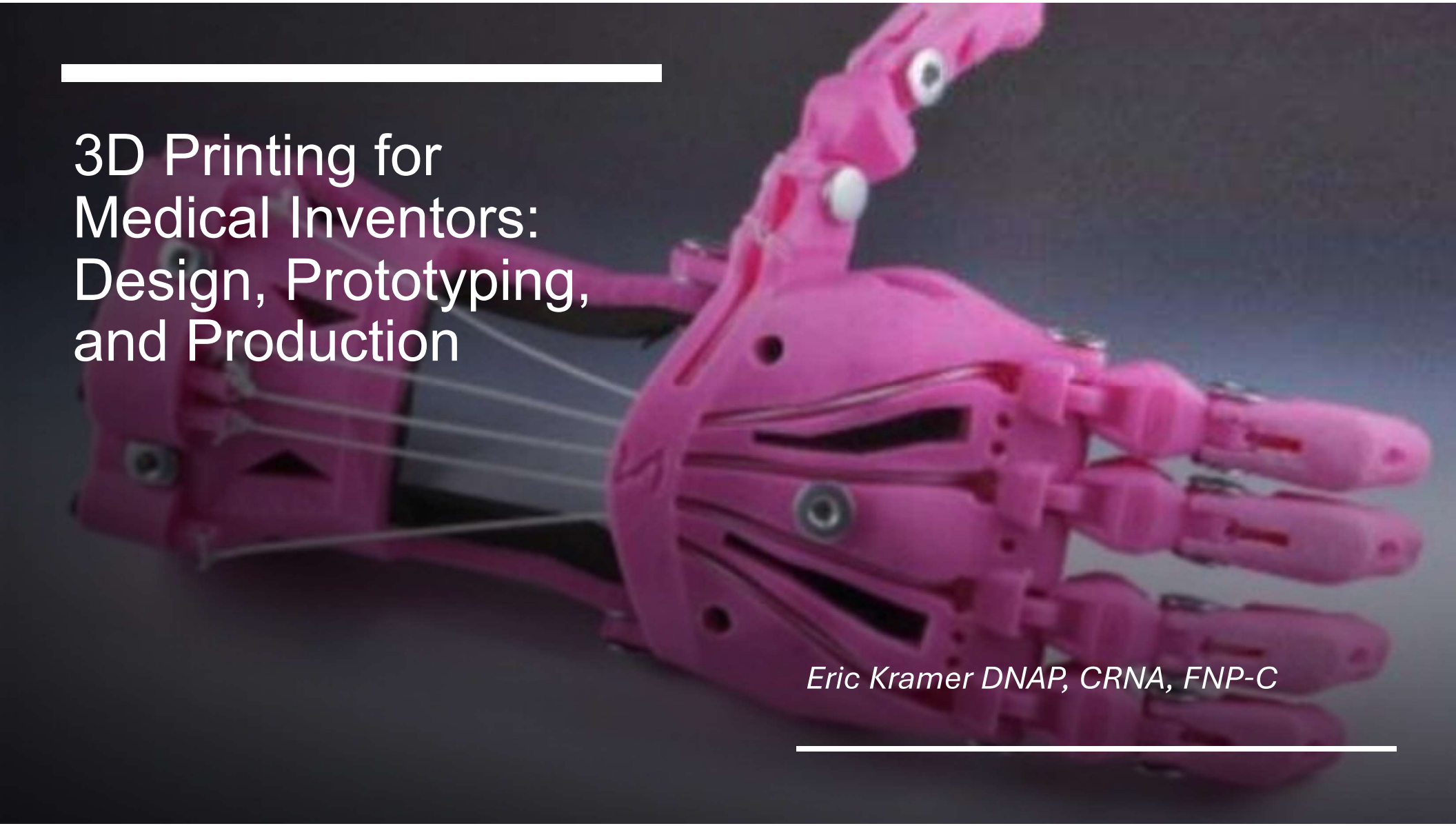


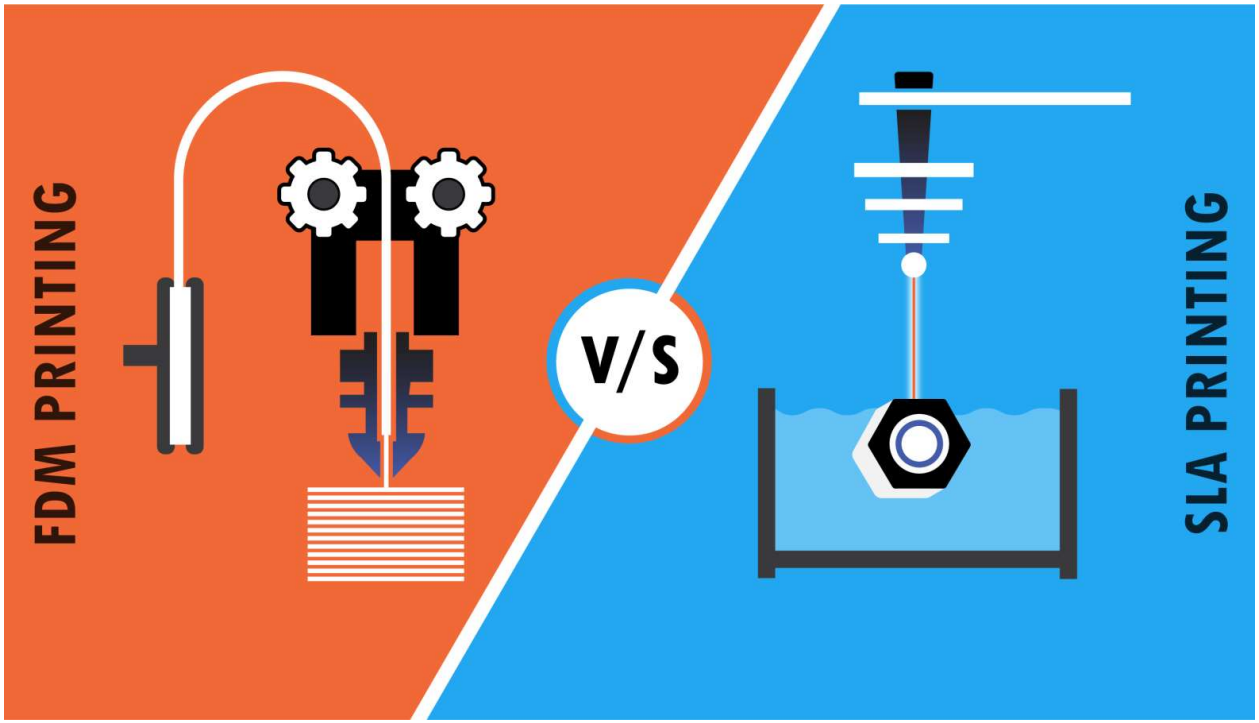
3D Printing for Medical Inventors: Design, Prototyping, and Production

Eric Kramer DNAP, CRNA, FNP-C

Objectives

- **Demystify the process of 3D printing**
- Discuss basic mechanism of how 3D prints are made, advantages and disadvantages
- Discuss 3D printers available to consumers
- Discuss software options for creating designs
- Review examples of 3d printing in medicine and anesthesia

What is 3D Printing?



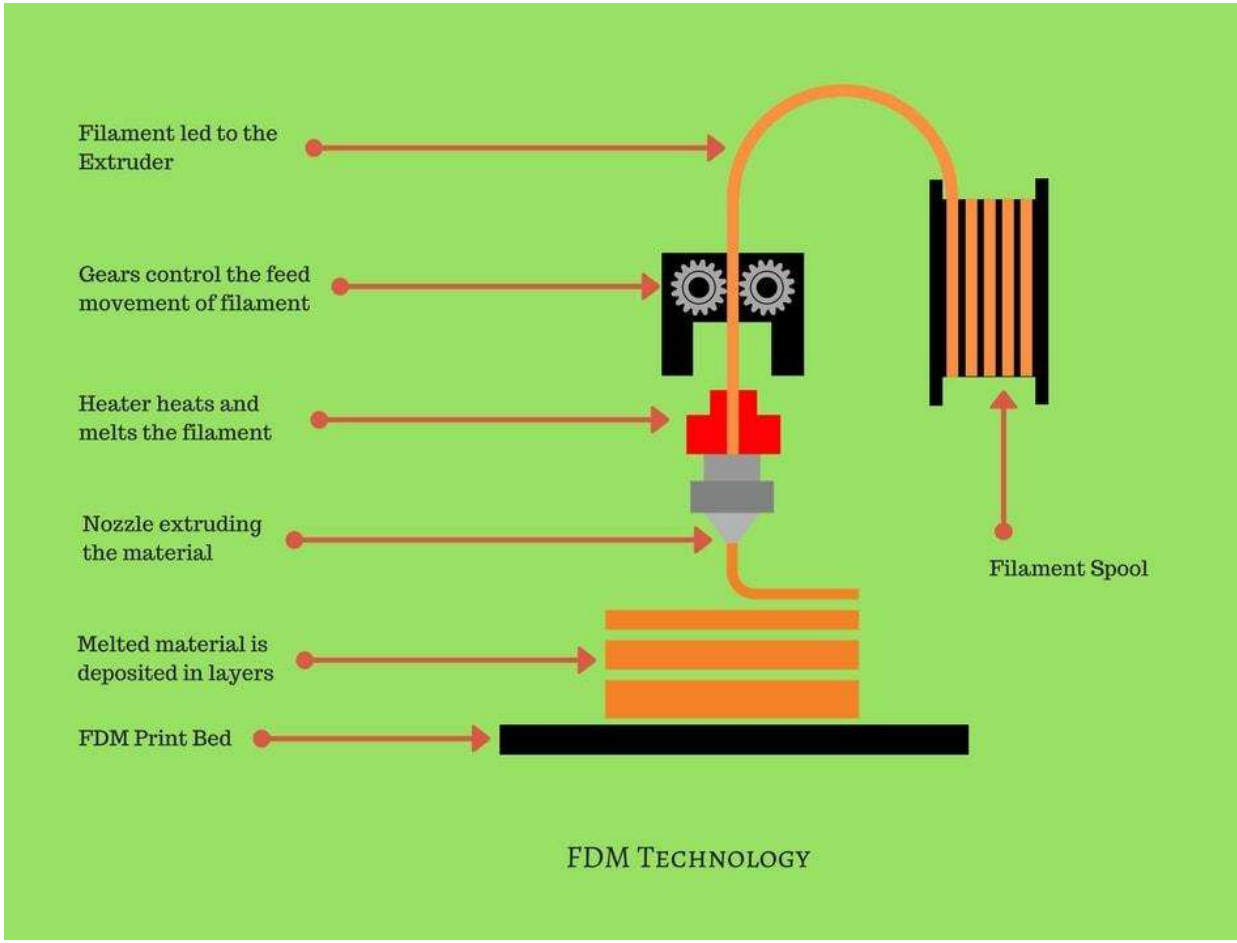
1.FDM (Fused Deposition Modeling)

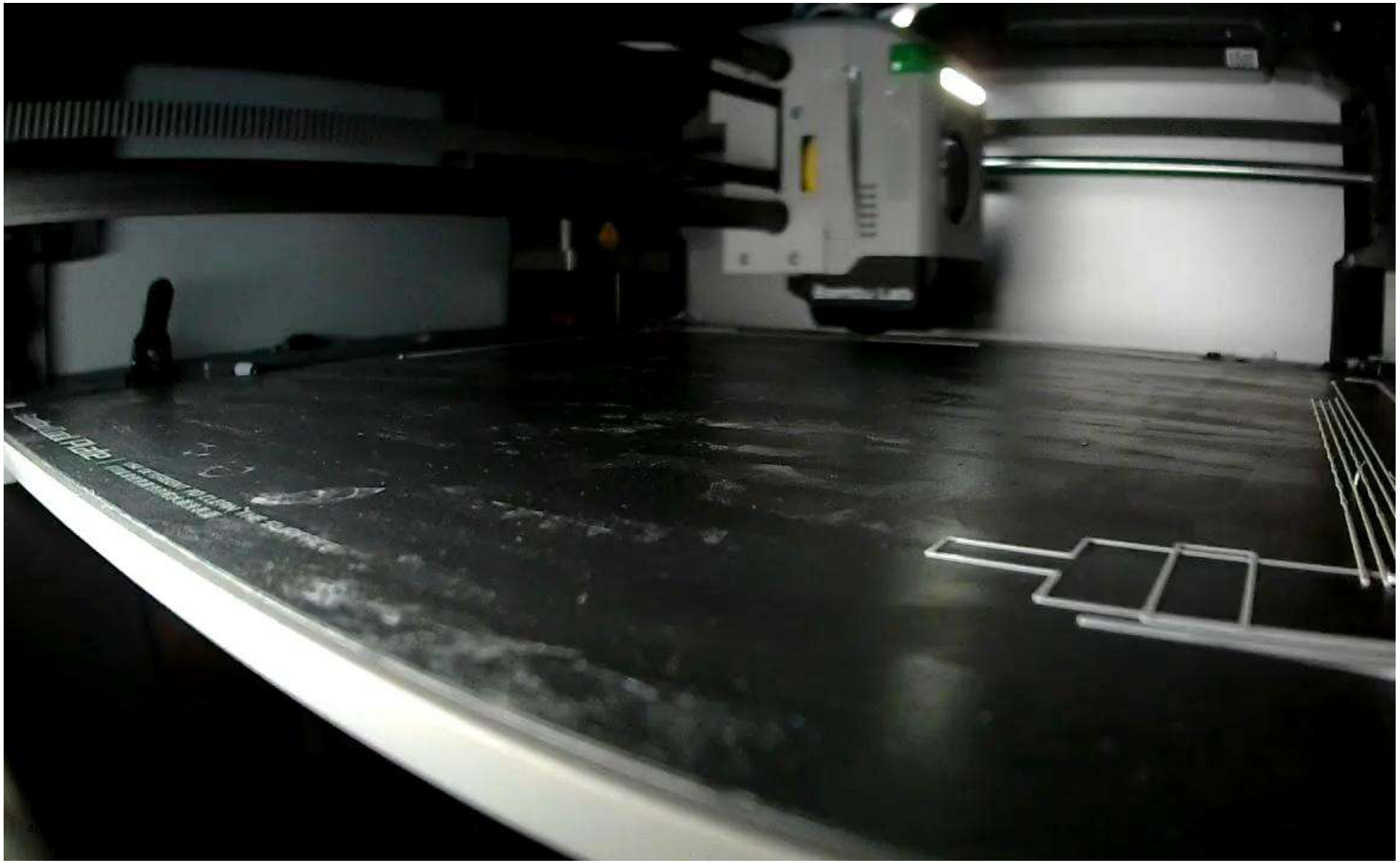
1. An additive manufacturing process that extrudes heated thermoplastic filaments to create an object layer by layer.
2. The most common and accessible form of 3D printing, particularly suitable for prototyping, functional testing, and some final product applications.

2.Resin Printing (SLA/DLP)

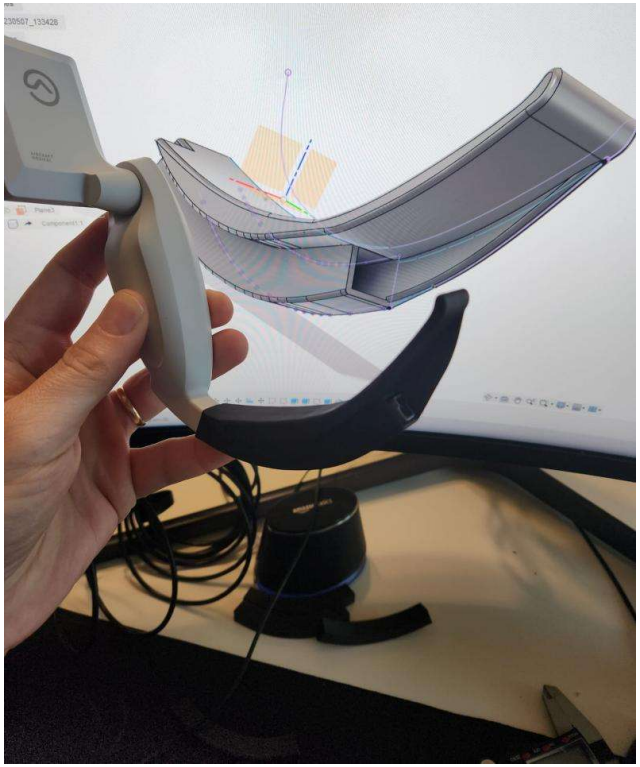
1. Uses a light source to cure liquid resin into hardened plastic in a layer-by-layer process to form objects.
2. Offers high resolution and detail, ideal for intricate designs, such as dental work, jewelry, and detailed prototypes.

Fusion Deposition Modeling (FDM)



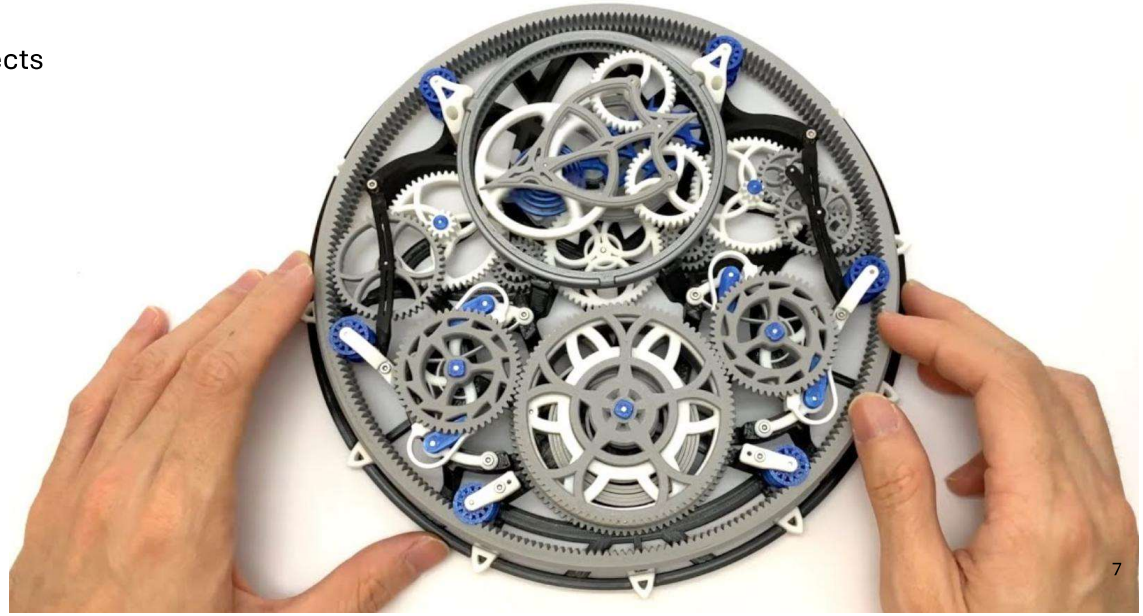


Rapid prototyping at your fingertips



Materials

- Filament is the strands of plastic that's melted by 3d printers into objects
  - 1.75 mm most common size
  - 1 kg rolls most common size
- PLA – bioplastic made of plant starch (corn, sugarcane)
  - The most commonly available
  - Deforms easily in heat
  - Strong/durable
  - Cheap - $14-22
- TPU – flexible, can be used to make malleable, bendable objects
- ABS/ASA
  - Lego plastic
  - Strong, durable, high heat resistance



Materials

- Nylon
  - Strong, heat resistant
  - Expensive ($60 +)
- Exotic/combination filaments
  - Polycarbonate
  - Filled filaments
    - carbon fiber, glass, wood, metal (copper etc)
  - Polypropylene

MatterHackers
NylonX Carbon Fiber Filament - 1.75mm (3kg)

★★★★½

$335.00 ($314.06 in bulk)

Add to Cart

+6 colors/patterns

OVV3D Wood 3D Printer Filament Bundle, Wood PLA Filament 1.75mm Bundle, Wood Filament More Than 30%...

★★★★½ 1,490

800+ bought in past month

$35.99

$34.19 with Subscribe & Save discount

Save 15% with coupon

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FREE delivery **Tomorrow**

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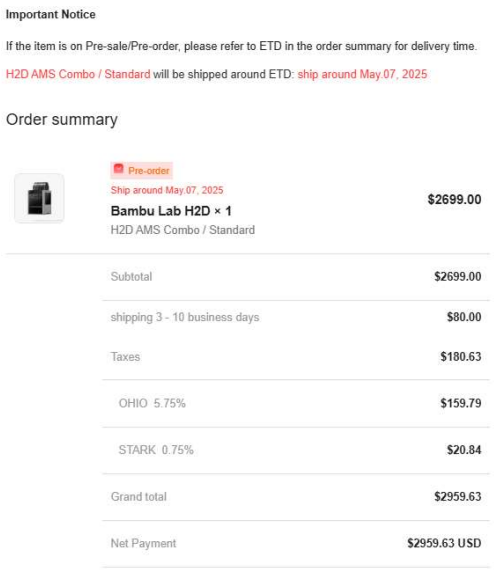
What about Printers?



1.Prusa i3 MK4

1. **Overview:** Latest model in the Prusa i3 series known for its reliability and high-quality prints.
2. **Key Features:** Improved extrusion system, auto-bed leveling, filament sensor.
3. **Build Volume:** 250 x 210 x 220
4. **Price:** Kit $799, assembled $1099

2.Bambu Lab P1P (X1C, H2D as alternatives)

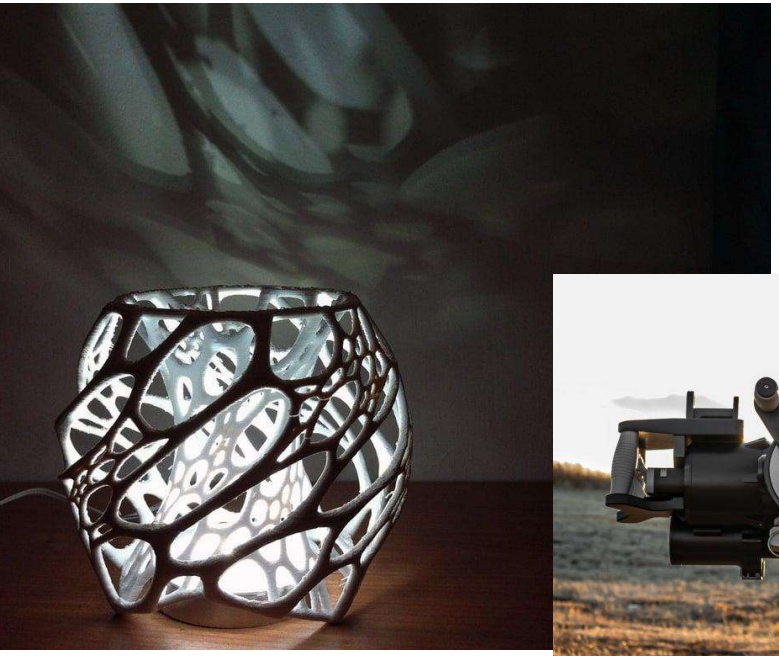
1. **Overview:** A “newcomer” promising high precision and speed with innovative features.
2. **Key Features:** AI-enhanced printing, multi-material support, built-in camera.
3. **Build Volume:** 256 x 256 x 256
4. **Price:** $600

3.Creality Ender 3

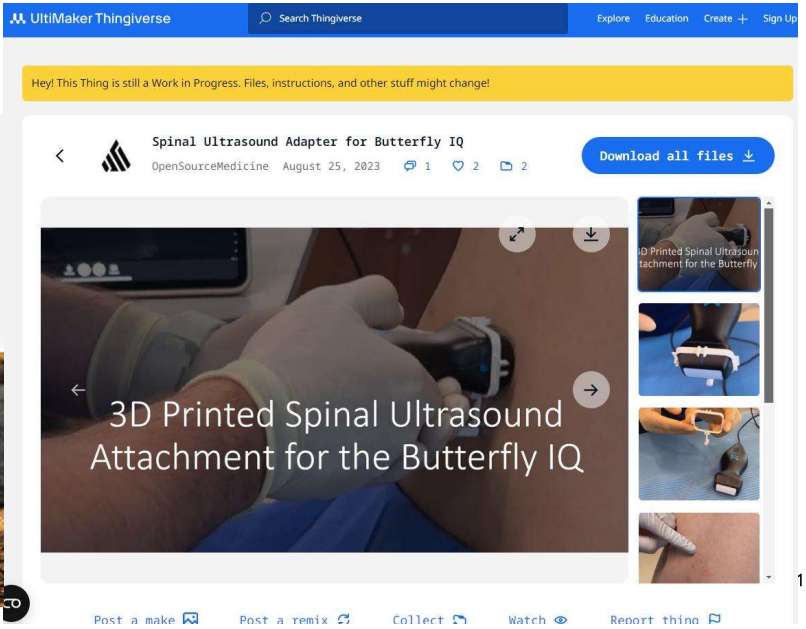
1. **Overview:** A popular choice for hobbyists, known for its affordability and modifiability.
2. **Key Features:** Large community support, heated bed, wide range of compatible materials.
3. **Build Volume:** 220 x 220 x 250mm
4. **Price Range:** Under $200

What about multiple color printing?

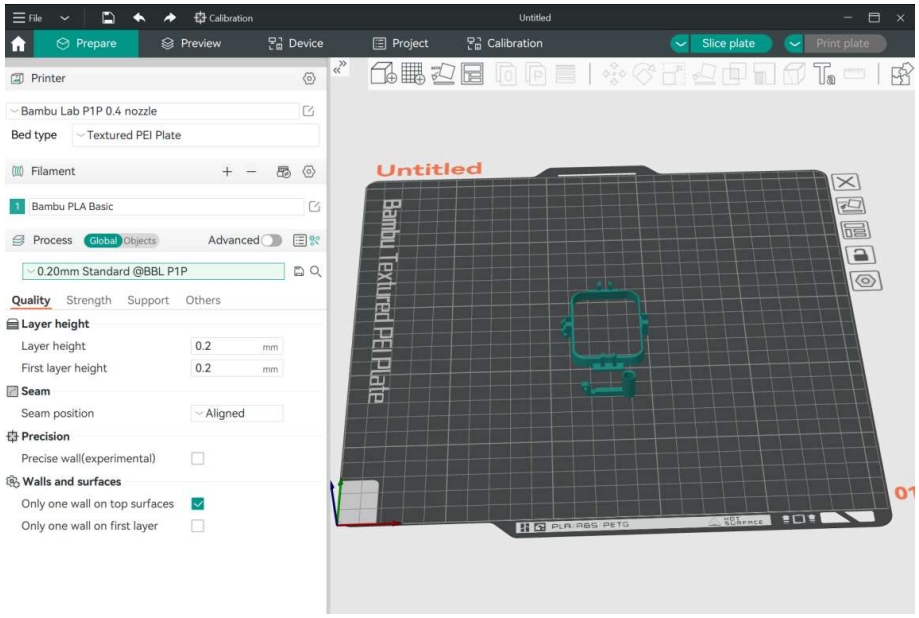
Finding Something to Print



- Downloaded from websites
  - Thingiverse.com
  - Cults3d.com
  - Printables.com
- 3D models can be designed using software
  - Fusion 360, TinkerCad
- 3D models come in various formats
  - STL, and 3MF



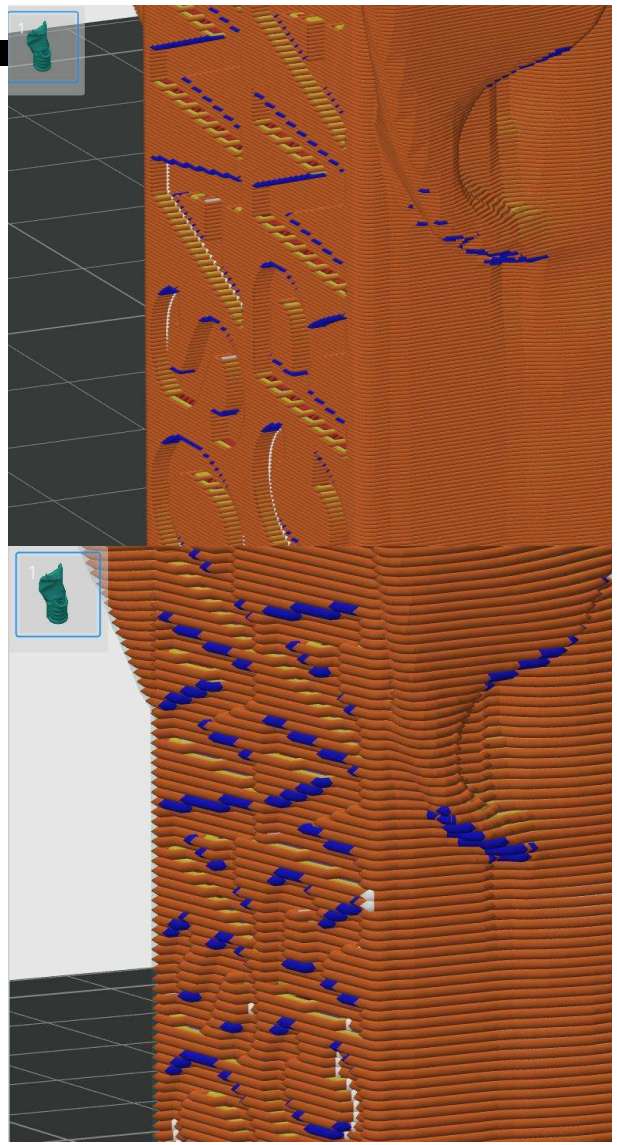
Slicing

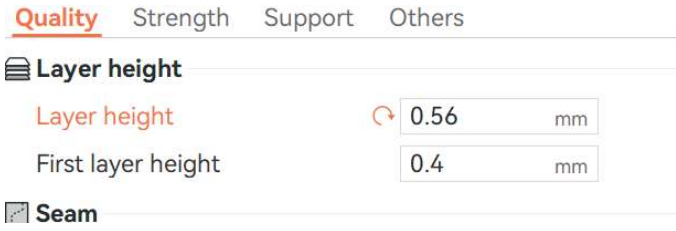


- "Slicers": Programs that tell the 3D printer how to print a 3D model
- Many slicers available
  - Cura
  - PrusaSlicer
  - BambuSlicer
  - OrcaSlicer
- Variables such as strength, model density, detail level can all be adjusted in the slicer
- After customizing the settings for your print, the program will "slice" the model
  - Develops step by step instructions for the printer:
    - What pattern to lay down plastic
    - How many layers of plastic to stack
    - How hot to heat the nozzle
    - What speed to move the print head
    - How to cool down the melted plastic as it prints

Slicer basics: Layer Height

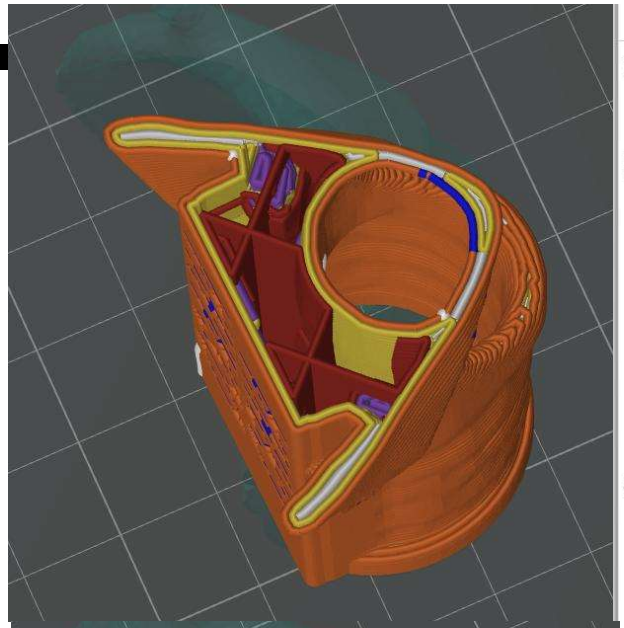
Strength vs detail

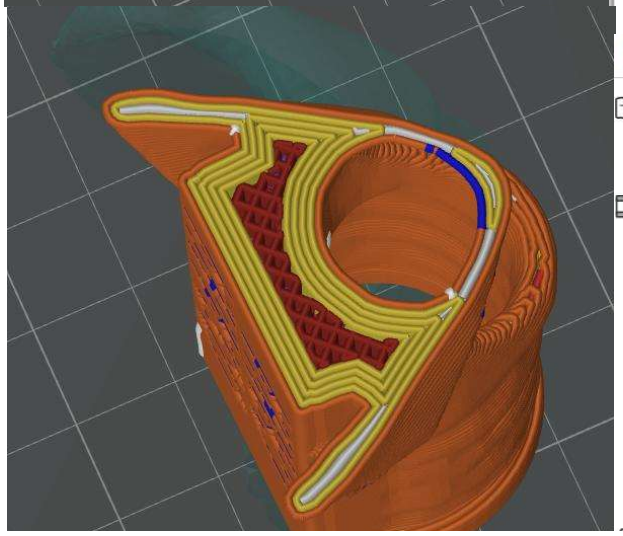


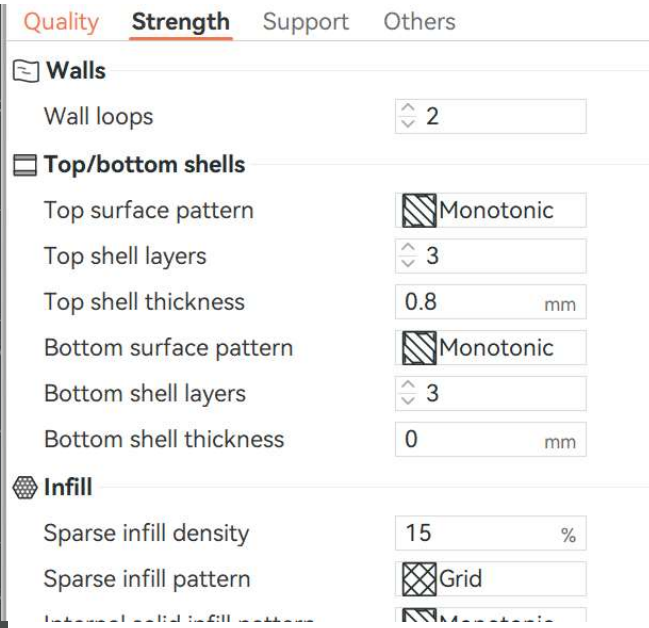


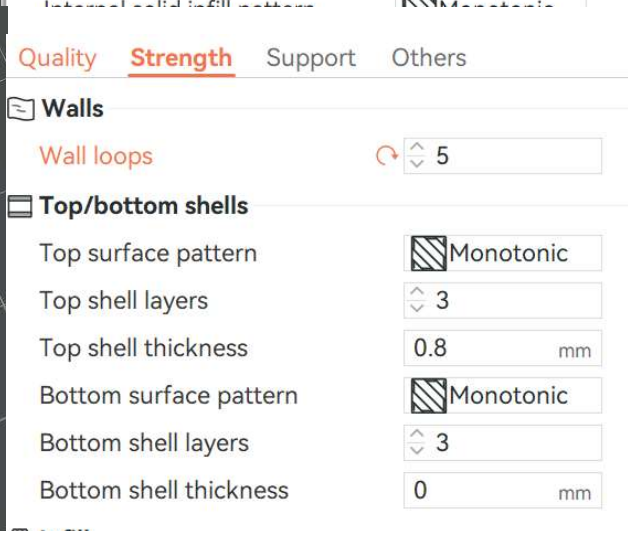
Slicer Basics: Strength

- Walls: how many perimeters of plastic make the edge of the model
- Infill: how solid the model is
- Decisions about these settings depend on purpose of the model

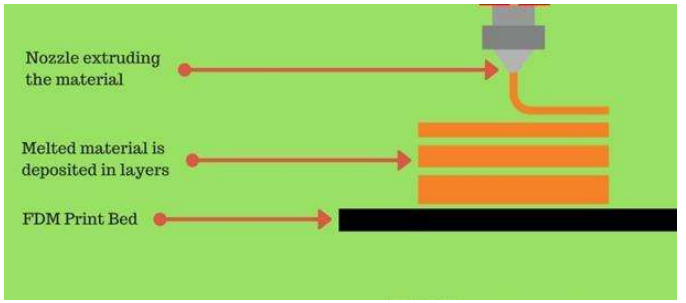


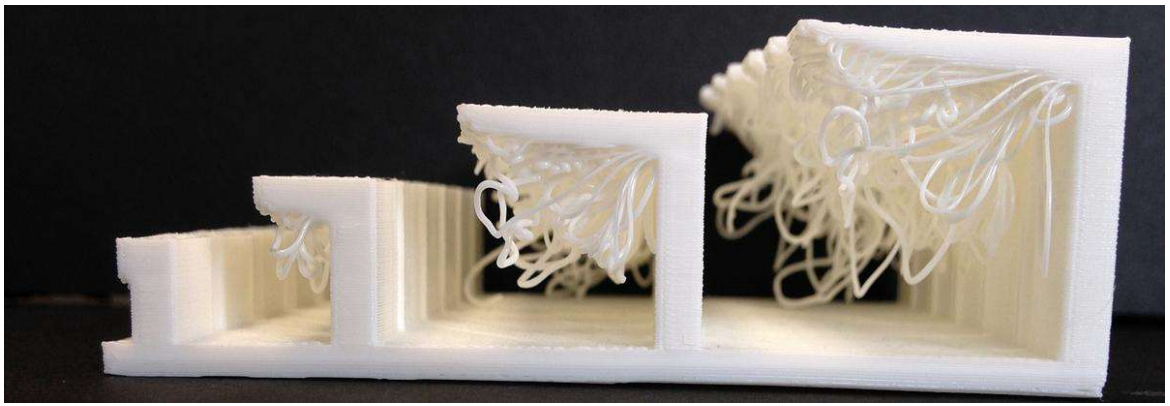


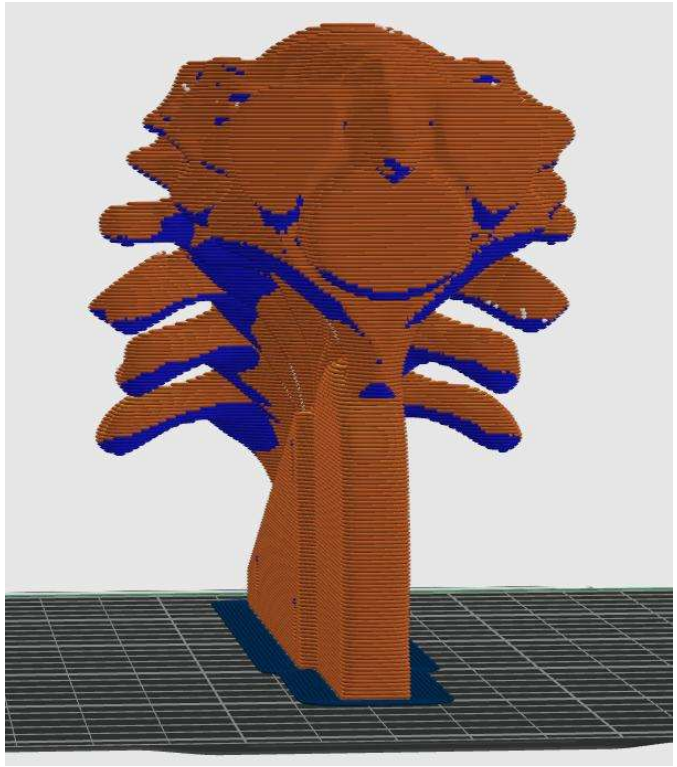




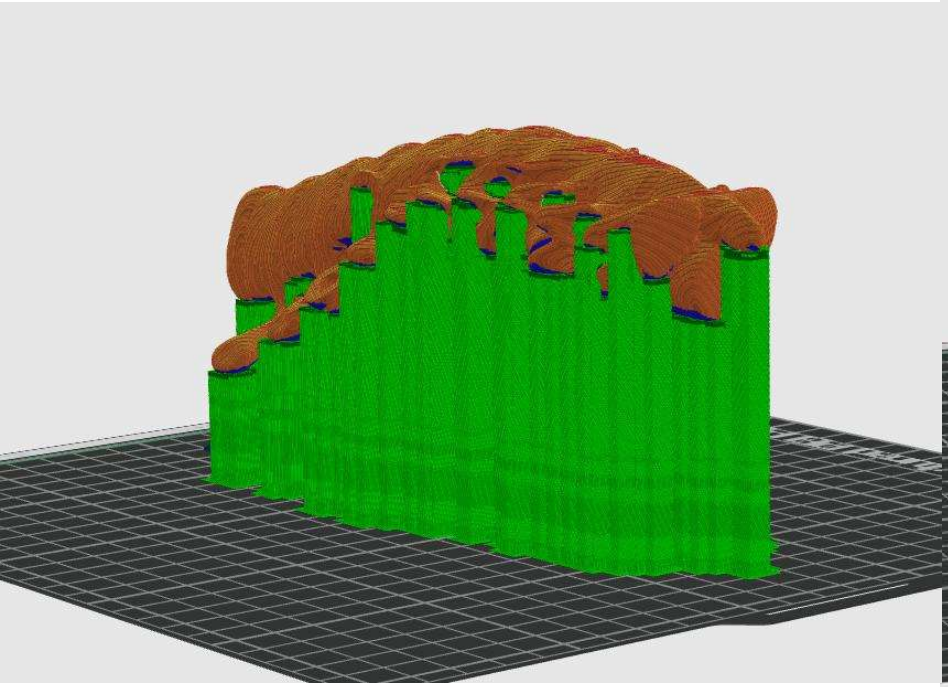
Slicer Basics: Orientation and Overhangs

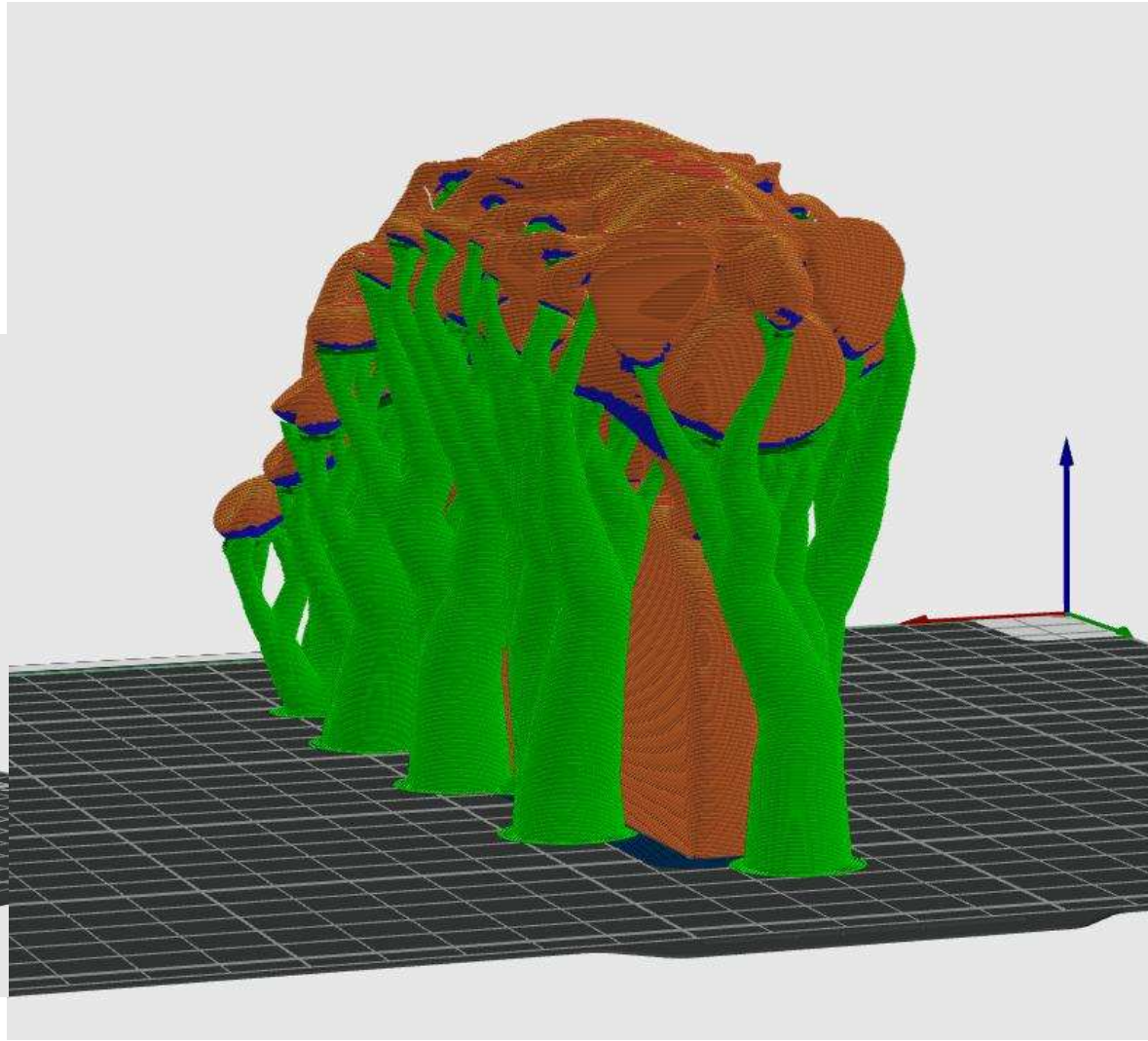




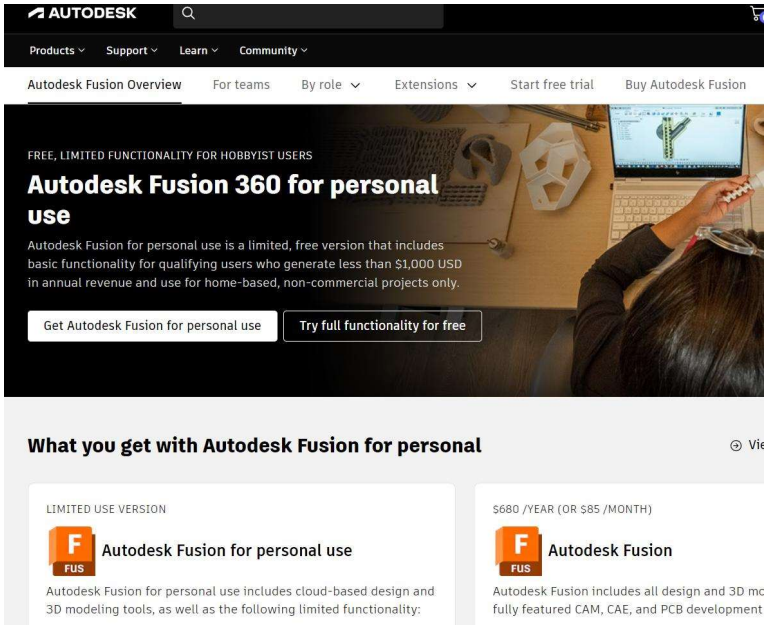


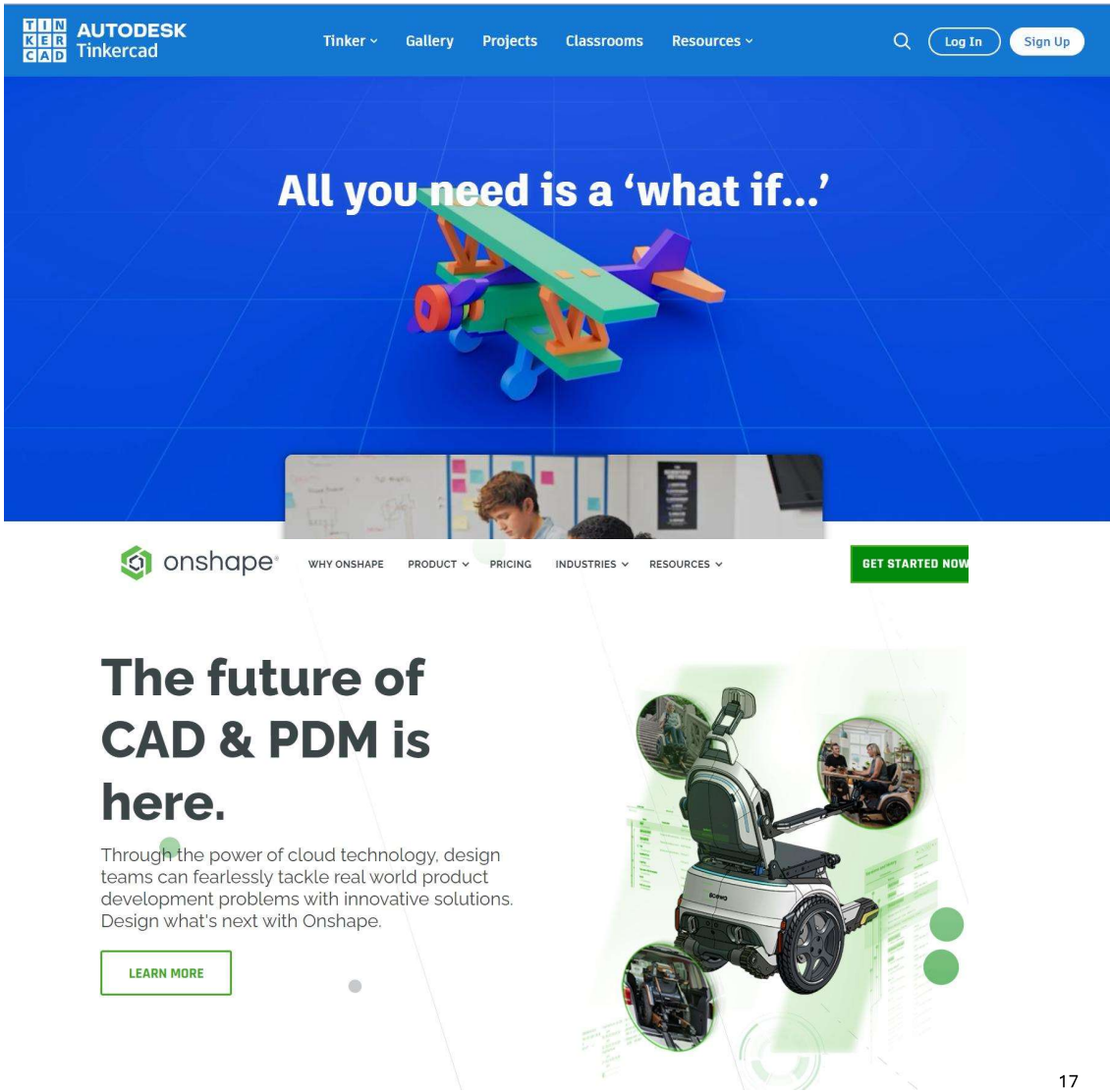
Slicer Basics: Supports



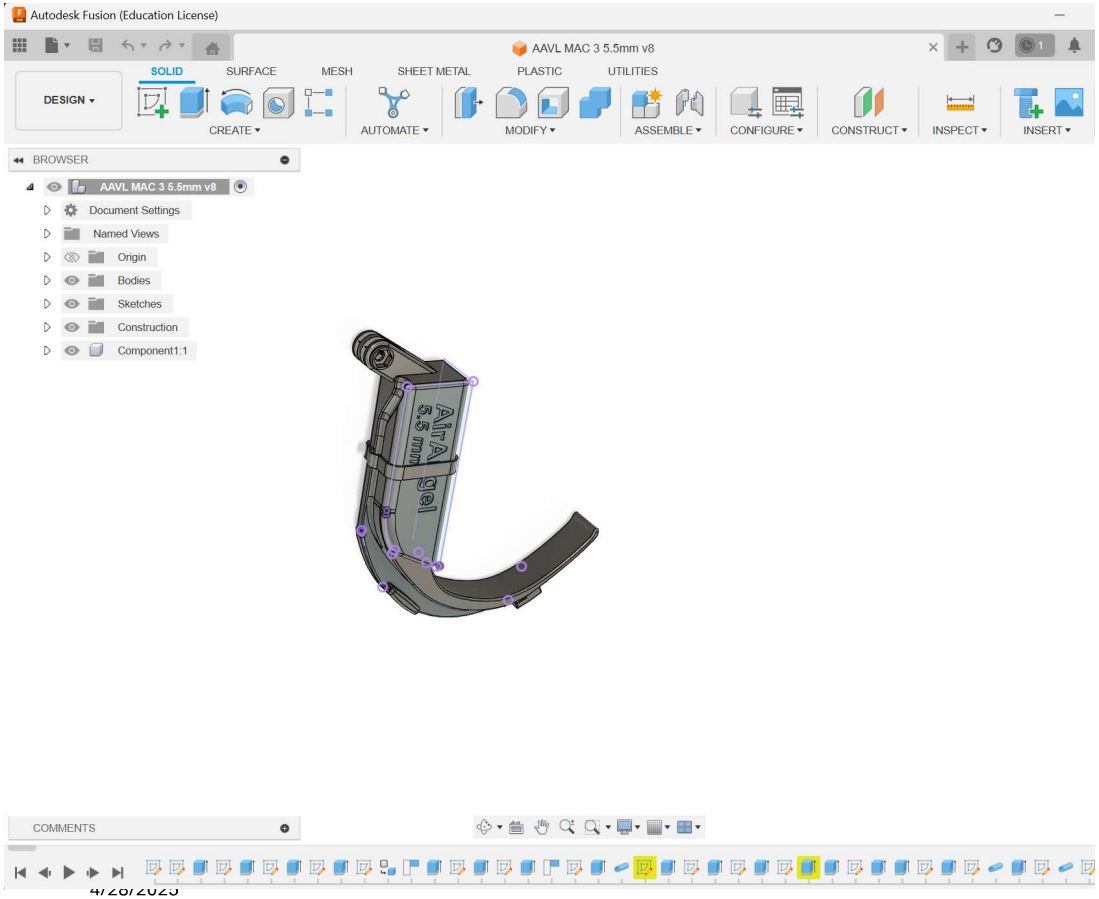


What about designing my own models??

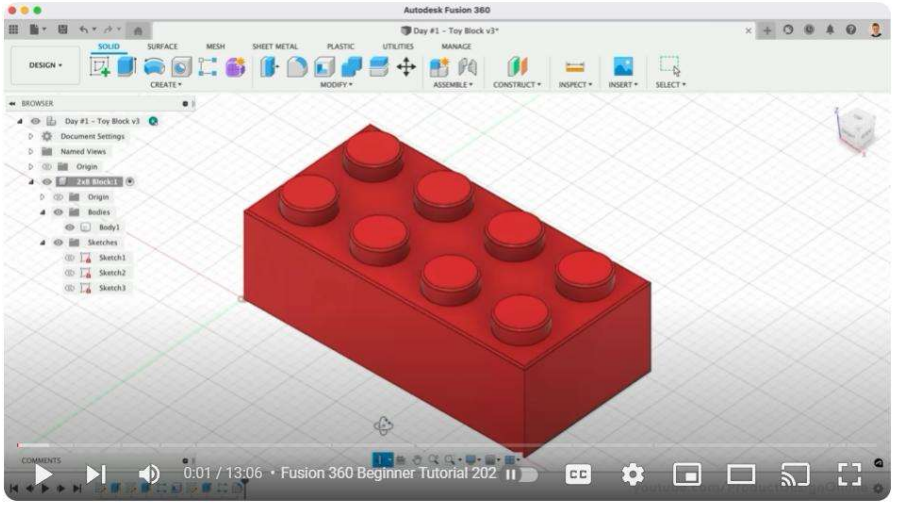




My Favorite? Fusion!



- Free for personal use
- Powerful design capabilities
- Tons of YouTube tutorials
- It's like learning a language – it takes time and effort



Day 1 of Learn Fusion 360 in 30 Days for Complete Beginners! - 2023 EDITION

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Stop! Example Time!

(Fusion 360 model design and slice)

- $30-50 to make
- Wireless, wired, dedicated monitor
- For low resource/developing countries

LETTER TO THE EDITOR

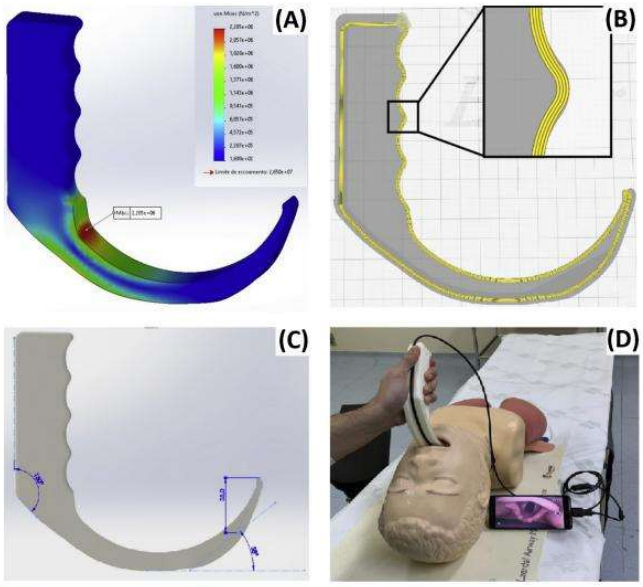

Figure 1 (A) Statistical analysis of tension; (B) Cross-section of printing layers; (C) Main angles and distances; (D) Video laryngoscope test on training dummy airway.

ELSEVIER
Trends in Anaesthesia and Critical Care
Volume 40, October 2021, Pages 35-40

Comparison of a commercial 3D fabricated laryngoscope (Airangel ®) with a widely-used video laryngoscope (Glidescope®): Randomized controlled cross-over study

The manuscript has been presented 16th Turkish Emergency Medicine Congress (oral presentation) at the 20–22 November 2020, TATKONONLINE, Turkey

Ali Kaan Ataman [a], Emel Altıntaş [b]

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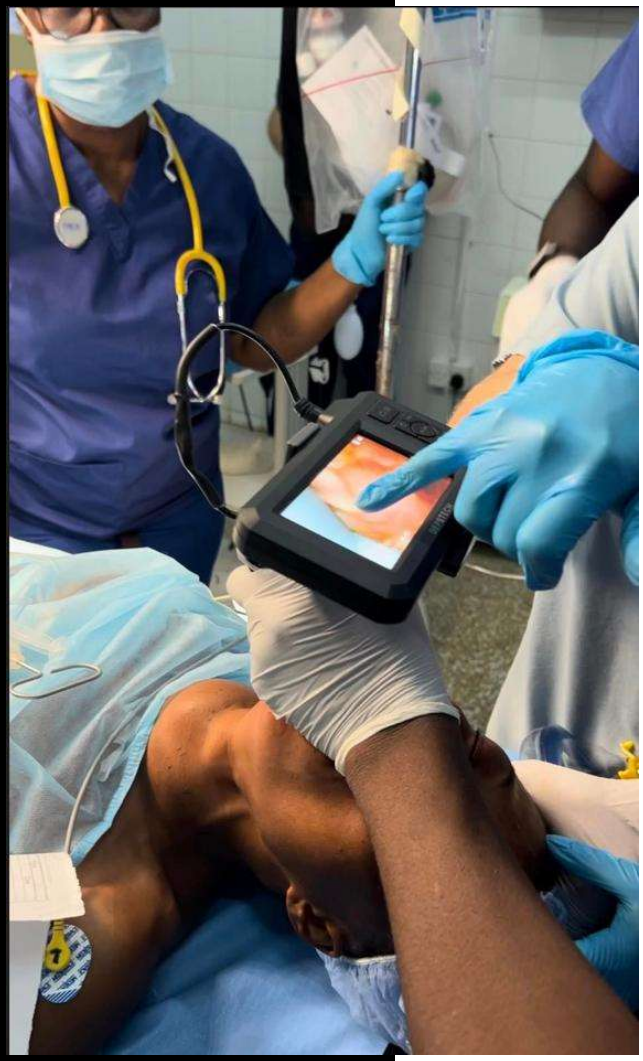


AirAngel Project Presents

The AirAngel V3 User Manual

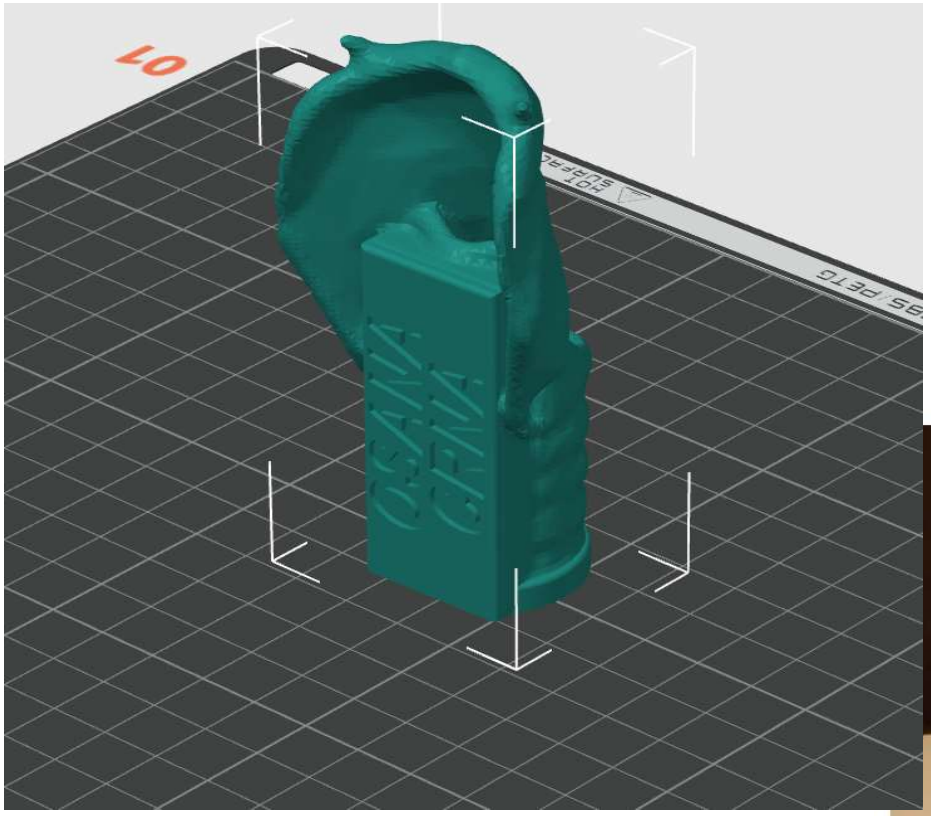
Eric Kramer DNAP, CRNA, FNP-C

- Research studies to be done:
  - What method is best to sterilize blades?
    - Ideally, hospital would have printer and they'd be one time use
    - Measure bacteria content after sterilization procedure
  - Do blades absorb fluid after soaking?
    - Blades weighed after soaking
    - Ideally, would test strength as well

- Laryngoscope blades can be disinfected with:
  1. 90% isopropyl alcohol
  2. 96% ethanol
  3. Cidex,
  4. Clorhexidine scrub
  5. 5000 ppm bleach solution (high level disinfection):
     1 cup (250ml) 5% household bleach mixed with 9 cups (2250 ml) of water
     A. Wear gloves while handling solution
     B. Leave solution on blade for minimum of one minute. 10 minutes of contact with disinfectant for high level disinfection is recommended. Submerging with a timer is acceptable
     C. Thoroughly rinse with water after disinfecting, let dry
     D. Once mixed, bleach solution is good for 24 hours. Mix new solution each day

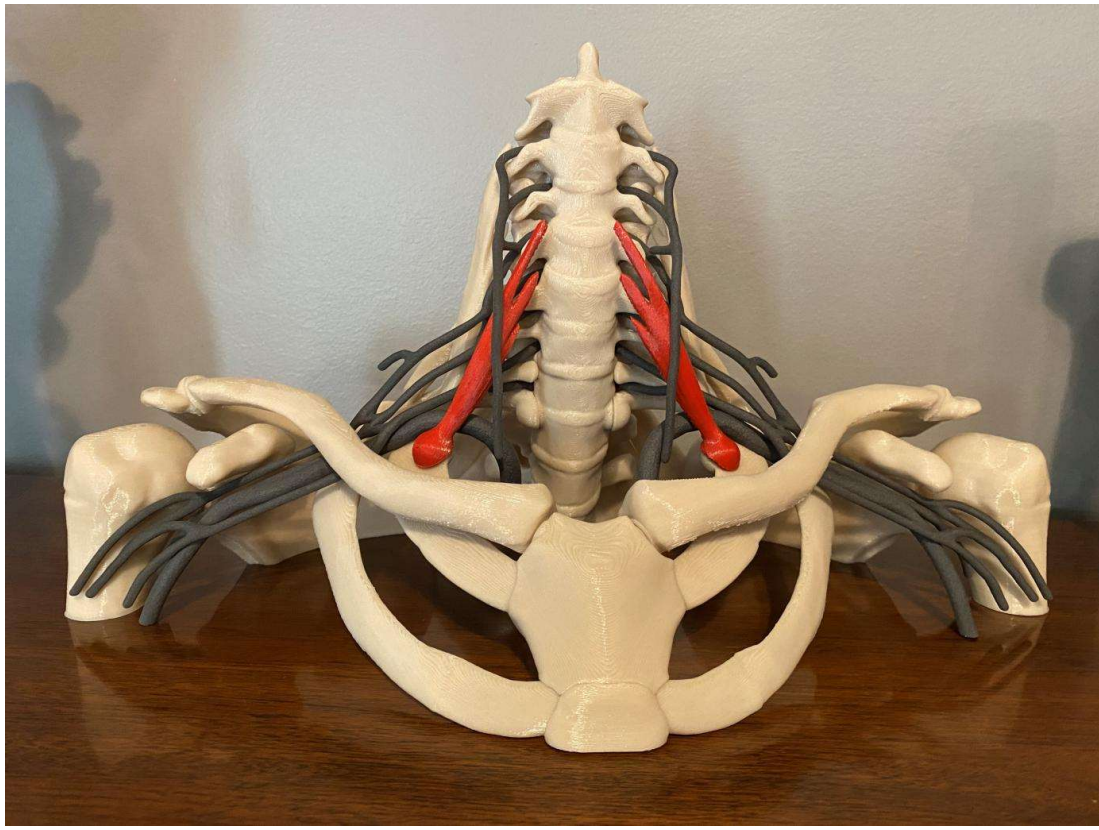
Cricothyrotomy

- Motor memory is key
- Fine motor degrades with high stress
- Any procedure that's not practiced will be difficult to perform under pressure
- Is it worth it if it will save one life in your career?

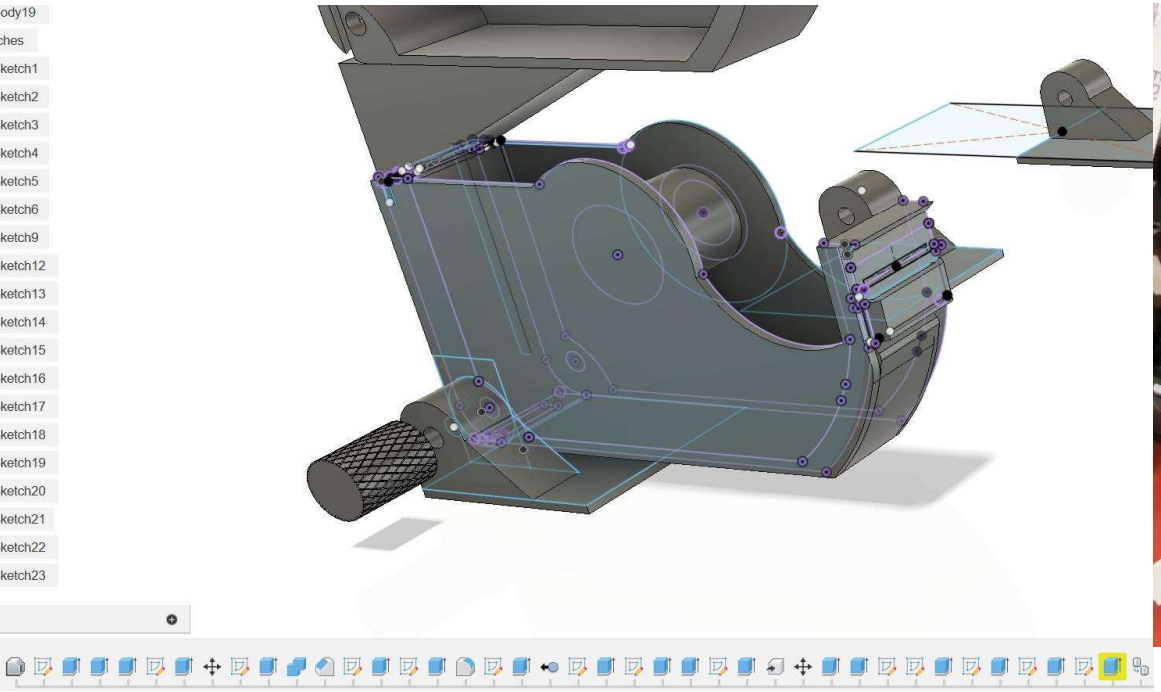


How to practice bougie-blade cricothyrotomy with a 3D printed cric

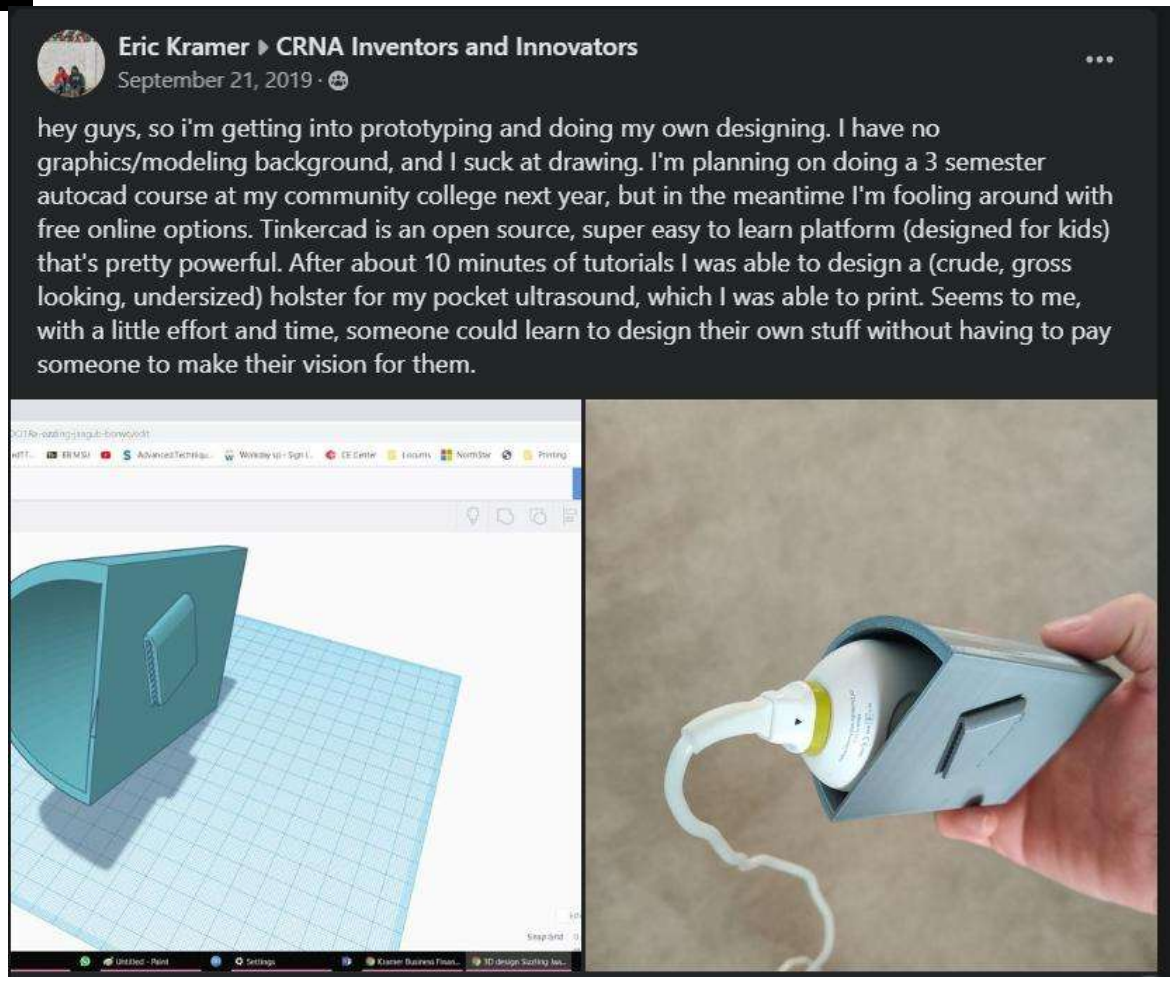
Brachial Plexus Model



Label Dispensers



Don’t give up.


Eric Kramer ▸ CRNA Inventors and Innovators
September 21, 2019 ·
hey guys, so i'm getting into prototyping and doing my own designing. I have no graphics/modeling background, and I suck at drawing. I'm planning on doing a 3 semester autocad course at my community college next year, but in the meantime I'm fooling around with free online options. Tinkercad is an open source, super easy to learn platform (designed for kids) that's pretty powerful. After about 10 minutes of tutorials I was able to design a (crude, gross looking, undersized) holster for my pocket ultrasound, which I was able to print. Seems to me, with a little effort and time, someone could learn to design their own stuff without having to pay someone to make their vision for them.