

## Solution

Indicator light to alert deck personnel as to when the instrument is pinging  
Wireless shutoff button



### Flashy Light Enclosure

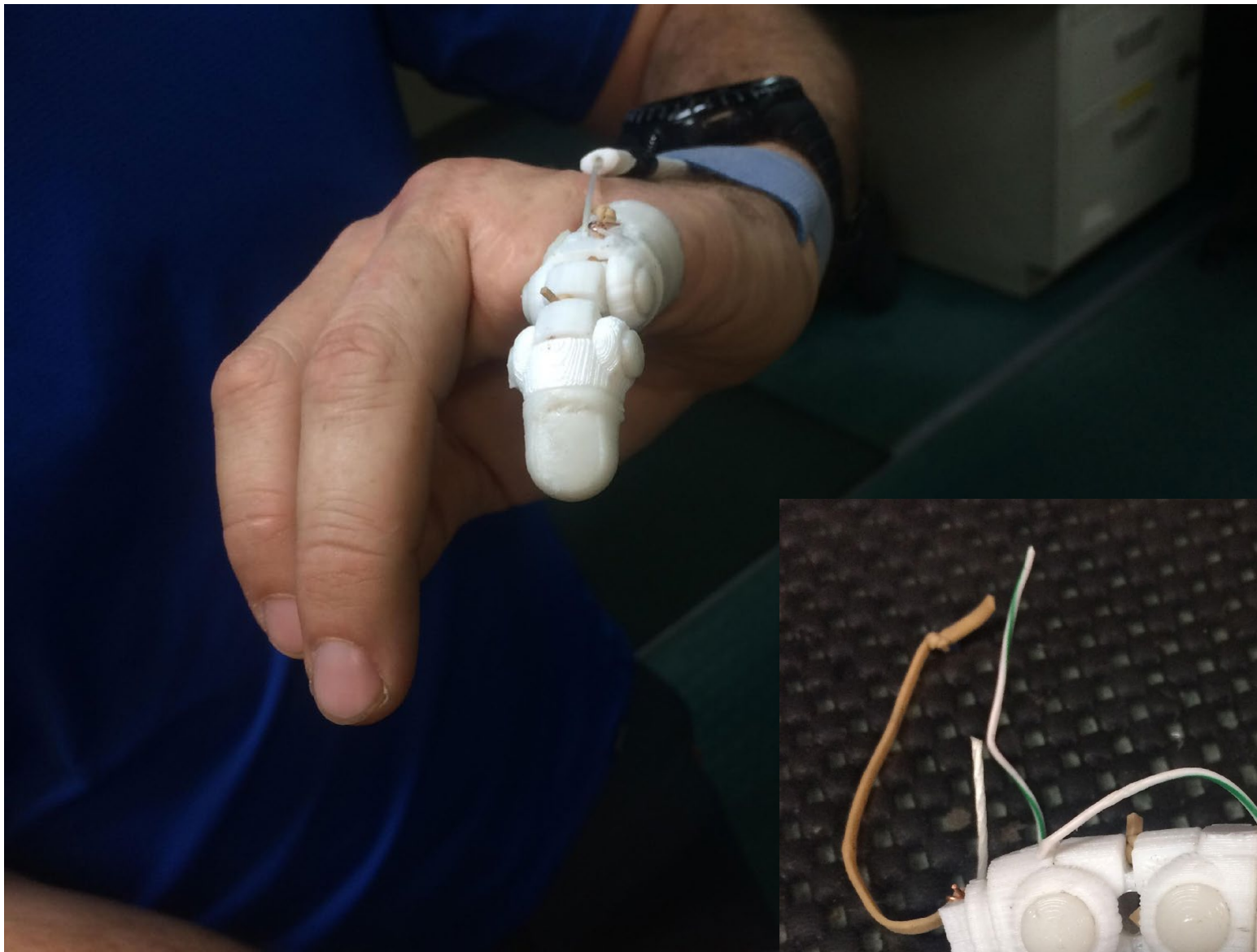
- Water tight
- Compartments for magnets for attachment to wall
- Seal around light
- Seal around cable penetration

### Wireless Shutoff Button Enclosure

- Water tight
- Seal around button
- Seal around lid
- Lanyard attachment point

# Lessons Learned

- 3d printers can break – have spare bits and print backup parts as soon as you can
- Manage your heat – building an enclosure around your setup to stabilize the temperature helps with warping/delamination
- Manage your fumes – some materials (ABS) outgas and may be unsuitable for printing in confined areas
- Manage your moisture – water absorption makes some materials (PLA) brittle and causes printing and part failure
- Good CAD tools and skills are key to making complex custom parts
- Be patient, experiment, have fun – it's an art form



Morale



# Questions???

