

California Hand Therapy Association
April 30-May 1, 2022

**HOSPITAL
FOR
SPECIAL
SURGERY**

WHERE THE
WORLD COMES
TO GET BACK
IN THE GAME

 **UNM**
HEALTH SCIENCES
CENTER

3D Printing: Innovative Use of Technology for the Hand Therapist

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The Future of Technology is Here!

First episode of the Jetsons aired September 23, 1962 (based on Futurism)

Facetime



Telehealth

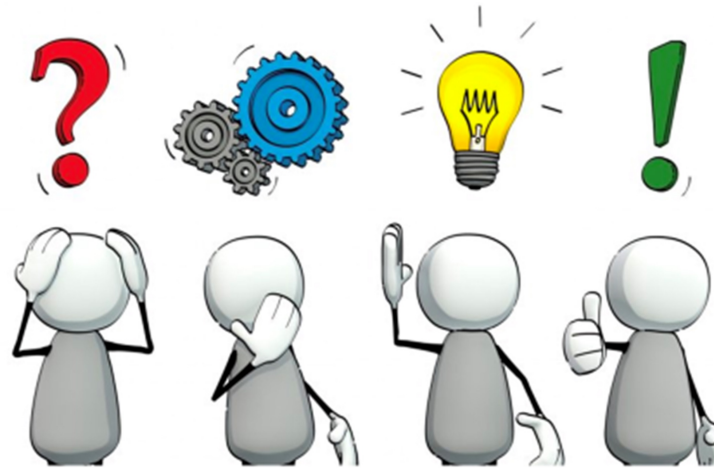


Internet



Pre-historic Apple watch

What is 3D Printing?



- It is an additive manufacturing process, where a layer of material is fused to another layer creating a 3D object, versus a subtractive process where material is removed to get to the desired shape.
- The object is printed using a computer-generated design.
- Objects can be printed using various materials, which are chosen depending on their characteristics ie. Durability, strength, flexibility

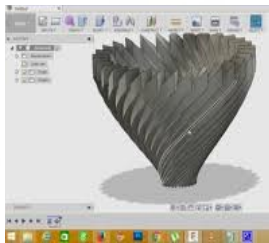
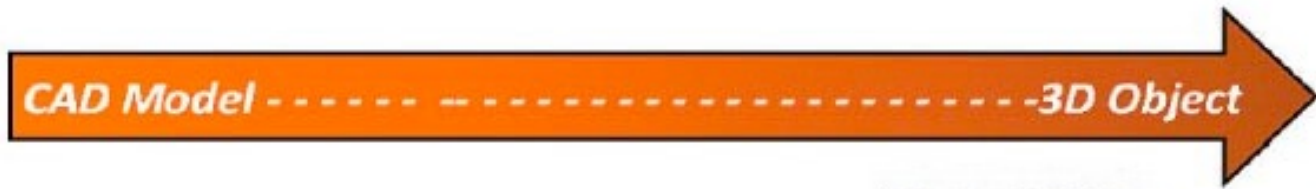
When to Use 3D Printing?



shutterstock.com · 650764684

When you have a problem that requires a solution.

3D Printing is a Step-By-Step Process: The Basics



3D Cad Model



.STL File
(Design file)



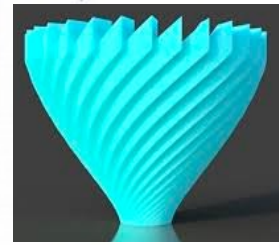
Slicing Software



G-Code
(printer language)



Printing



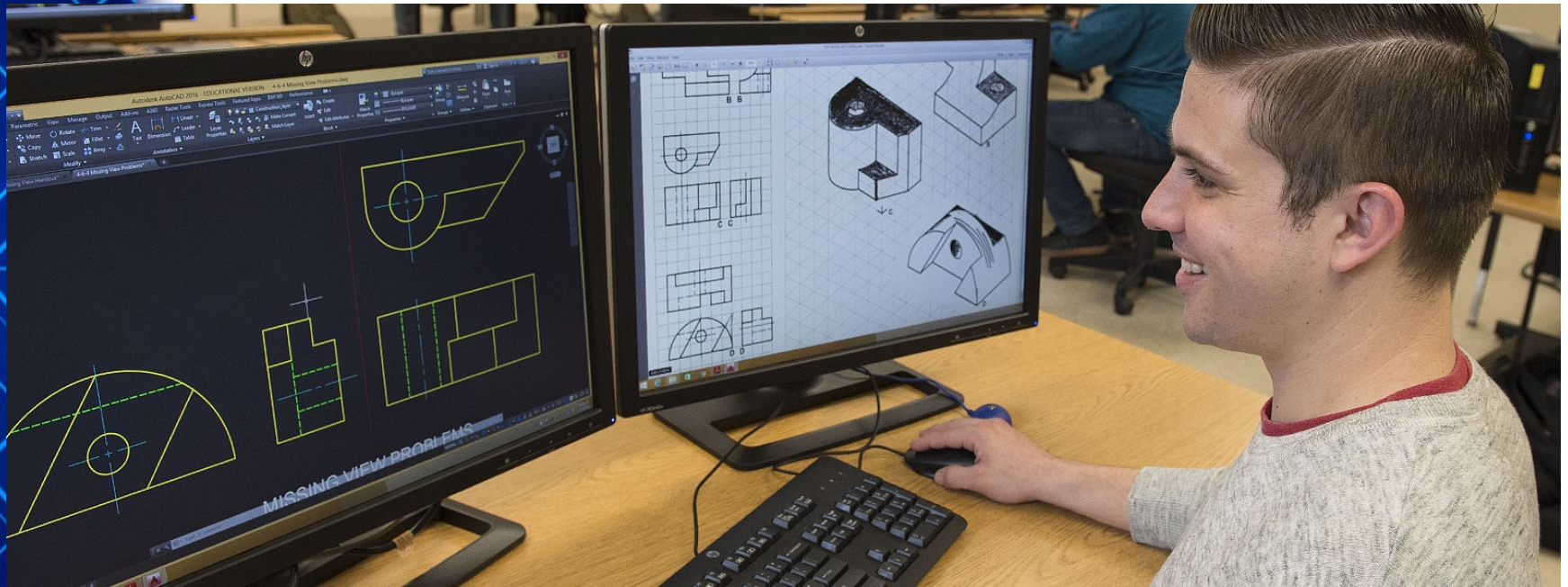
3D Object

Generalized Additive Manufacturing Process.

Three Methods of Design

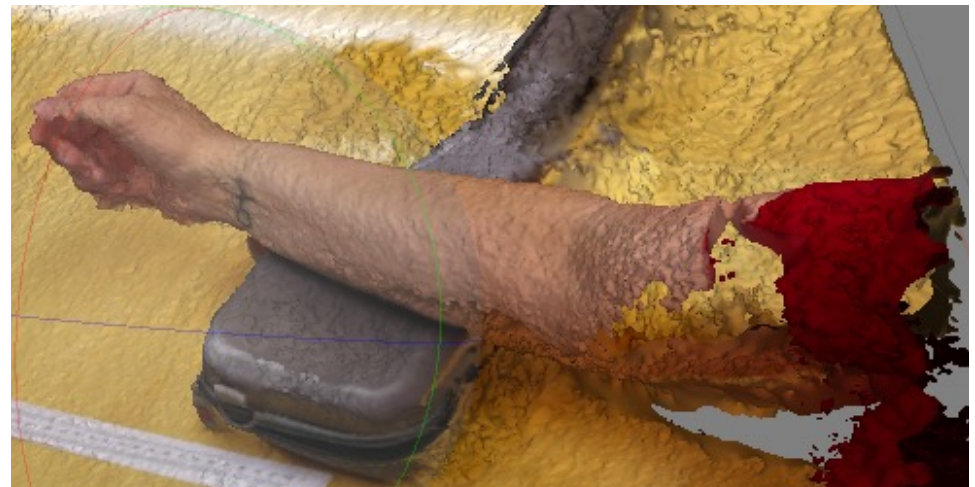
- Computer Assisted Design (CAD)
- Scanning
- Open source

Computer Assistive Design (CAD)



Basically Engineering

Scanners: You Can Print What You Scan



“Open source” (free sharing) Repositories for pre-made models



Thangs.com

Cost: free

Thingiverse <http://thingiverse.com>

Cost: free



By GirgisDesigns
Iphone 6 case



By mgeorge3
G stand for Iphone 4, 4S, 5



By Moby_inc
Moby iphone dock

PLA / ABS Filament



What is the cost of 3D Printing?

- Short answer: Very cheap
- 1kg of Thermoplastic filament is approximately \$20
- \$0.02 a gram
- Smart phone case weighs 20-25 grams
- Can print a phone case for less than \$0.50
- A lot less than if you bought it

7 Categories of additive manufacturing

Categories	Examples
<ul style="list-style-type: none">• Material extrusion	<ul style="list-style-type: none">• Fused deposition modeling (FDM or FFF)
<ul style="list-style-type: none">• Powder bed fusion	<ul style="list-style-type: none">• Selective Laser Sintering (SLS), mainly use polymers/resins
<ul style="list-style-type: none">• Vat photopolymerization	<ul style="list-style-type: none">• Stereolithography (SLA)
<ul style="list-style-type: none">• Binder jetting	<ul style="list-style-type: none">• Binder Jetting (BJ)
<ul style="list-style-type: none">• Direct energy deposition	<ul style="list-style-type: none">• Mixture of material extrusion & powder bed fusion
<ul style="list-style-type: none">• Material jetting	<ul style="list-style-type: none">• Liquid photopolymer, similar to inkjet
<ul style="list-style-type: none">• Sheet lamination	<ul style="list-style-type: none">• Using sheets of material to build a part

Advantages and Disadvantages of 3D Printing

Advantages

- Fast (depending on 3D technology and material)
- Ability to reuse, edit and share 3D models with others.
- The computer aided design (CAD) files (such as STL files) are easy to customize and modify by trained users.
- Many parts can be produced at the same time allowing for production of an entire assembly or family of parts in one job.
- The machine can run unattended thus lowering labor costs.
- Multi-material printing is possible.
- Plethora of free instructional websites and online videos related to 3D printing.
- Free online 3D model repositories.

Disadvantages

- Slow (depending on 3D technology and material)
- The learning curve to CAD files is high.
- Not cost effective for high volume manufacturing.
- Currently limited to smaller parts.
- Thin sections are susceptible to collapse.
- Thick sections take longer to manufacture.
- Some types of 3D printers create 3D physical models that are susceptible to distortion and require material supports during the build.
- Some materials need post processing, cleaning, sanding or Ultraviolet ovens to solidify photo- reactive resins.

Barriers to 3D printing for the hand therapist

- From a rehab engineering standpoint, “3D printing within hand therapy is still very much in its infancy” Ben Salatin in Patterson, et.al, 2020
- There are no purpose-built software programs for UE orthotic design. Which means a digital design needs to be created from scratch.
- Digital design software programs (CAD) require huge learning curves because they are very technical and take a lot of time to learn. Many therapists may not be willing to invest the time or don't have the time due to heavy work loads in busy clinics.
- The foundation of capturing the patient's UE anatomy into a computer model is thru Scanning. Due to the complexity of the hand, sometimes it is difficult to get a high-resolution scan. Which then requires using more software to “clean-up the scan.”

Academia

- At the Department of Occupational Therapy, School of Health and Human Sciences, Indiana University, students are taught digital design and fabrication technologies.

• They are taught:

- Acquisition

- a) to acquire a 3D model they learn how to create designs in CAD programs
- b) How to use repositories to find completed designs/models, which are usually free aka “open source”.

- Preparation

Using a “slicing” software program to prepare and format the model into a “file” that provides instruction to the printer telling it what to print layer by layer, as well as other important details like temperature, the thickness of the walls etc.

- 3D Printing

Transferring the file to a printer via USB, WIFI, flash drive or SD card.

After printing the object, post-processing may be necessary to clean up any supports, smooth the surface

*Empowering new therapists with cutting edge technology will close some gaps and barriers.

Current 3D Printing Trends for Applications in Hand Therapy

- Educational and Treatment tools
- ADL / Adaptive and Assistive devices
- Orthotics
- Prosthetics

Educational Tools

Yeggi.com (not free, but affordable - 3D printable models)

The screenshot shows a product listing on the CGTrader website. The header includes the CGTrader logo, navigation menus for '3D Models', 'Freelance 3D Projects', 'Sell 3D Models', and '3D Content Production', a search bar with '1 360 00' results, and a 'LOG IN' button. The breadcrumb trail reads '3D Print Models / Science / Biology / Hand anatomy model 3D print model'. The main image is a detailed 3D anatomical model of a human hand, showing bones and muscles. Below the main image are six smaller thumbnail images showing different views of the hand model. To the right of the image, the price is listed as '\$23.00' with a crossed-out 'Offer price' and a 'Save with CGTrader Credits' link. Below the price, it says 'Royalty Free License' with an information icon. A red 'Add to cart' button is present. The seller's profile is for 'Pirkka', who has a 5-star rating from 3 reviews and a 'Response - % in - h' indicator. Below the profile, there are tags for '3D Modeling' and '3D Print Modeling', and a green 'Hire me' button. At the bottom of the listing, there are buttons for '+ Add to wish list', '1.55k' views, '9' likes, a share icon, and a more options icon. A '3D Model formats' section with a 'Format limitations' link is also visible.

cgtrader 3D Models ▾ Freelance 3D Projects ▾ Sell 3D Models 3D Content Production Search 1 360 00 LOG IN

3D Print Models / Science / Biology / Hand anatomy model 3D print model

1 / 6

\$23.00 ~~Offer price~~
Save with [CGTrader Credits](#)

Royalty Free License

Add to cart

Pirkka
★★★★★ (3 reviews)

Response - % in - h

3D Modeling 3D Print Modeling

Hand anatomy model 3D print model

1.55k 9

3D Model formats
Format limitations

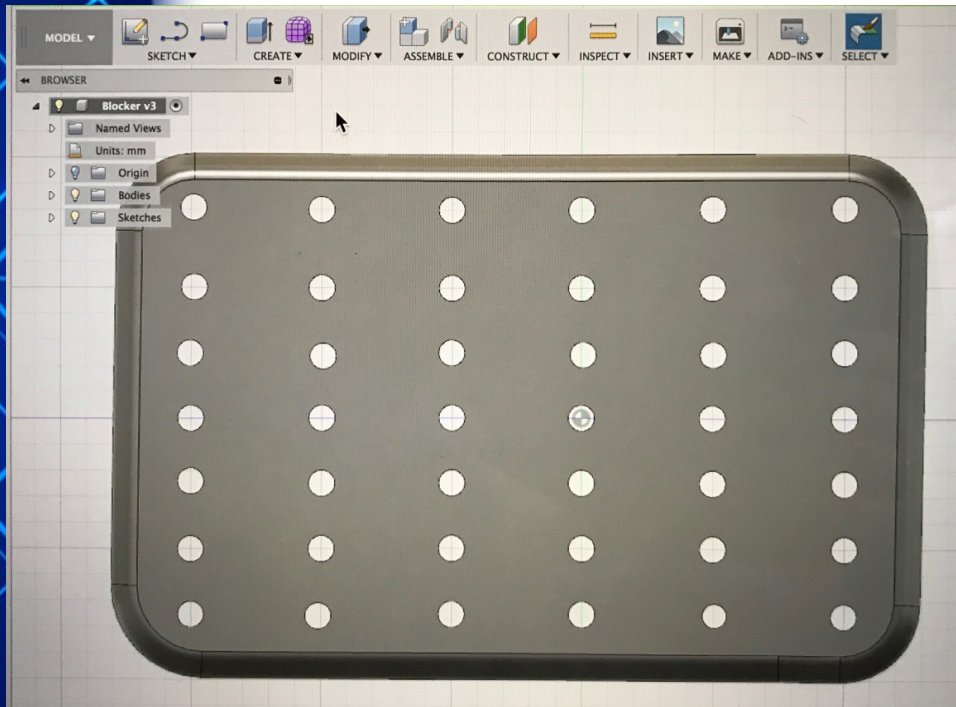
Treatment Tools: Blocker





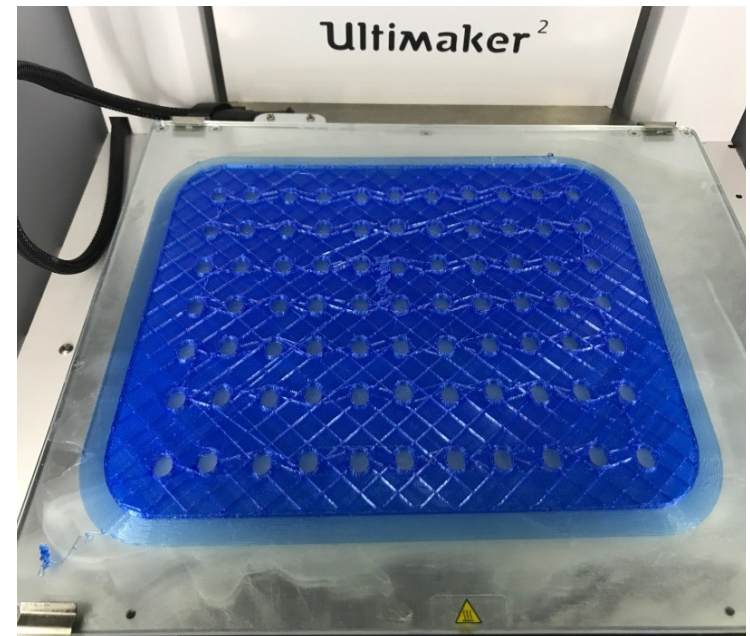
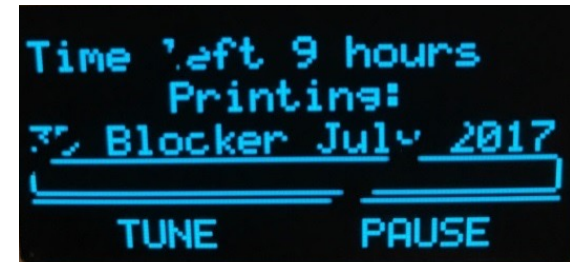
CAD model of a new blocker using Fusion360

CAD model



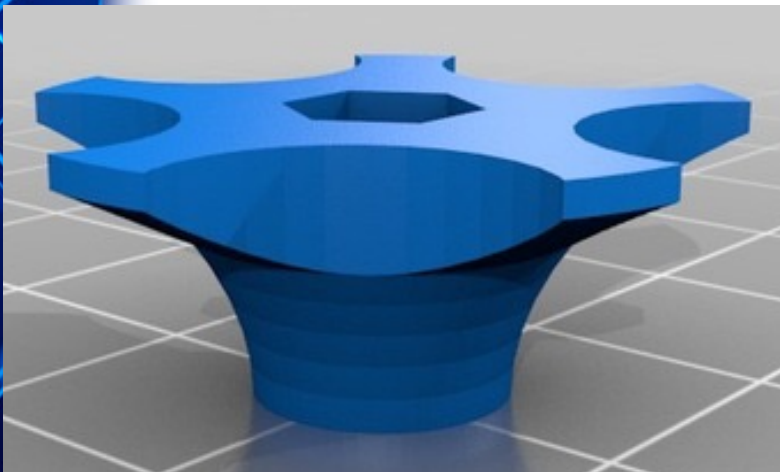
10 hour print

Print in progress



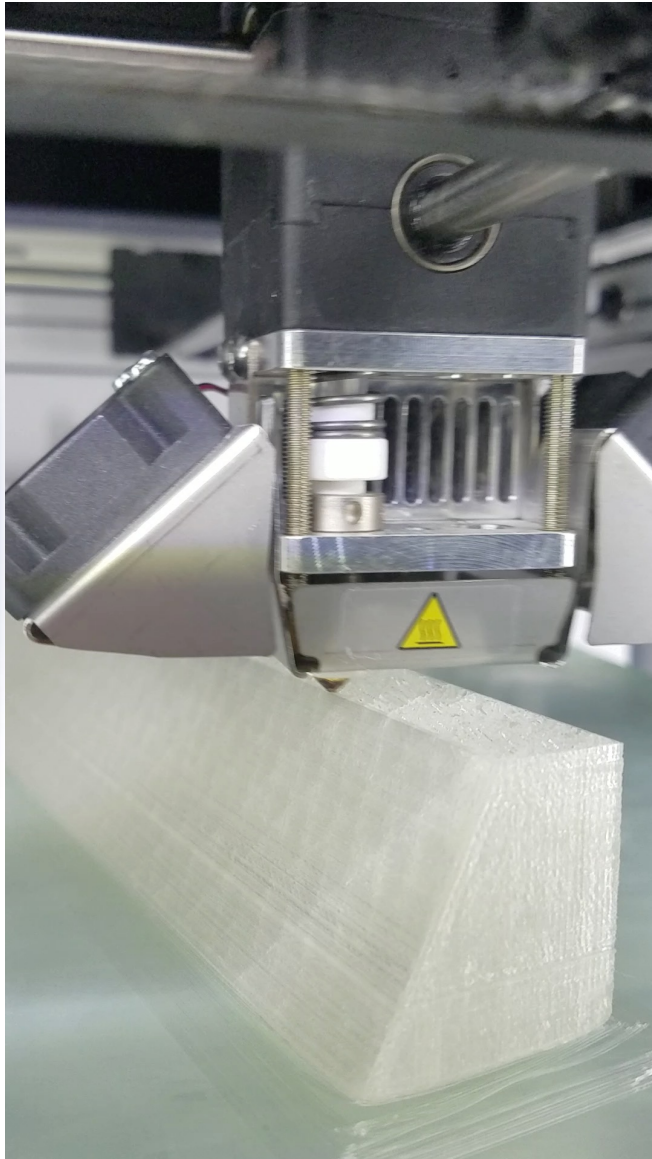
Adaptive Devices: Enlarged Handles and Knobs

by wstein



45-60 min print
\$0.50 in material cost

Wheelchair Door Ramp



Design by [shazmataz](https://www.thingiverse.com/shazmataz):Thingiverse.com

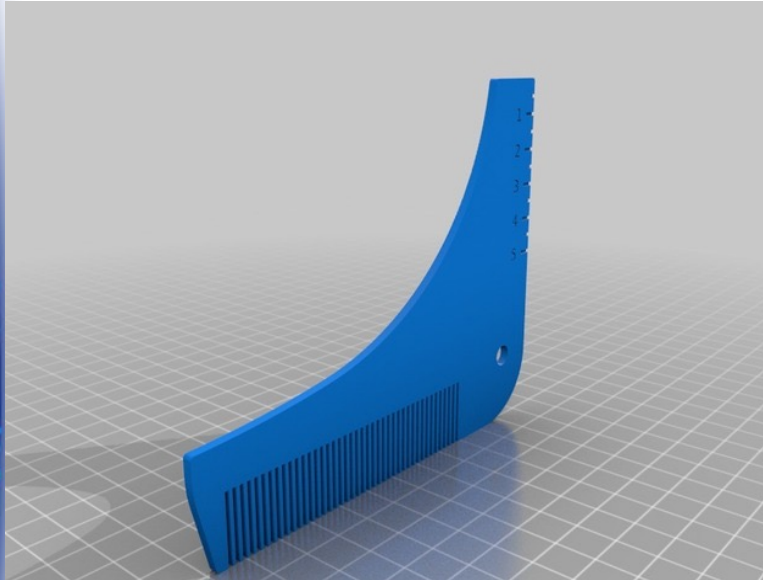


8 hour print (each)
\$5.00 each in material cost

ADL: Beard shaping tool

Beard shaping tool
by [eried](#) October 03, 2016:
Thingiverse.com

Trim your beard precisely.



Indispensable Dispenser

by [Erazmataz](#) May 17, 2015: Thingiverse.com



Orthotics


SPENTYS CMC Orthosis
REINVENTING ORTHOPEDICS



2-3 Day Lead Time !!!


SPENTYS Brussels, Belgium
REINVENTING ORTHOPEDICS



Bryan Craft, 2022

3D Printed Wrist Support

Wrist support



Forearm based thumb spica

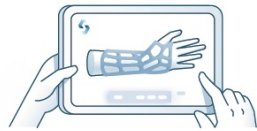


Digital Workflow

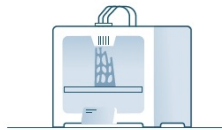
The Digital Workflow With 3D



Step 1: 3D Scanning of the Body part.



Step 2: 3D Modeling of the Orthotic



Step 3: 3D Printing



Step 4: Fitting

- Scan the extremity

- Make modifications to the scan as needed
- Model the orthosis over the scanned extremity

- Print the model
- Post-production

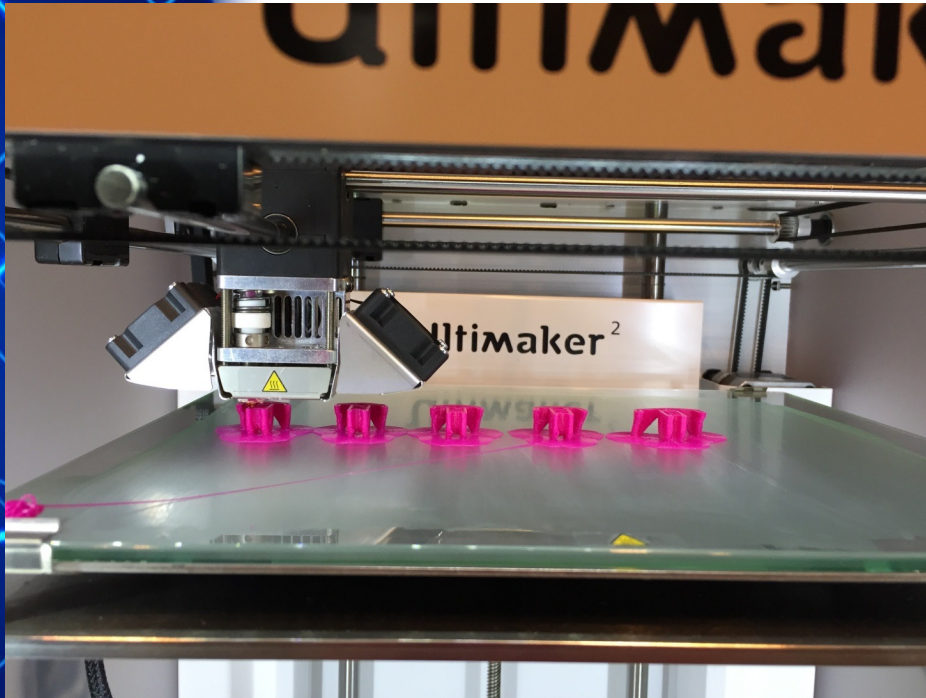
- Fit orthosis

Prosthetics: Varying Levels of Limb Loss

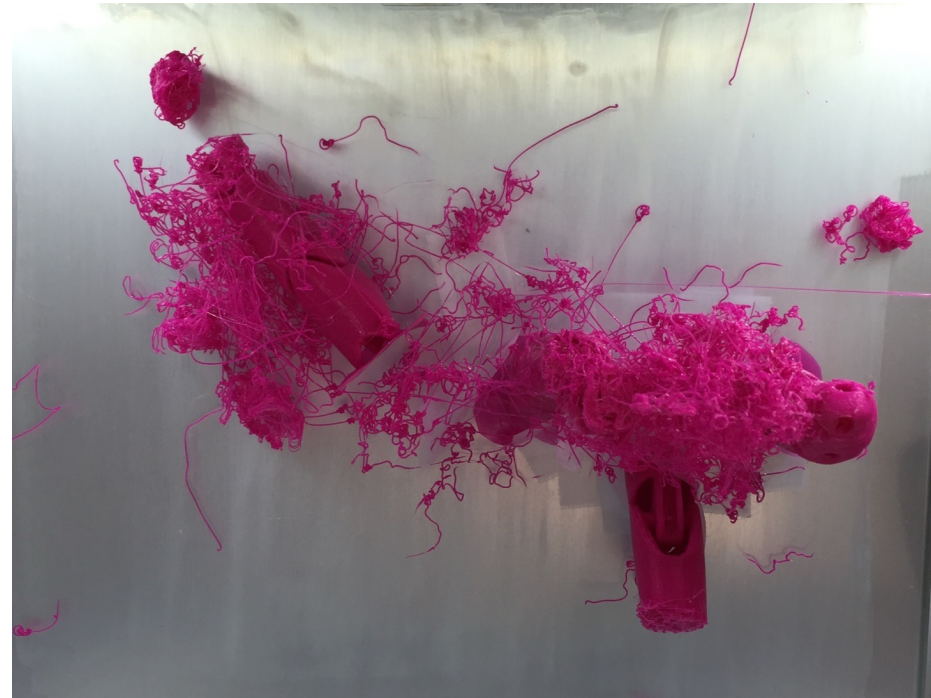


Prosthetics: K1 Hand: Printing 5 Digits

K1 Hand: Printing 5 Digits



And then there were none!



8 Hour EPIC Fail

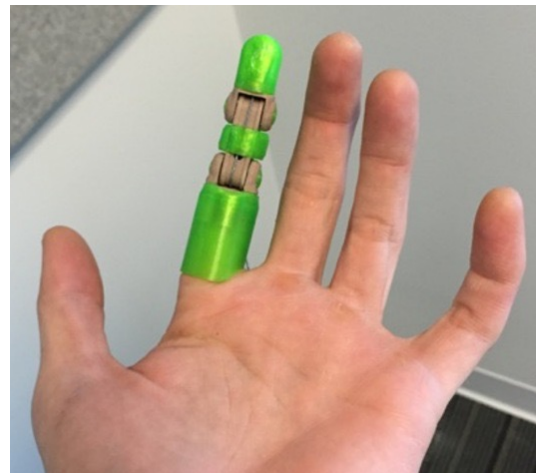
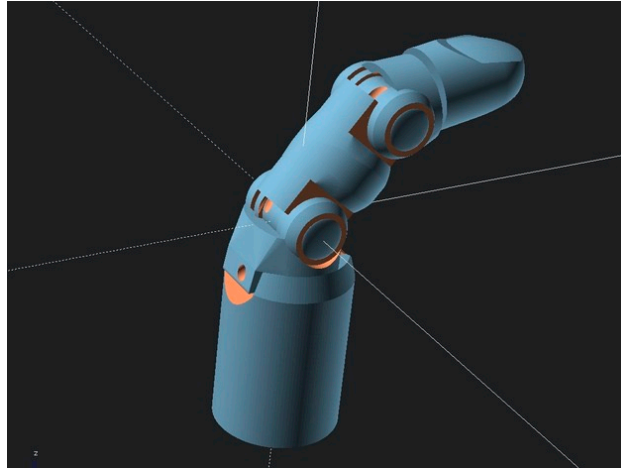
Success!

Completed Hand Prosthesis



Knick's Finger v.3.5.5

(Single Digit Amputation) by knick
<https://www.thingiverse.com/thing:1340624>



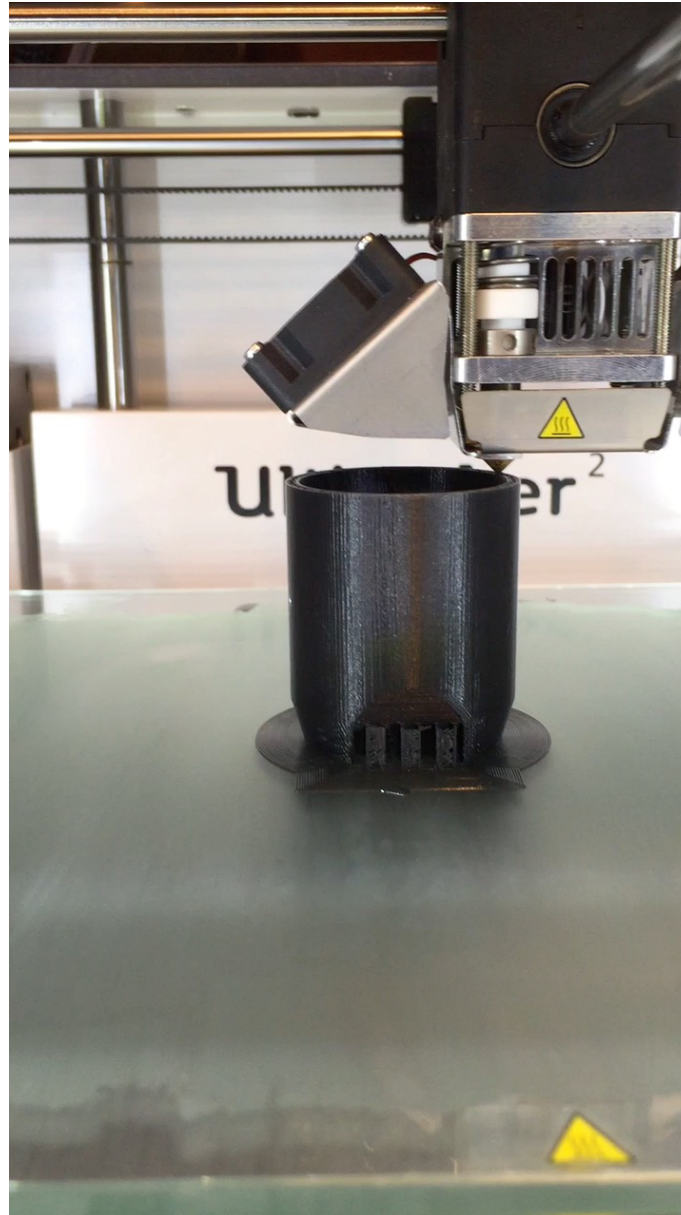
Customizing Knick's Finger for P.S.



Customization: Measuring length for proper scale of digit with Digital Caliper

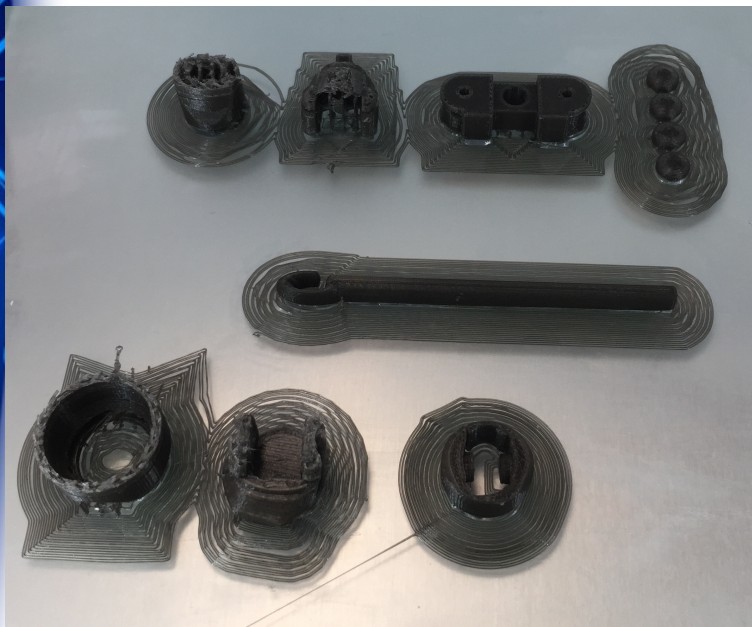


Printing Digital Socket



Customized 3D Printed Parts of the Knick's Finger for P.S.

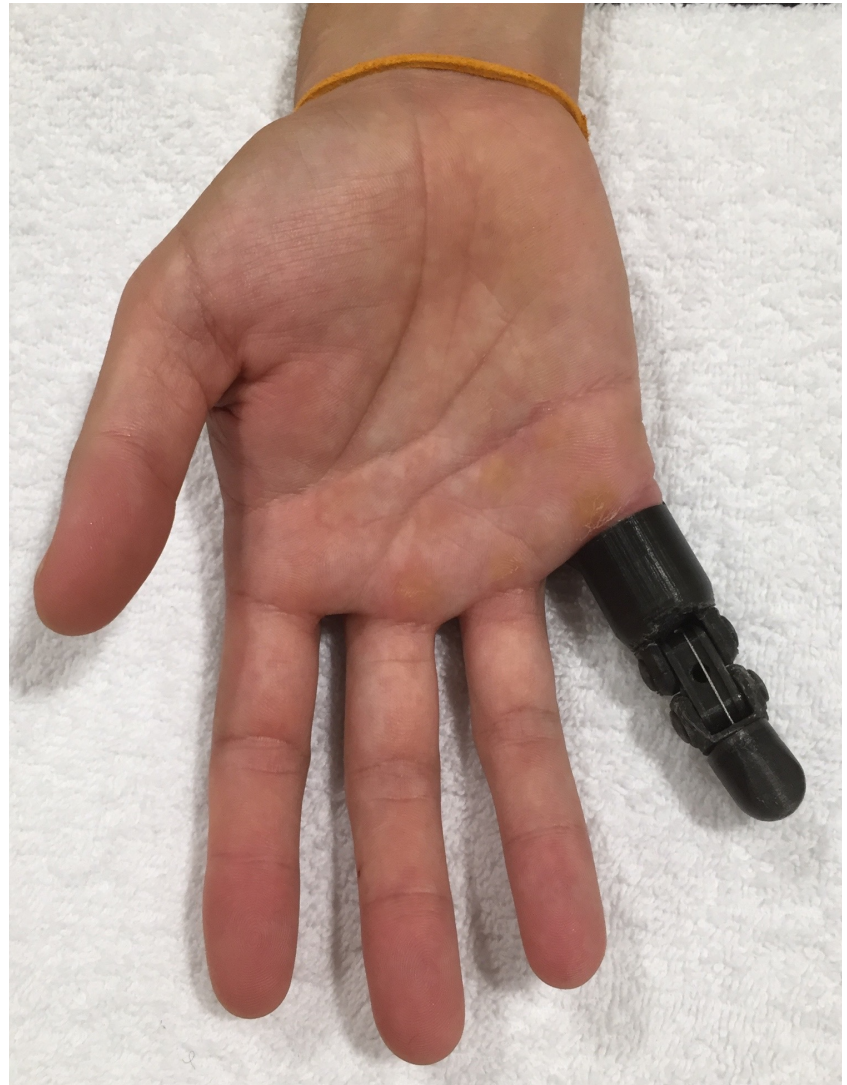
Parts hot off the printing bed



Post Production Process:
Parts Cleaned Up



Successful And Functional Print!



Knick's finger functional use



Actively Engaged Patient in his Treatment



Hanging Loose with the Knick's finger



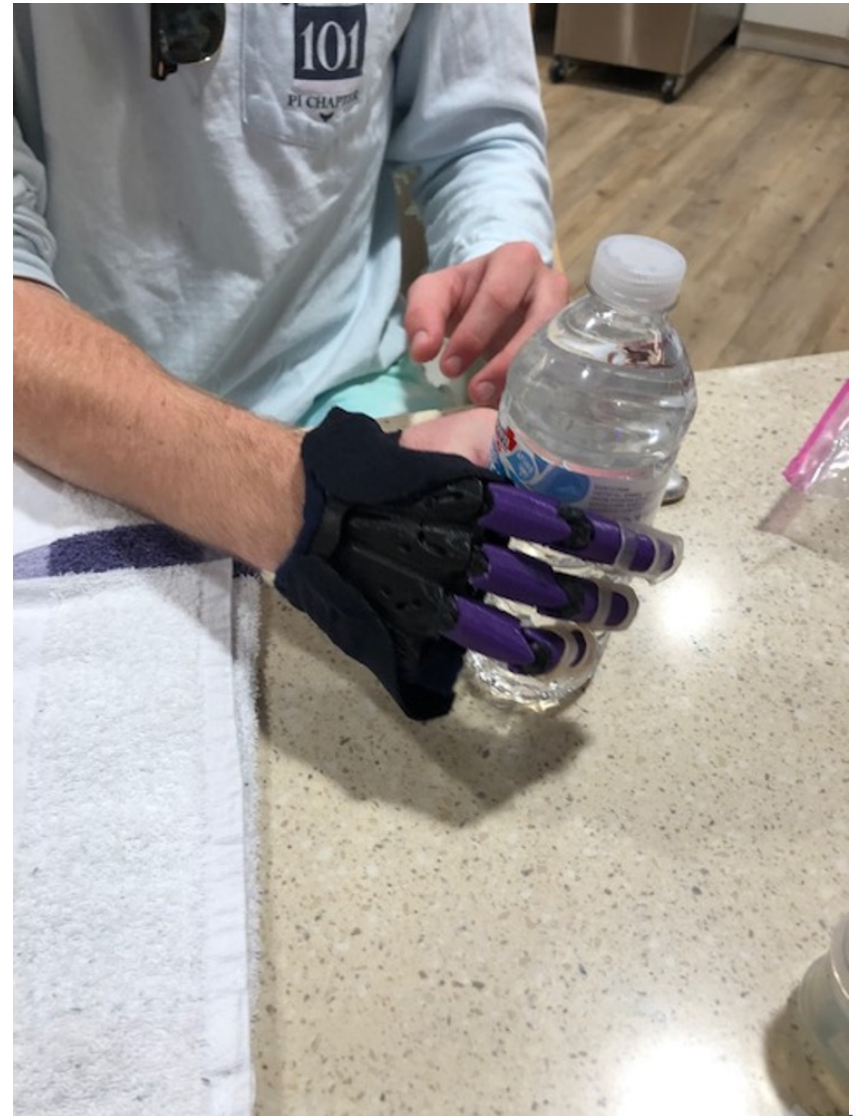
Transmetacarpal Amputation



Problem Solving for Fit and Function



Fit and Function- Successful



Using Prosthetic as an Assist



Empowering Him to Figure Out What He CAN Do!



Kinetic Hand- Design by Mat Bowtell

Free 3D Hands



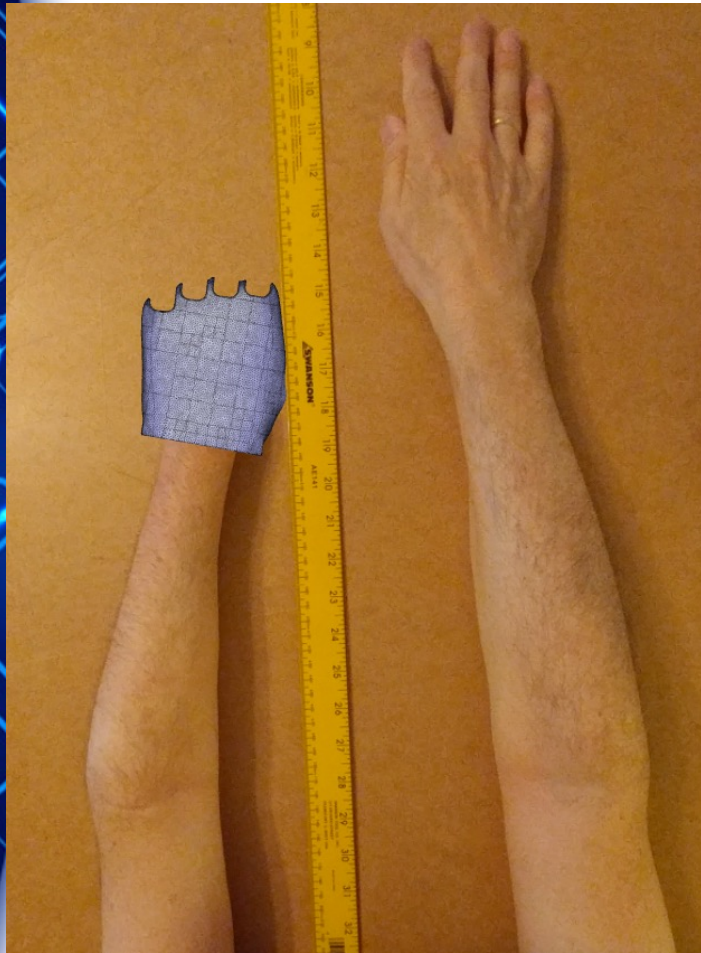
FREE 3D HANDS

Giving Back to e-Nable Recipient: The higher the amputation the more complex the prosthesis is...



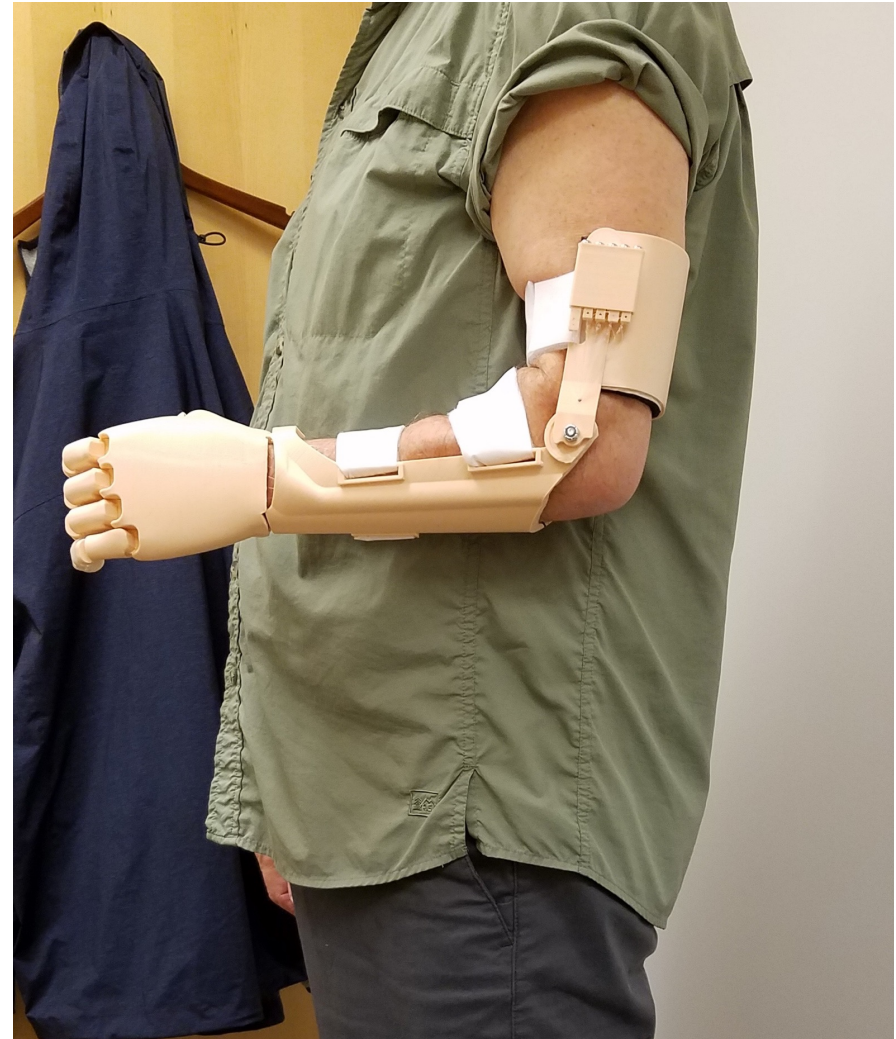
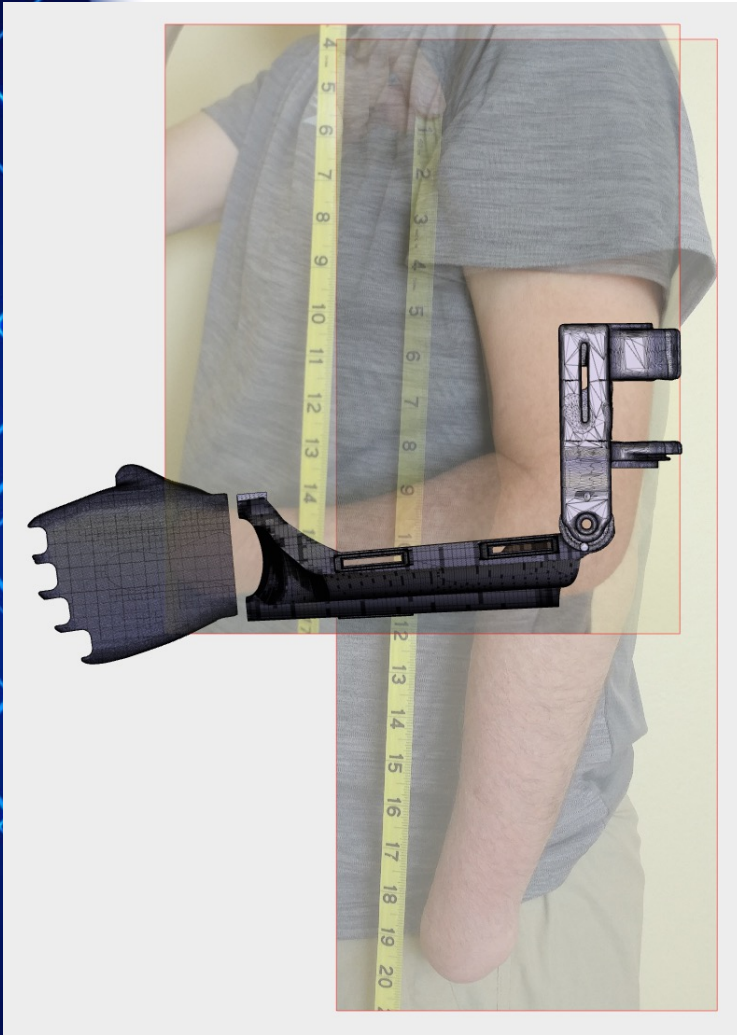
Used with permission: James Shin, MD, Exofix Labs, LLC

Scaling the Palm Piece through Photos and Fusion 360 (CAD)



Used with permission: James Shin, MD, Exofix Labs, LLC

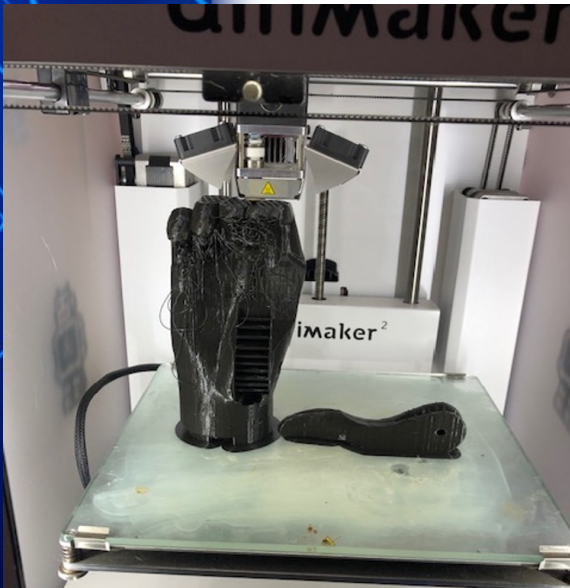
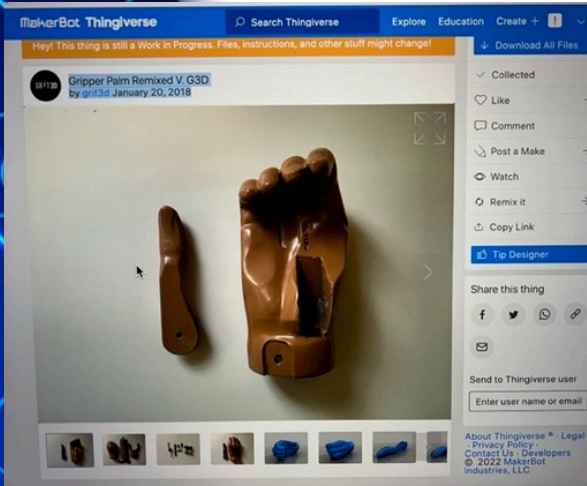
Scaling and Fitting of Prosthesis



Used with permission: James Shin, MD, Exofix Labs, LLC

Gripper Palm Remixed V. G3D

by [grit3d](#) January 20, 2018 (Scooter Hand)



Patient's Goal is to be able to Hold onto Scooter Handle



Fabrication of Socket to Stabilize 3D Hand using BSN Medical Delta-Cast Conformable Material to Fabricate a Socket



Finishing Up Scooter Hand



Testing the Grip



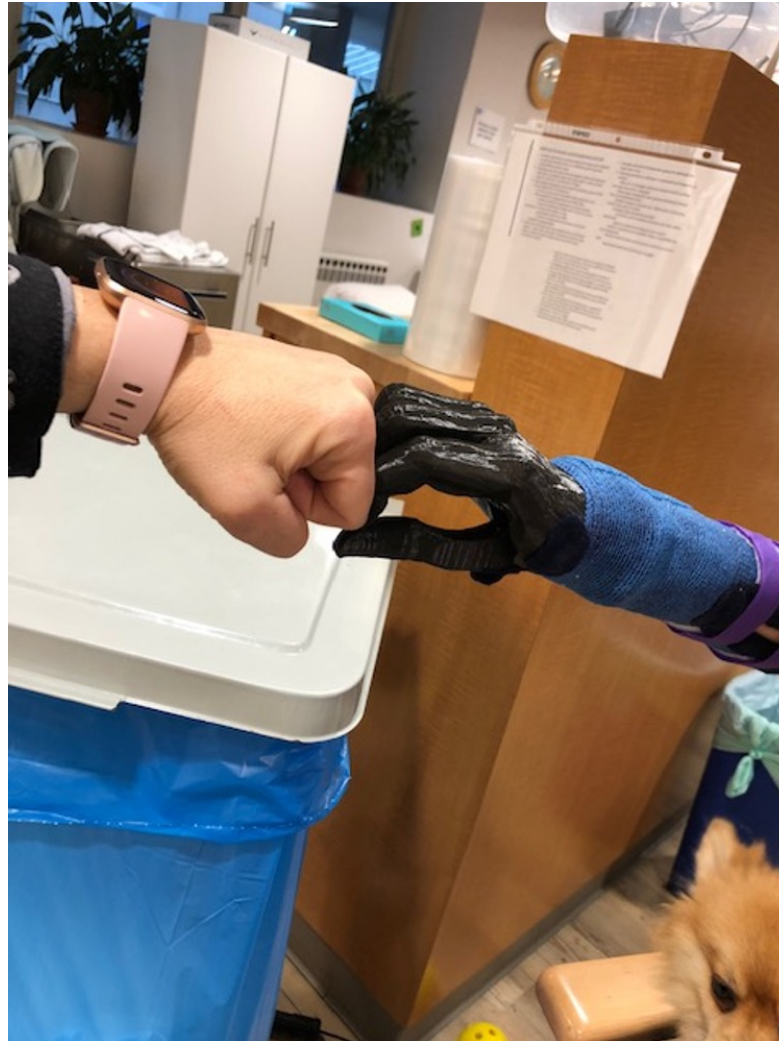
Patient Sent Photos of Scooter Hand in Action



Scooter Hand in Action!



Fist Bump Made Possible! Thank You!!



Resources

- www.thingiverse.com
- www.shapeways.com
- www.3dhubs.com
- i.materialise.com
- store.makerbot.com
- Spentys.com

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Recommended Books

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