

Challenges and Opportunities for Integrating 3D Printing into Physical Therapy

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Information Systems Department



Talk Outline

Digital fabrication and AT “Disruption”?

- Overview of relevant tools and capabilities
- Systematic review of Thingiverse.com

Explorations with PTs and 3D Printing

- Alternative 3D modeling software
- Teaching 3D modeling and design
- Strategic outsourcing

Lessons learned and recommendations

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Traditional “Making” Tools



New Making Tools

*“Personal-scale manufacturing tools **enable people that have no special training** in woodworking, metalsmithing, or embroidery to manufacture their own complex, **one-of-a-kind artisan-style objects**”*
--Lipson, Factory@Home



3D Printed Plastic



Laser Cut Wood



CNC Milled Metal

Finding Making Tools

Buy a printer



Printer Sharing



3D Printers & Supplies

Department: Industrial & Scientific
Additive Manufacturing Products
3D Printer Parts and Accessories (72)
3D Printers (29)
3D Printing Materials (817)

Amazon Prime
Prime Eligible (134)

Featured Brands
SainSmart (16)
OCTAVE (29)
Zen Toolworks (11)
cubilly (2)
3D Printer Supplies (165)
Taufman 618 (3)
Africa (24)
See more...

Avg. Customer Review
★★★★★ & Up (111)
★★★★ & Up (138)
★★★ & Up (159)
★★ & Up (170)

Discount
10% Off or More (26)
25% Off or More (20)

Seller
MossySapwood (112)

3D Printers
Learn more

Filament
See more

CAD Software
See more

Featured 3D Printing Categories

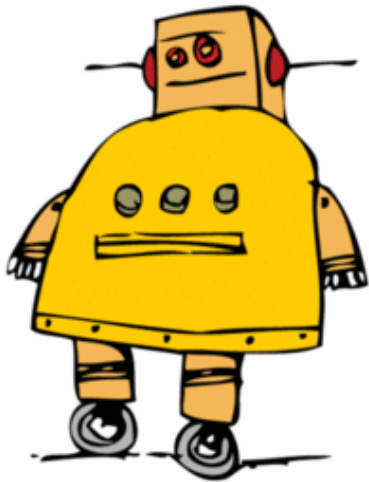
3D Printers
3D Printer Filament
Parts & Accessories
3D Printer Books
CAD Software

Best Selling 3D Printing Materials

3D PRINTED BY
shapeways

Online Communities

Enable users to share designs, modifications, experiences, knowledge and inspiration



instructables.com

THE WORLD'S BIGGEST SHOW & TELL



RSS feed



STUMBLEUPON



TWITTER



FACEBOOK



FLICKR pool



Talk Outline

Digital fabrication and AT “Disruption”?

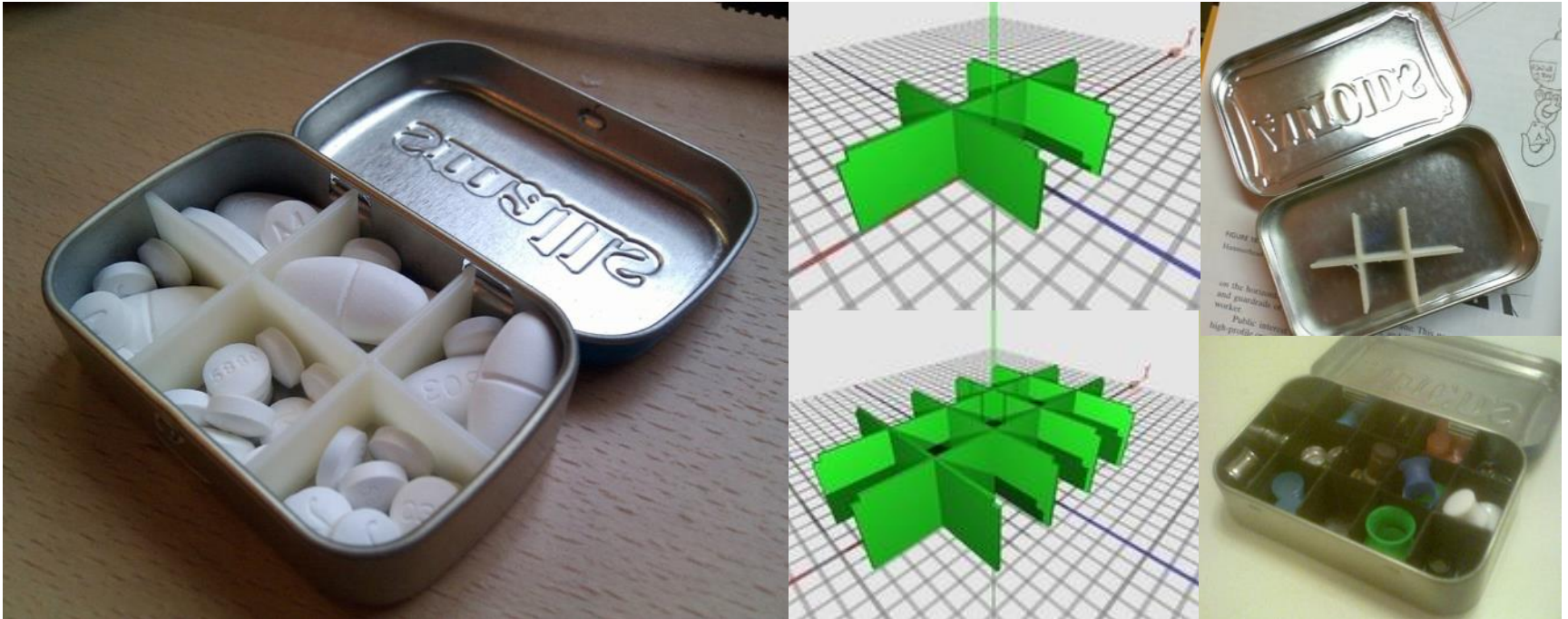
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Sharing 3D Designs on Thingiverse



Pill box insert for Altoids tins by [scanlime](#)

Share files ready to be manufactured

Users share images and experiences

Encourage modifications

What Kinds of Designs are Posted?

Example designs
by inclusion
criteria



thing:23729



thing:61329



thing:315819



thing:324072



thing:261462



thing:84635



thing:359348

Surveyed all AT posted
between 2008-2015

Less than 1% was AT

(363 designs out of 100,000)

1. *Traditional assistive technologies* (6%)
2. *Accessible media* (11%)
3. *Accessories for assistive devices* (8%)
4. *New assistive technology prototype* (4%)
5. *Prosthetic limbs* (17%)
6. *Medication management tools* (36%)
7. *Other design explicitly intended for disabled or senior users* (18%)

[CHI 2015]

What are People Making?

likes



919

thing:261462



854

thing:242639



699

thing:92937



513

thing:114247



513

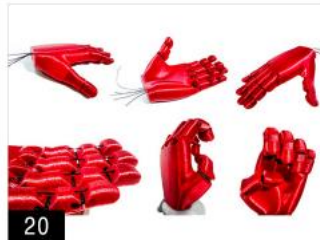
thing:380665

makes



21

thing:188275



20

thing:242639



19

thing:114247



17

thing:92937



16

thing:261462

remixes



379

thing:114247



347

thing:188275



86

thing:201304



25

thing:201304

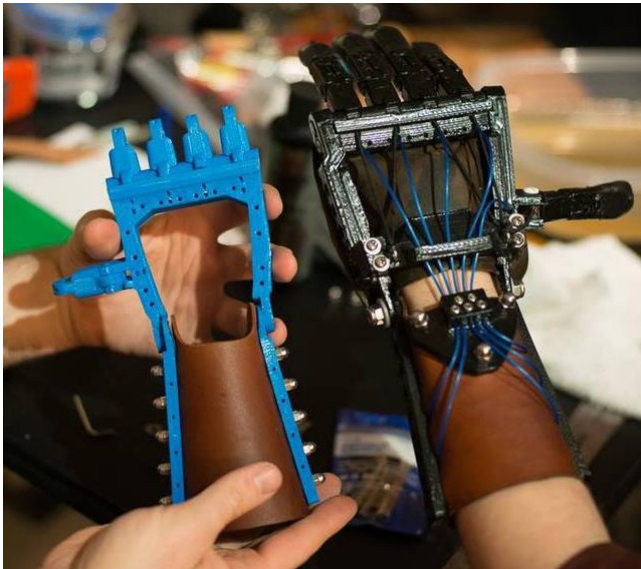


24

thing:157174

[CHI 2015]

Who are the Designers?



Online survey with 69 designers to understand why they made and shared the AT

24	I made this for someone I know
13	I made this for myself
13	This was a personal challenge
8	This isn't intended for a disability
6	This was part of a research project
5	This was required for a class or competition

[CHI 2015]

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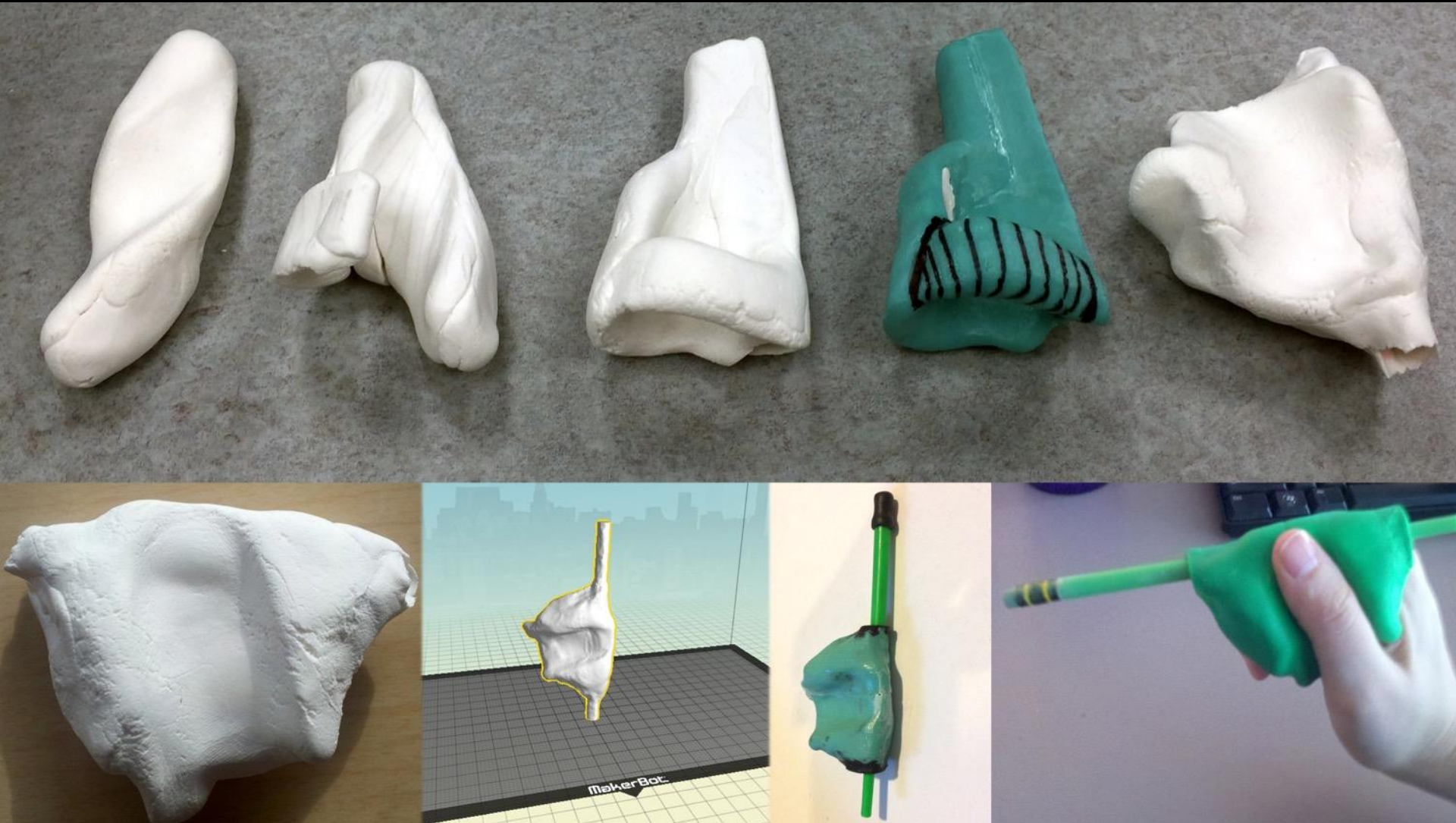
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Designing Stylus Grip With Clinicians



GripFab Interface

Grips Hole Settings **Barrel Settings**

What kind of barrel would you like?

None

Creates a simple grip with a hole for items to slide into.

Grip Depth: 0.0 mm
The diameter of your circle should fit tightly around your object.

Barrel Length: 0 mm
The barrel length should run the length of the item it is supporting.

Angle: 0 degrees
The angle at which you want the barrel to point

☐ Left Handed Grip?

Grip

Hole

Grip Depth

Submit Barrel

Grips Hole Settings **Barrel Settings** Finish

How would you like the hole shaped?

Circle

Creates a circular hole for the item to slide into. Good for pens.

Diameter: 0.0 mm
The diameter of your circle should fit tightly around your object.

Height: 0.0 mm
The height of your rectangle should fit tightly around your object.

Width: 0 mm
The width of your rectangle should fit tightly around your object.

Barrel

Diameter

Hole

Submit Hole

[TACCESS 2016, ASSETS 2014]

GripFab Interface

Grips Hole Settings Barrel Settings

What kind of barrel would you like?

Straight

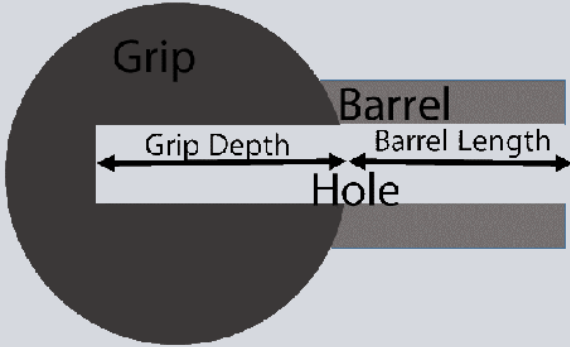
Creates an straight barrel. Adds support to longer items. Great for writing.

Grip Depth: 12.4 mm
The diameter of your circle should fit tightly around your object.

Barrel Length: 40 mm
The barrel length should run the length of the item it is supporting.

Angle: 0 degrees
The angle at which you want the barrel to point

☐ Left Handed Grip?



Submit Barrel

Grips Hole Settings Barrel Settings

What kind of barrel would you like?

Angled

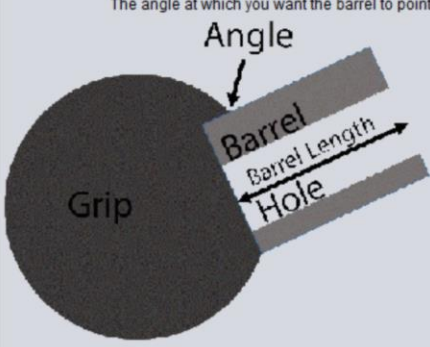
Creates an angled barrel. Adds support to the item and points it at and angle.

Grip Depth: 0 mm
The diameter of your circle should fit tightly around your object.

Barrel Length: 40 mm
The barrel length should run the length of the item it is supporting.

Angle: degrees
The angle at which you want the barrel to point

☐ Left Handed Grip?



Submit Barrel

[TACCESS 2016, ASSETS 2014]

GripFab Output Barrels and Angles



[TACCESS 2016, ASSETS 2014]

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Teaching 3D Printing



PT intro class at University Maryland, Baltimore

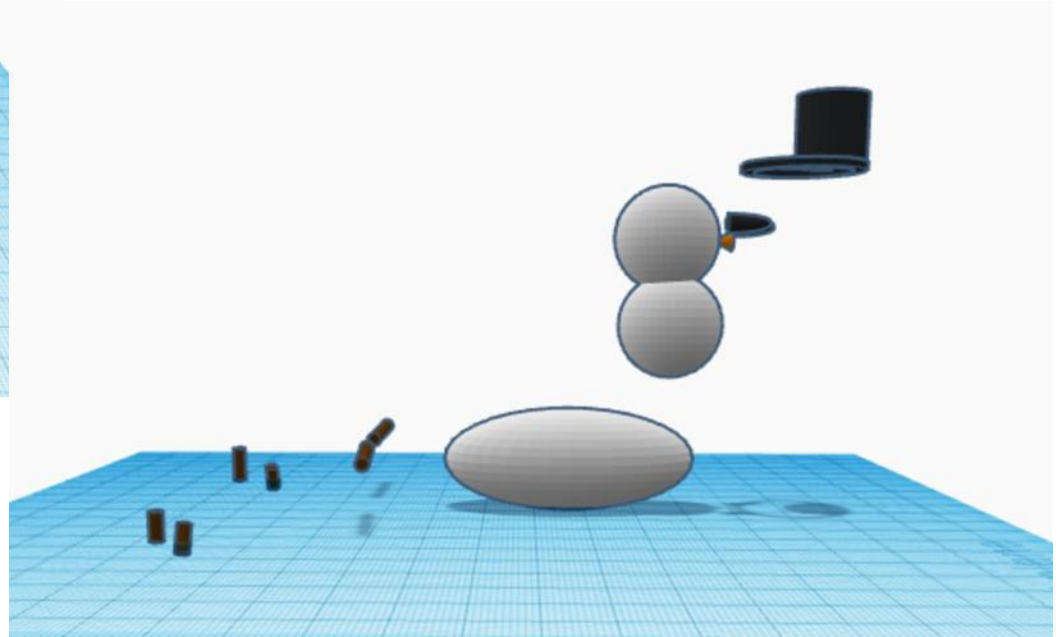
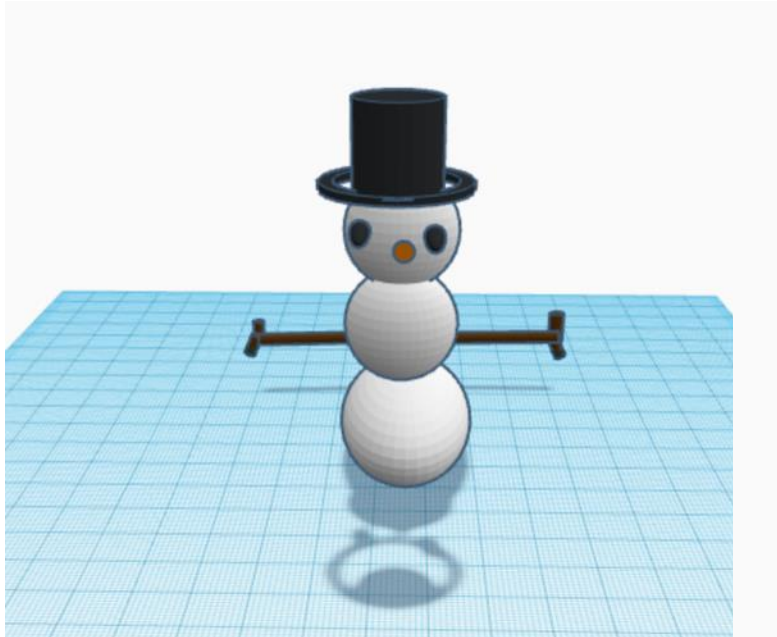
1st Class Sessions:

1. Demystify 3D printing
2. Demystify 3D modeling
3. Create AT using clay
4. Evaluate final AT

Taught class three times

Anticipate a Steep Learning Curve

What is 3D?



[ASSETS 2016]

Teaching 3D Printing



PT intro class at University Maryland, Baltimore

2nd Class Sessions:

1. Demystify 3D printing
- ~~2. Demystify 3D modeling~~
2. Create AT using clay
3. Revise 3D printed AT
4. Evaluate final AT

3D Printing Design Exercises

Female (Age 45)

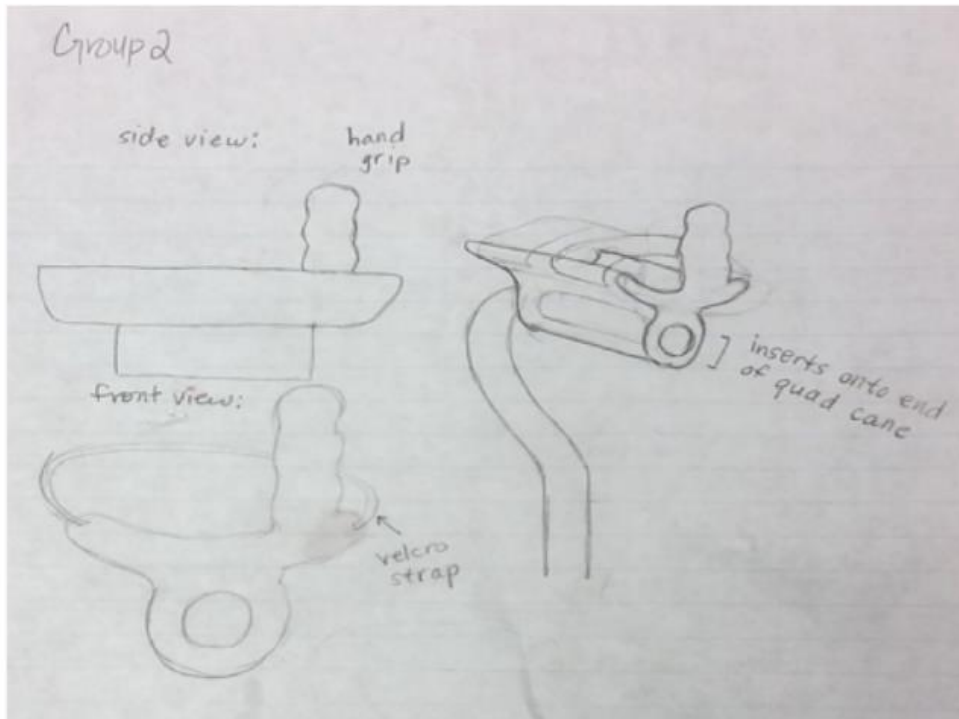
Clinical: Status post TBI, requires use of right quad cane, limited by right wrist flexor synergy

Laymen: Traumatic brain injury caused patient to have limited balance and reduced control of movement of her wrist. Patient uses a cane with four legs.

[ASSETS 2016]

Design Exercises (Simulated Patient)

Created arm-rest with hand grips for a quad cane. Designed to limit wrist mobility.



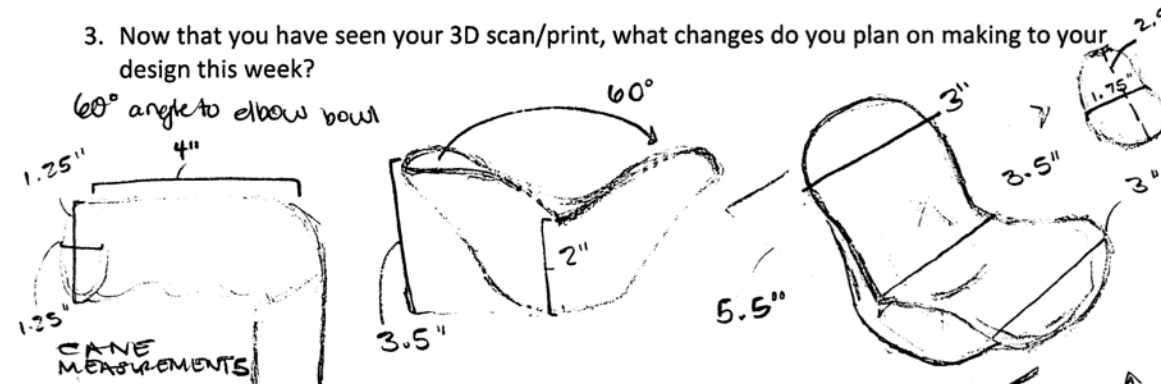
[ASSETS 2016]

Year 1 Solution

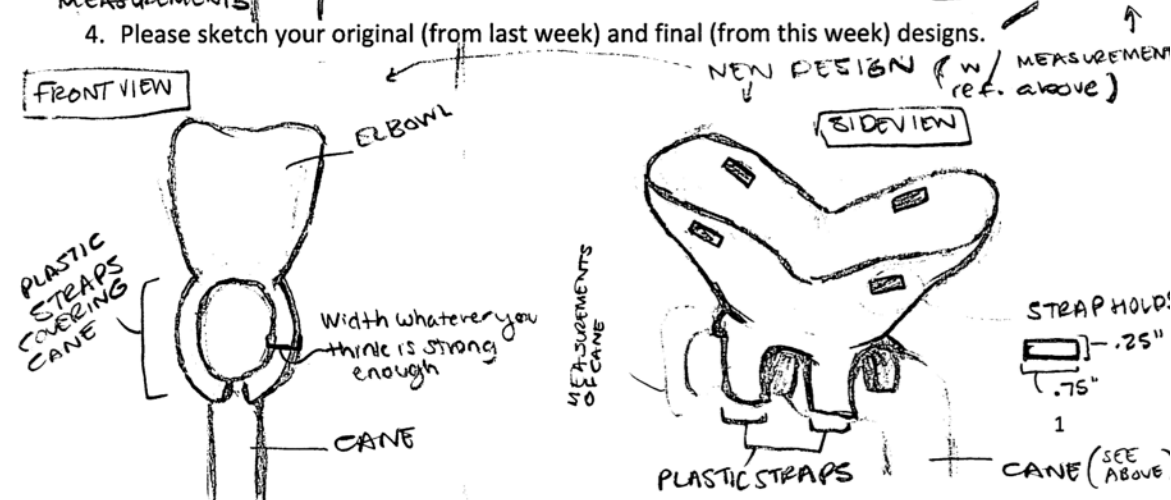
Design Exercises (Simulated Patient)

3. Now that you have seen your 3D scan/print, what changes do you plan on making to your design this week?

60° angle to elbow bowl



4. Please sketch your original (from last week) and final (from this week) designs.



Design Exercises (Real Patients)



Class for 2nd year students

3 Class sessions

1. Need finding and initial design with patient
2. Revision of first round of 3D models
3. Evaluate 3D printed AT with patient

Communication with Fabricators

Team KP (Group 9)
Case Number (Circle One): 1 2 3 4 5

3D Print Order Form

- Patient description: please provide a description about the client.
 - Fake name: Anything Smith
 - Age: 70
 - Need for assistive device (diagnosis): extension of MP and PIP jts
 - Expected use of the assisted device: assist w/ opening of ^② hand
 - Expected impact of patient the assistive device: improve door opening and cooking
- Surface Details: Are there any decorative aspects (surface details) that are not important to your finished print (e.g., fingerprints or other small details)?

NO

- Material (circle one): STIFF FLEXIBLE

Please provide a detailed description for why your object should be stiff or flexible?

~~use as hand~~ improving hand use
flexibility provides more functionality

Will this 3D printed object come in contact with your patient's skin? (circle one) YES NO

If yes, please describe where the patient will touch it, and how much weight you think they will put on it.

The pt. will be using the device at the hand/finger joints. NOT much weight will be put on it

- Density (circle one): HOLLOW PARTIALLY FILLED SOLID

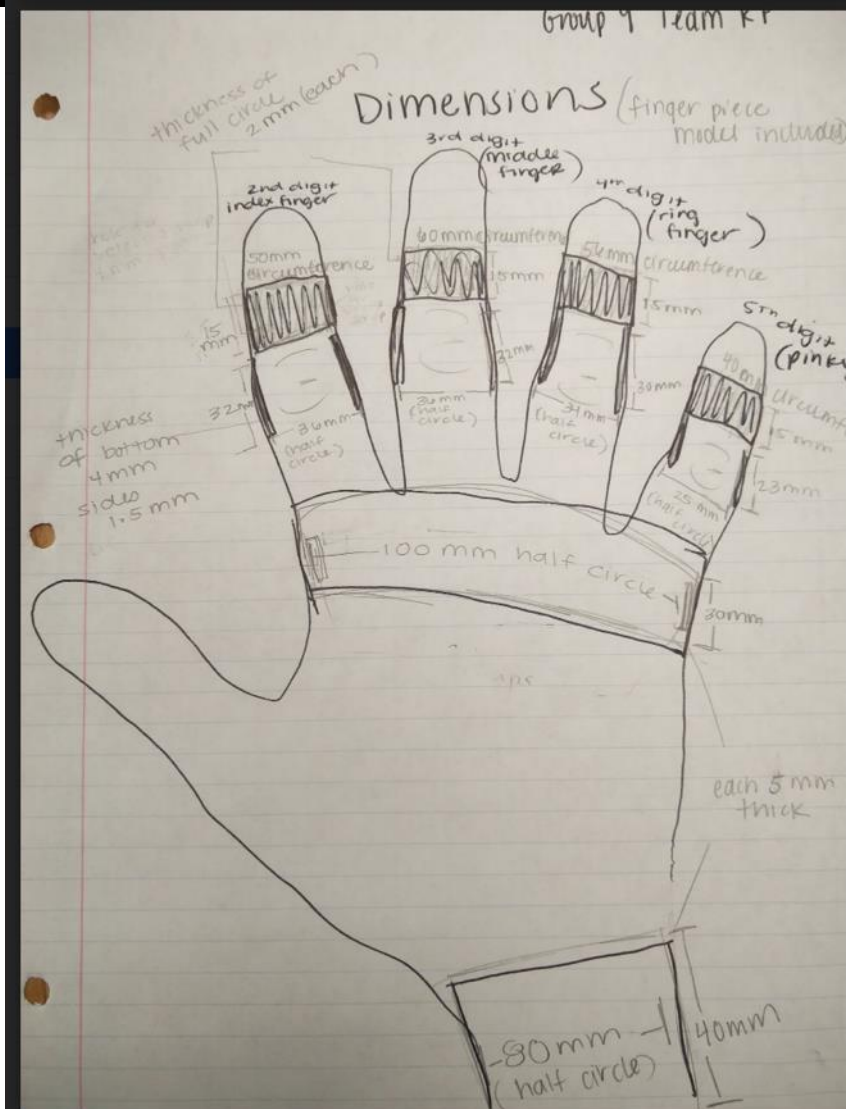
How much weight will your object hold (e.g., in pounds)? How much stress will it be under (e.g., constant)?

No weight, constant tension to keep jts in extension
some compressive force w/ finger bend

- Size: Should your printed object be the same size as your clay model? (circle one):

YES please see measurements for borders NO

If no, should your model be scaled up or down? (Maximum dimensions of 139mm x 139mm x 139mm)



Designs for Real Clients



Printshop created 3D model from sketches
PT students collaboratively fit device to patient

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Maker Employment



New Models of Making



Design session with print shop employee, client, and students



Patient holding final 3D printed Grip

"I planned on studying culinary arts in college, but my experiences with the print shop kinda changed my views a little ... I'm thinking about going somewhere in the technology field."

Printshop as a Living Laboratory

Workflow	Hardware and Software
3D Printing	3D Printer Brands (11): Atom 2.0, Dremel Ideabuilder, Flashforge Creator, Flashforge Finder, Image3D JellyBOX, Lulzbot Taz 4, Raise 3D N2 Plus, Prusa i3, Ultimaker 2 Extended, Ultimaker 3, Rostock Max V2 Software: Autodesk Print Studio, Cura, Ideamaker, Matter Control
3D Scanning	3D Scanner: NextEngine 3D Scanner Software: NextEngine Scan Studio, Autodesk Meshmixer, Meshlab
3D Design	3D Design Software: Autodesk Tinkercad, Autodesk Fusion
Collab.	Software: Google Calendar, Google Docs, Google Sheets, Gmail, Slack

- Collaboration and documentation success and breakdowns
- Technical skill development
- Professional skill development
- Impact and use of community makerspace
- STEM career awareness

Topics

Digital fabrication and AT “Disruption”?

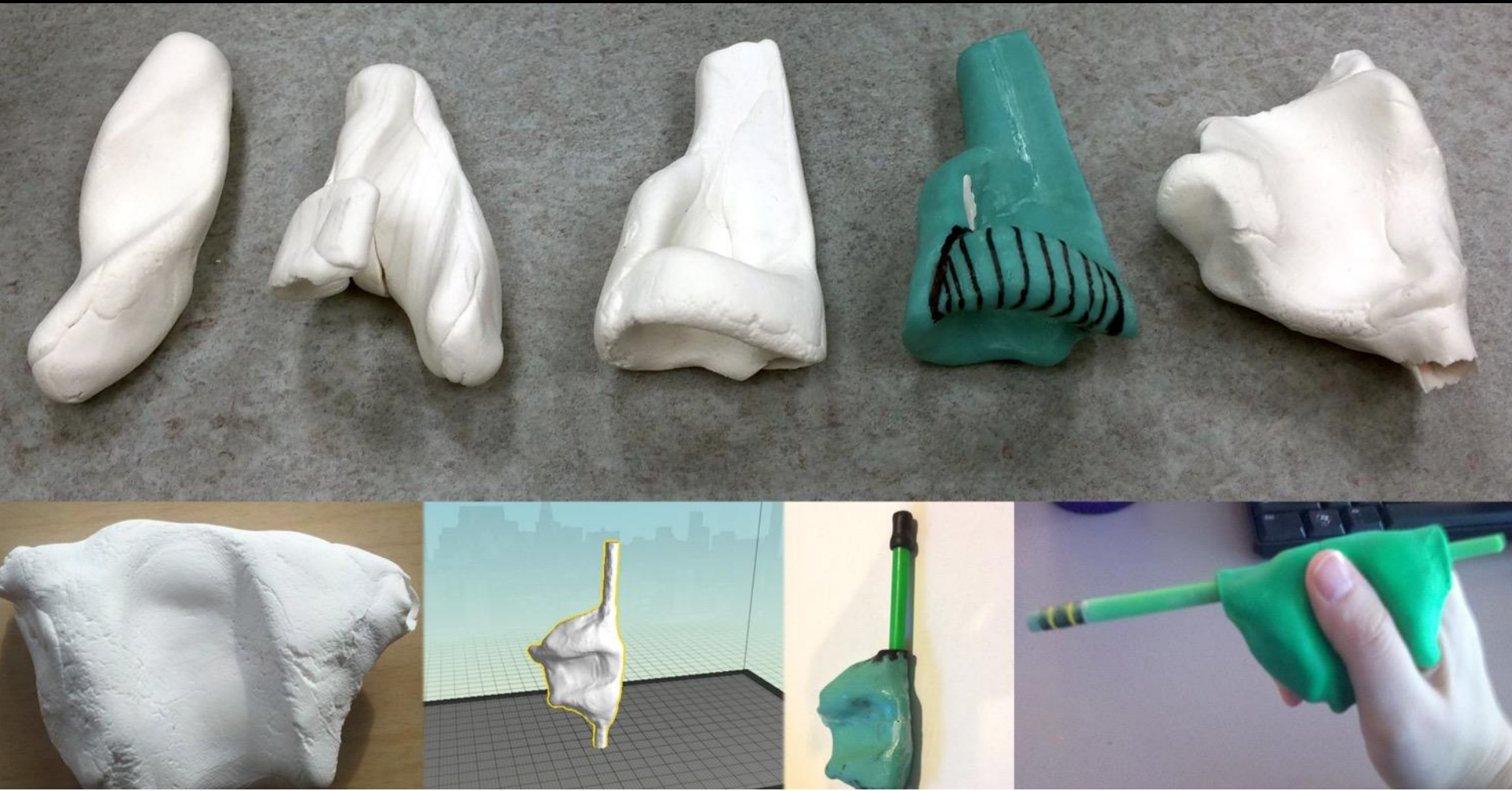
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Time is Most Expensive Resource



[ASSETS 2014, TACCESS 2015, ASSETS 2016]

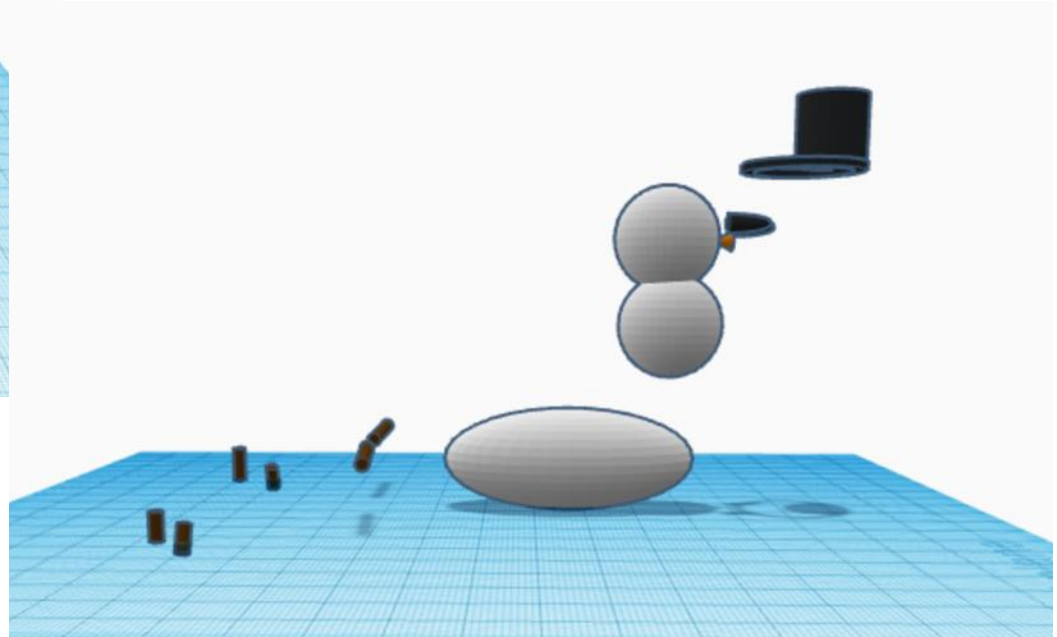
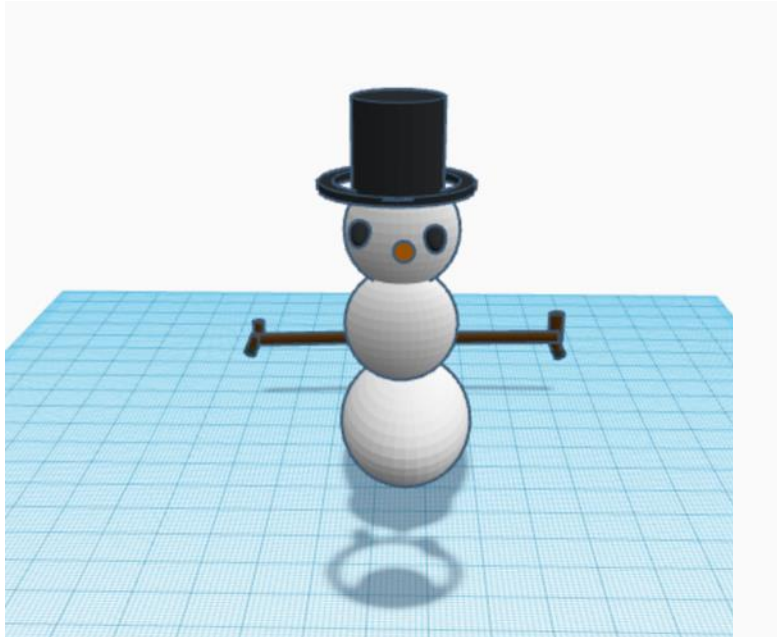
Design with Familiar Tools



[ASSETS 2016]

Anticipate a Steep Learning Curve

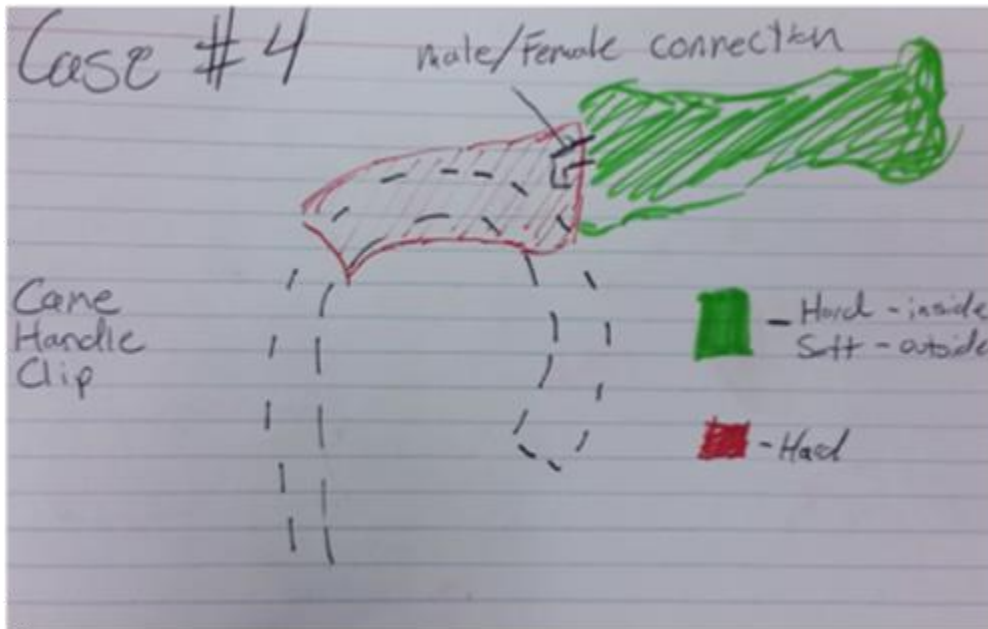
What is 3D?



[ASSETS 2016]

Anticipate a Steep Learning Curve

Will it scan?



[ASSETS 2016]

Size Matters



[ASSETS 2016]

Materials Matter



[ASSETS 2016]

Explore New Work Models



What's Next?

Continue studying adoption of “DIY” culture and assistive technology

Study impact of teaching high-tech skills to non-engineers

Create and study opportunities for “Maker” employment

Thank You!

To learn more: **amyhurst.com**
hcc.umbc.edu **isrc.umbc.edu**

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