# Challenges and Opportunities for Integrating 3D Printing into Physical Therapy

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AN HONORS UNIVERSITY IN MARYLAND

# 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

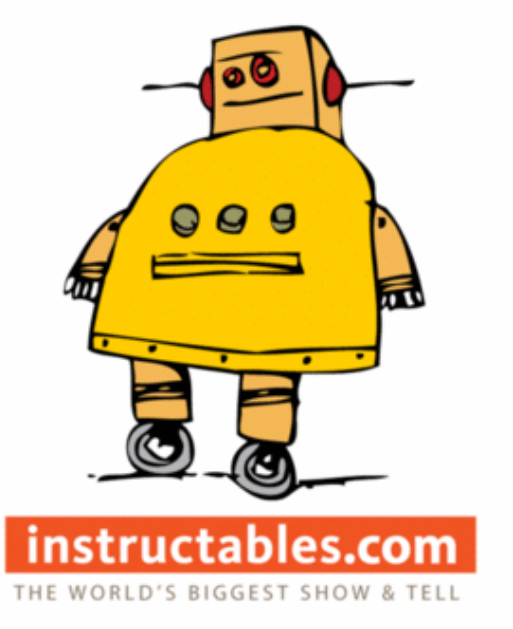


## Printer Sharing

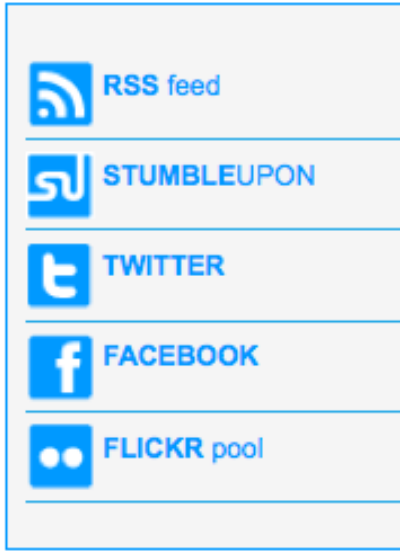

3D PRINTED BY shapeways

# Online Communities

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







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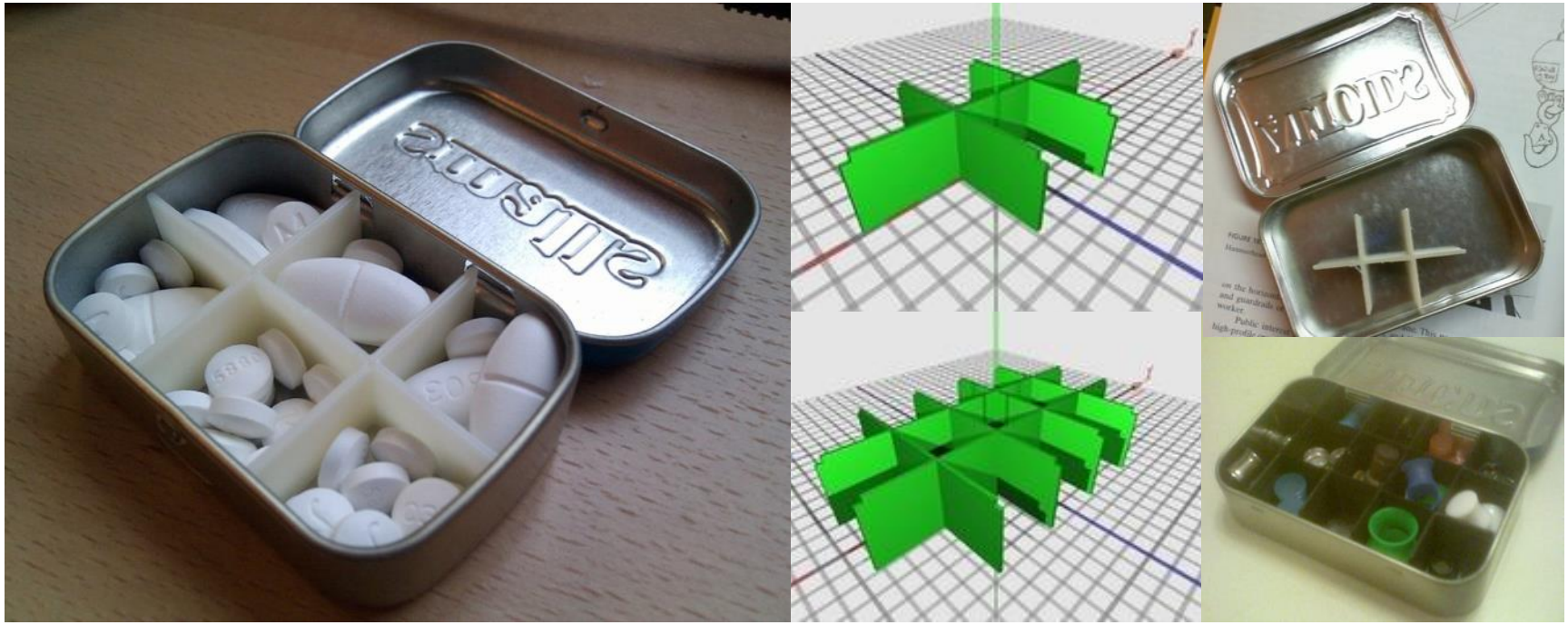
# Sharing 3D Designs on Thingiverse



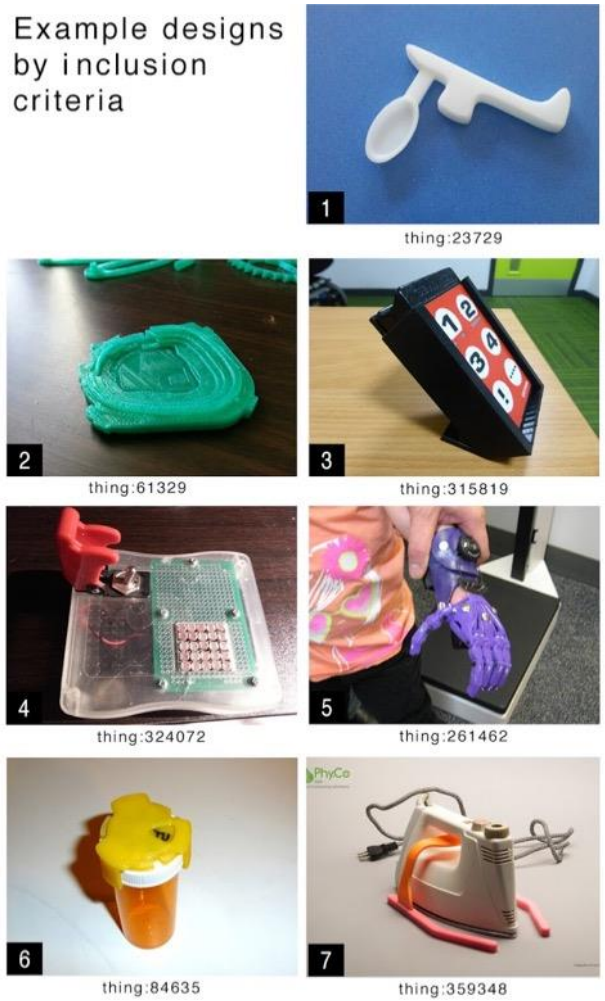
**Pill box insert for Altoids tins by [scanlime]**

Share files ready to be manufactured

Users share images and experiences

Encourage modifications

# What Kinds of Designs are Posted?




[CHI 2015]

Surveyed all AT posted between 2008-2015

Less than 1% was AT

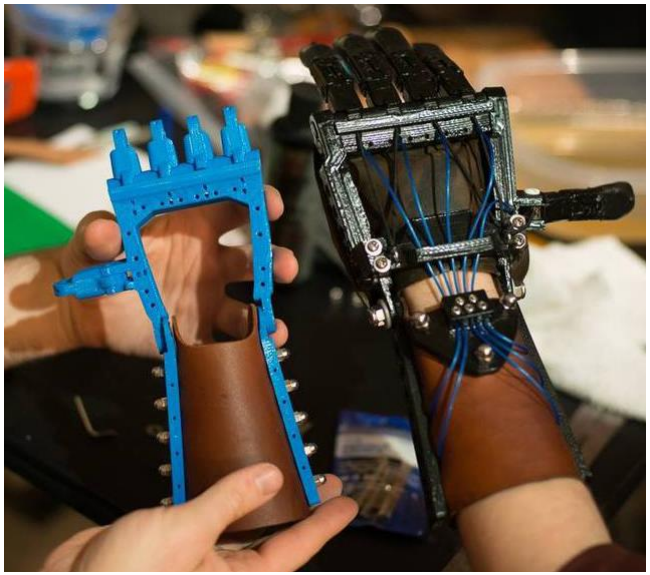
(363 designs out of 100,000)

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%)

# What are People Making?


[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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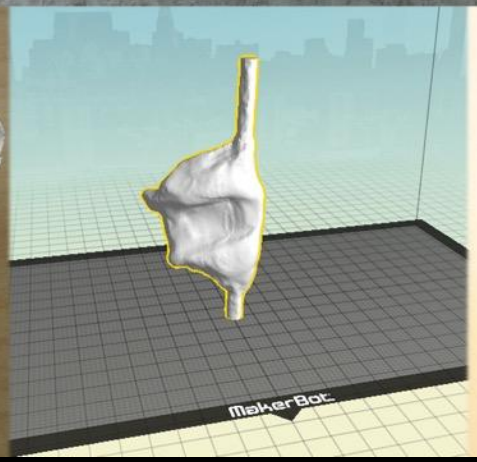
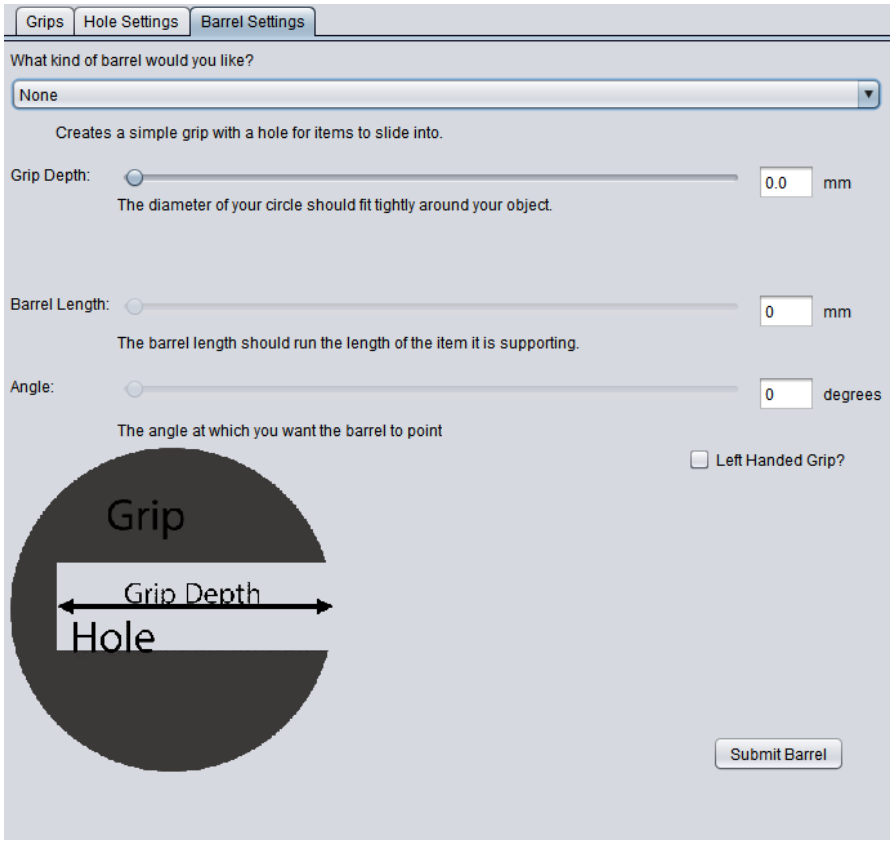
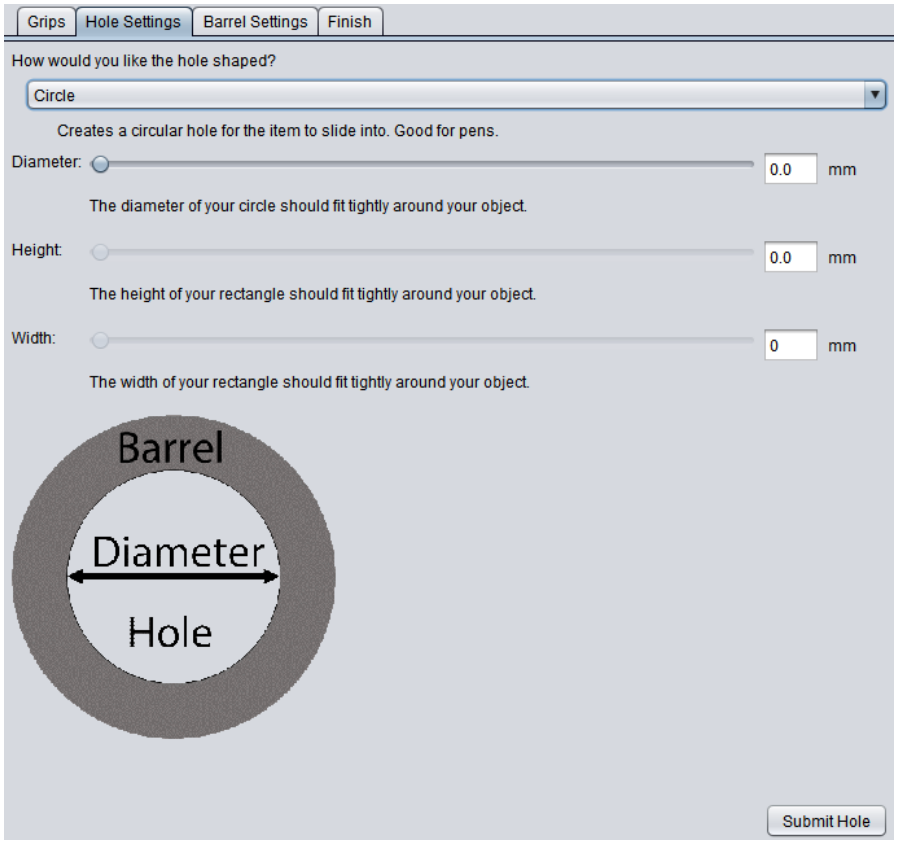
# Designing Stylus Grip With Clinicians



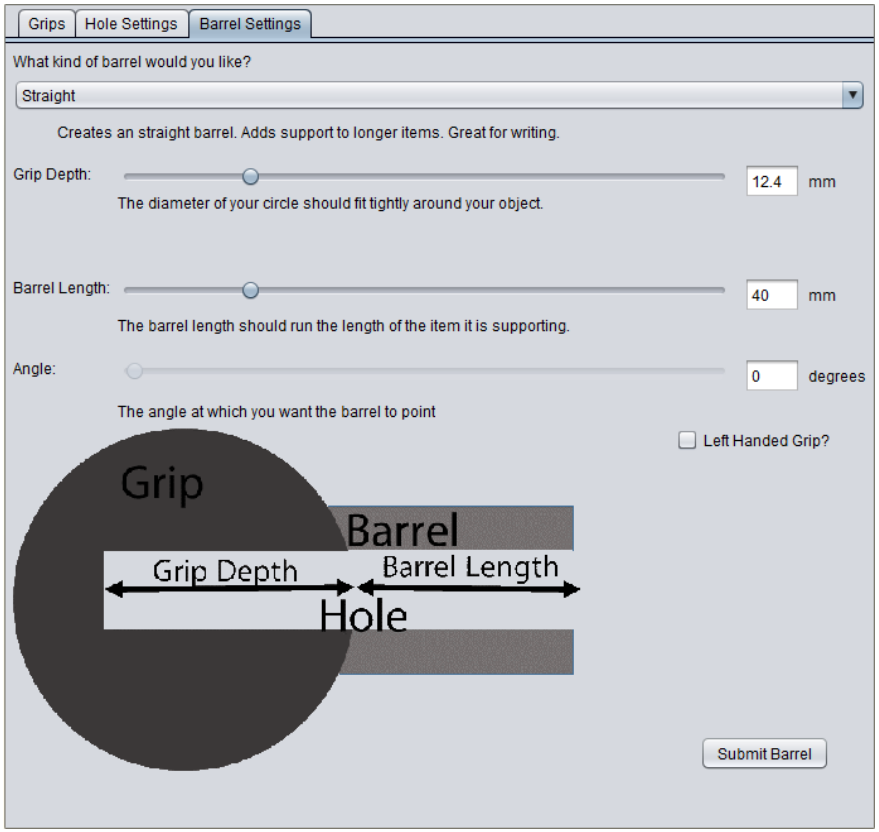

# GripFab Interface

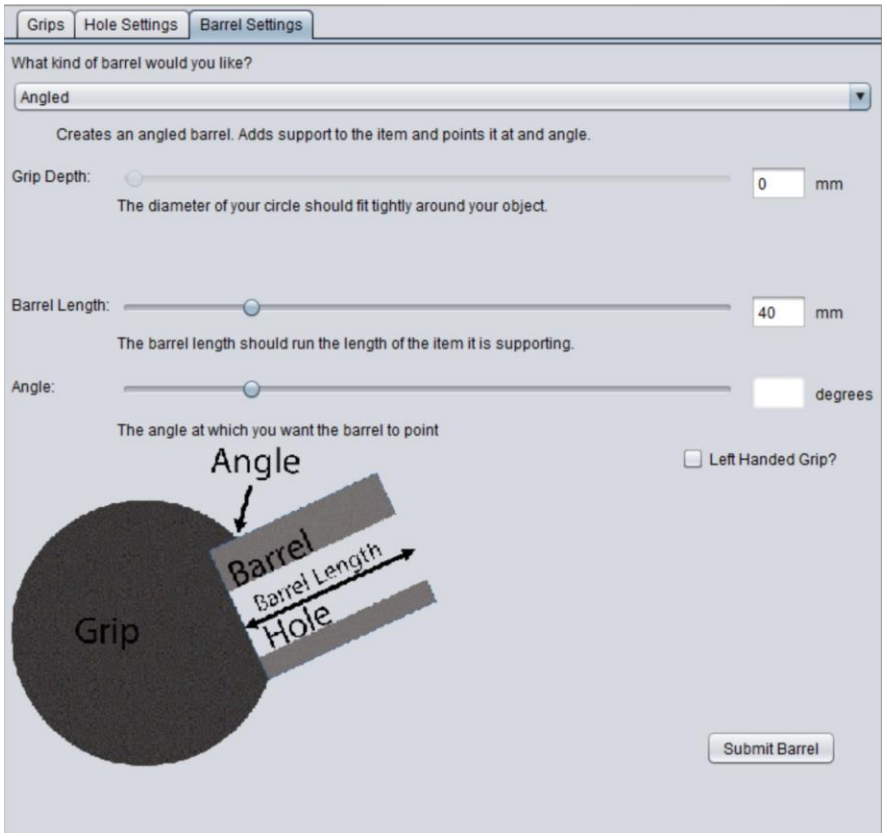



[TACCESS 2016, ASSETS 2014]

# GripFab Interface




[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

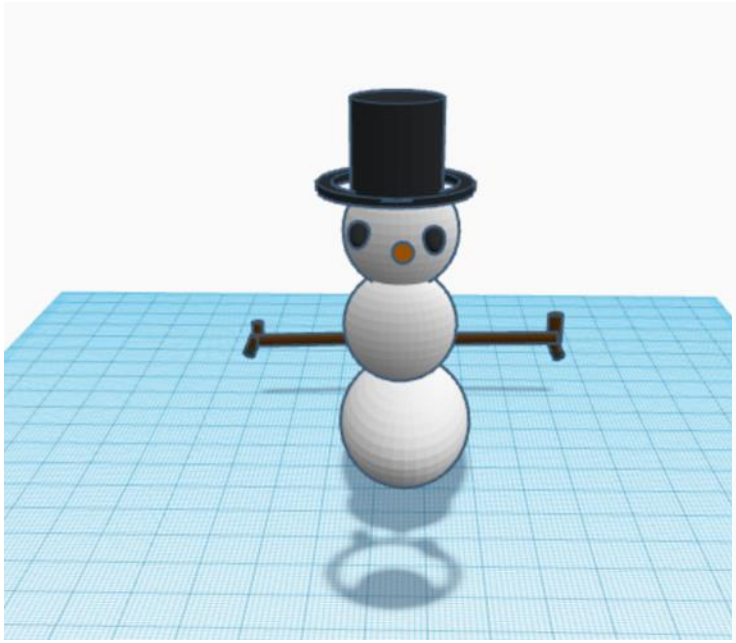
1st Class Sessions:

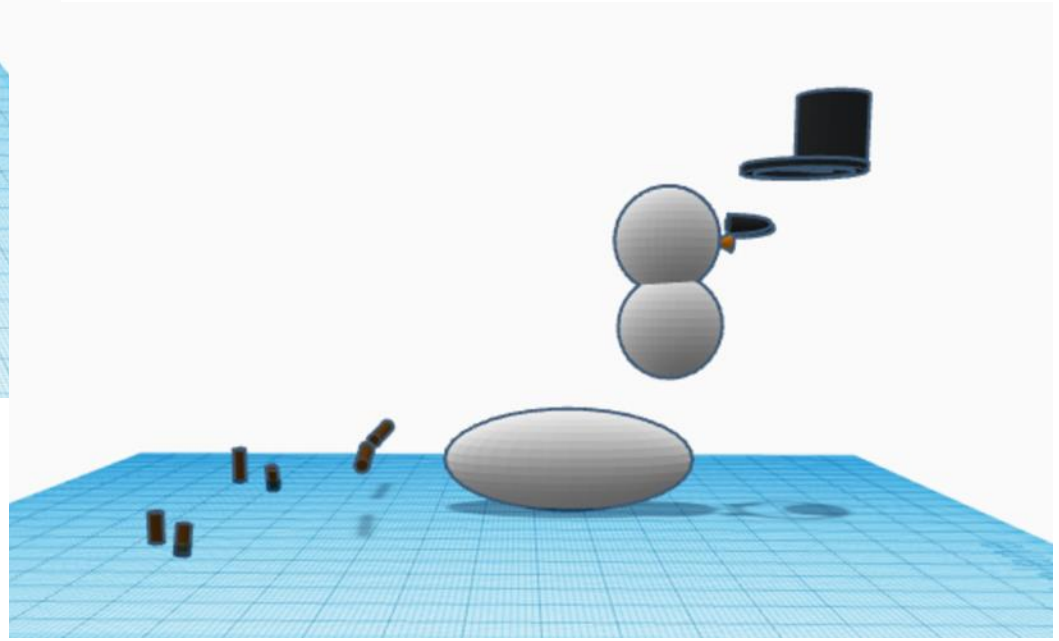
1. Demystify 3D printing
2. Demystify 3D modeling
3. Create AT using clay
4. Evaluate final AT

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)

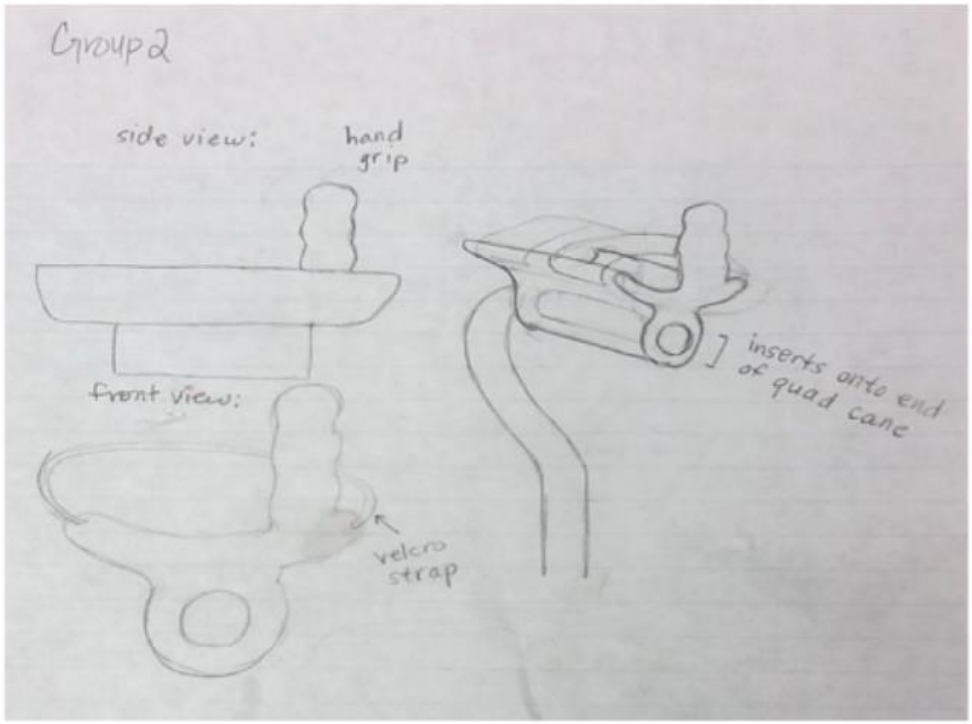
**Clinical:** Status post TBI, requires use of right quad cane, limited by right wrist flexor synergy

**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)

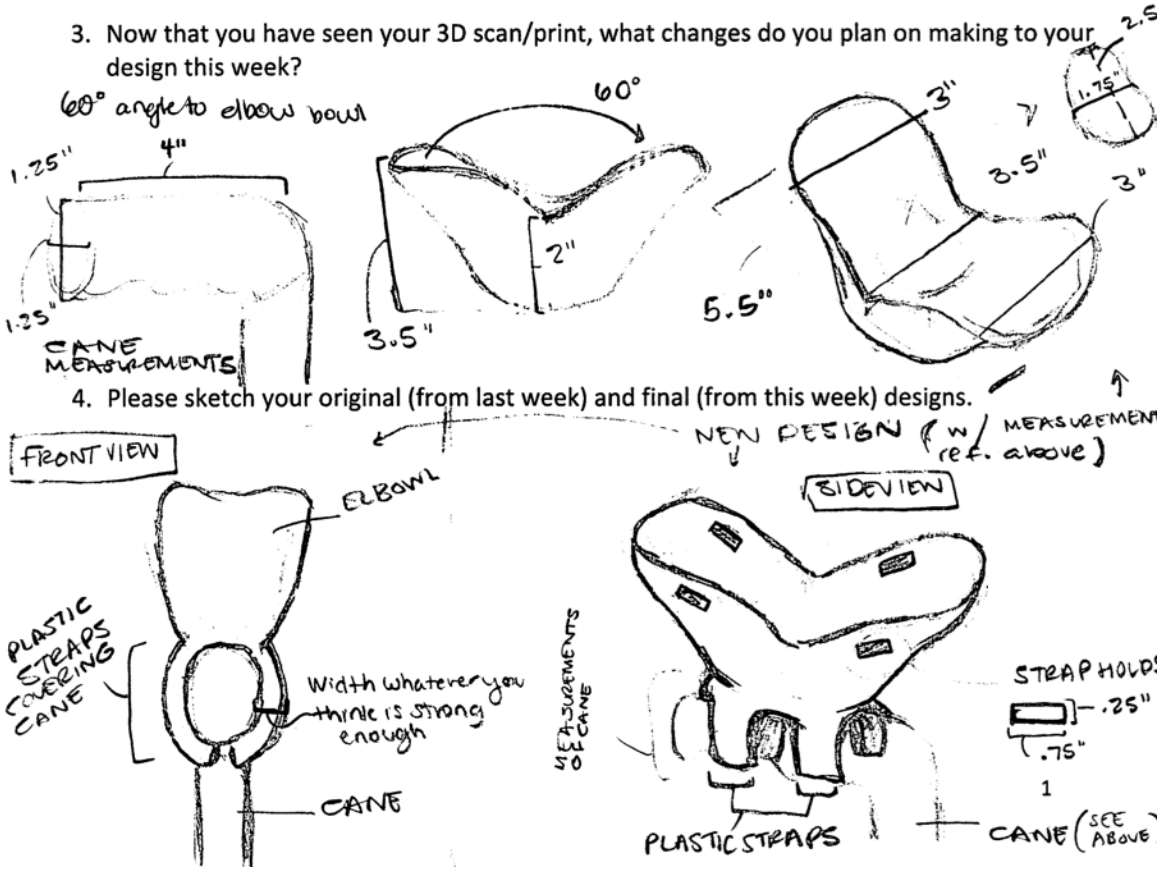
Created arm-rest with hand grips for a quad cane. Designed to limit wrist mobility.

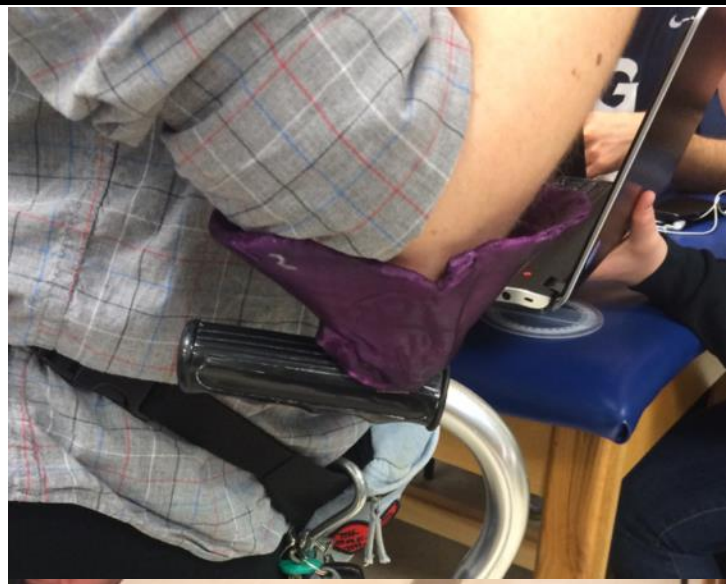



Year 1 Solution

[ASSETS 2016]

# Design Exercises (Simulated Patient)



# 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**

1. **Patient description:** please provide a description about the client.
   a. Fake name: Anything Smith
   b. Age: 70
   c. Need for assistive device (diagnosis): extension of MP and PIP jts (R)
   d. Expected use of the assisted device: assist w/ opening of (R) hand
   e. Expected impact of patient the assistive device: improve door opening and cooking
2. **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
3. **Material** (circle one): STIFF (FLEXIBLE)

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

   ~~life 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
4. **Density** (circle one): HOLLOW PARTIALLY FILLED (SOLID)

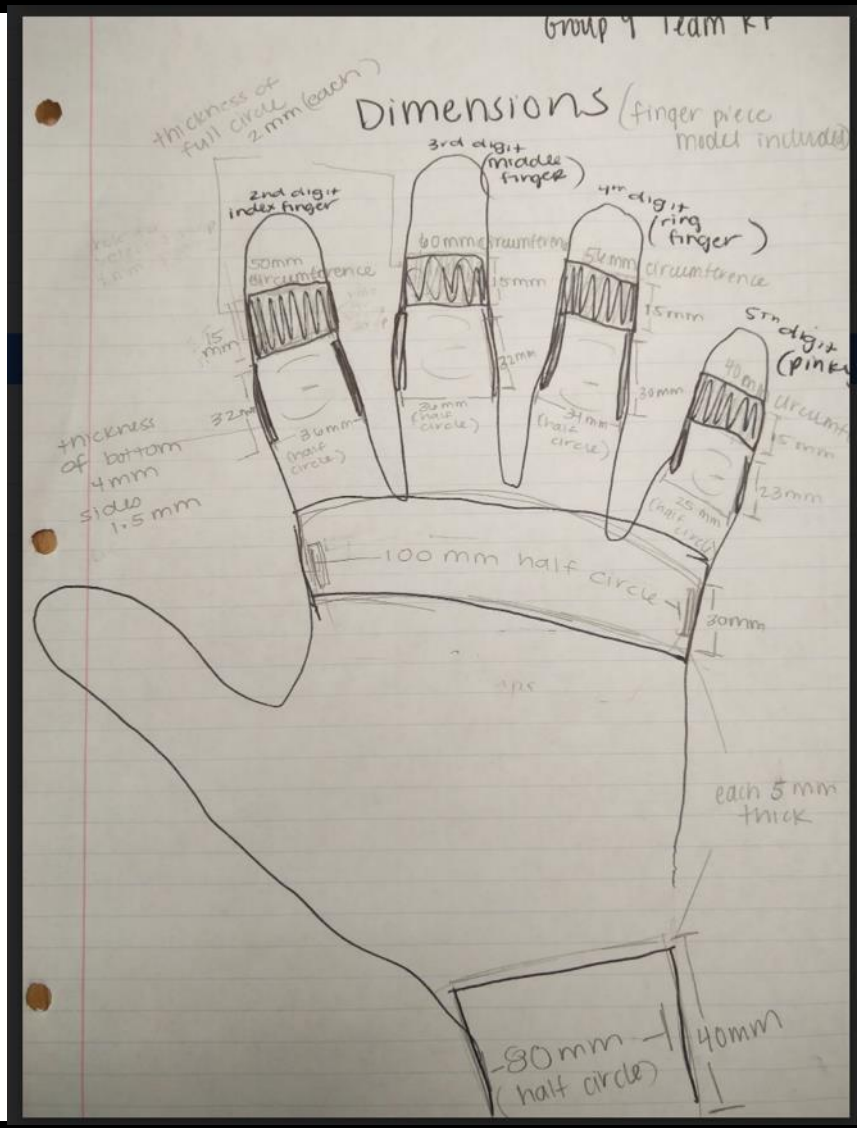
   How much weight will your object hold (e.g., in pounds)? How much stress will it be under (e.g., constant)?

   No weight, constant tension to keep jts in extension some compressive force w/ finger bend
5. **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)

1



# Designs for Real Clients

Printshop created 3D model from sketches

PT students collaboratively fit device to patient

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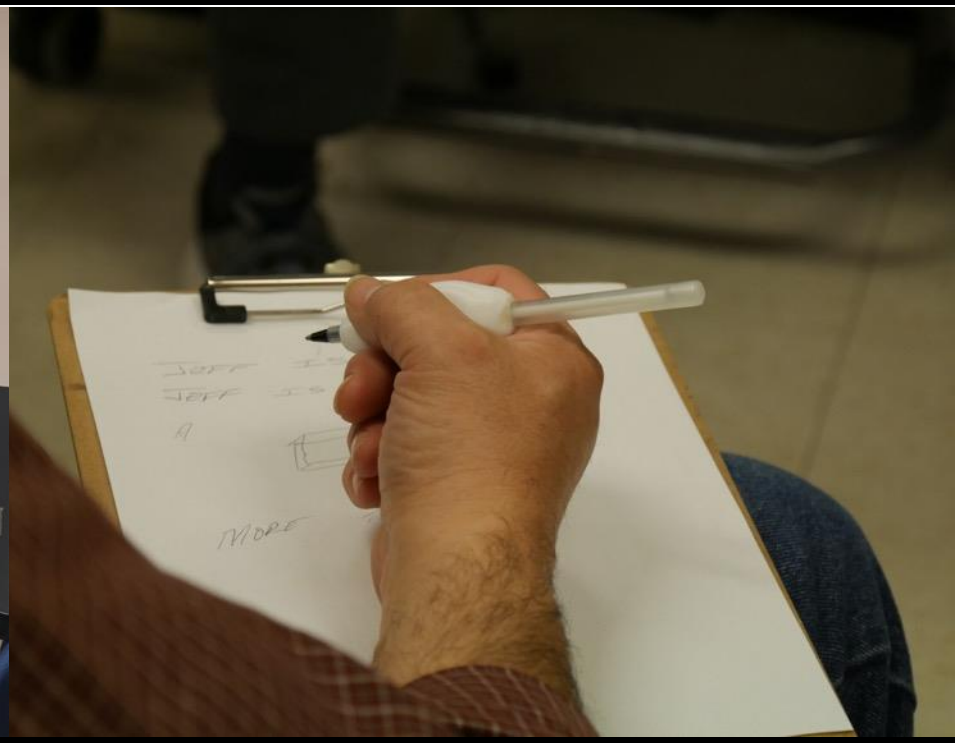
# Maker Employment

# 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<br>Software: Autodesk Print Studio, Cura, Ideamaker, Matter Control |
| 3D Scanning | 3D Scanner: NextEngine 3D Scanner<br>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

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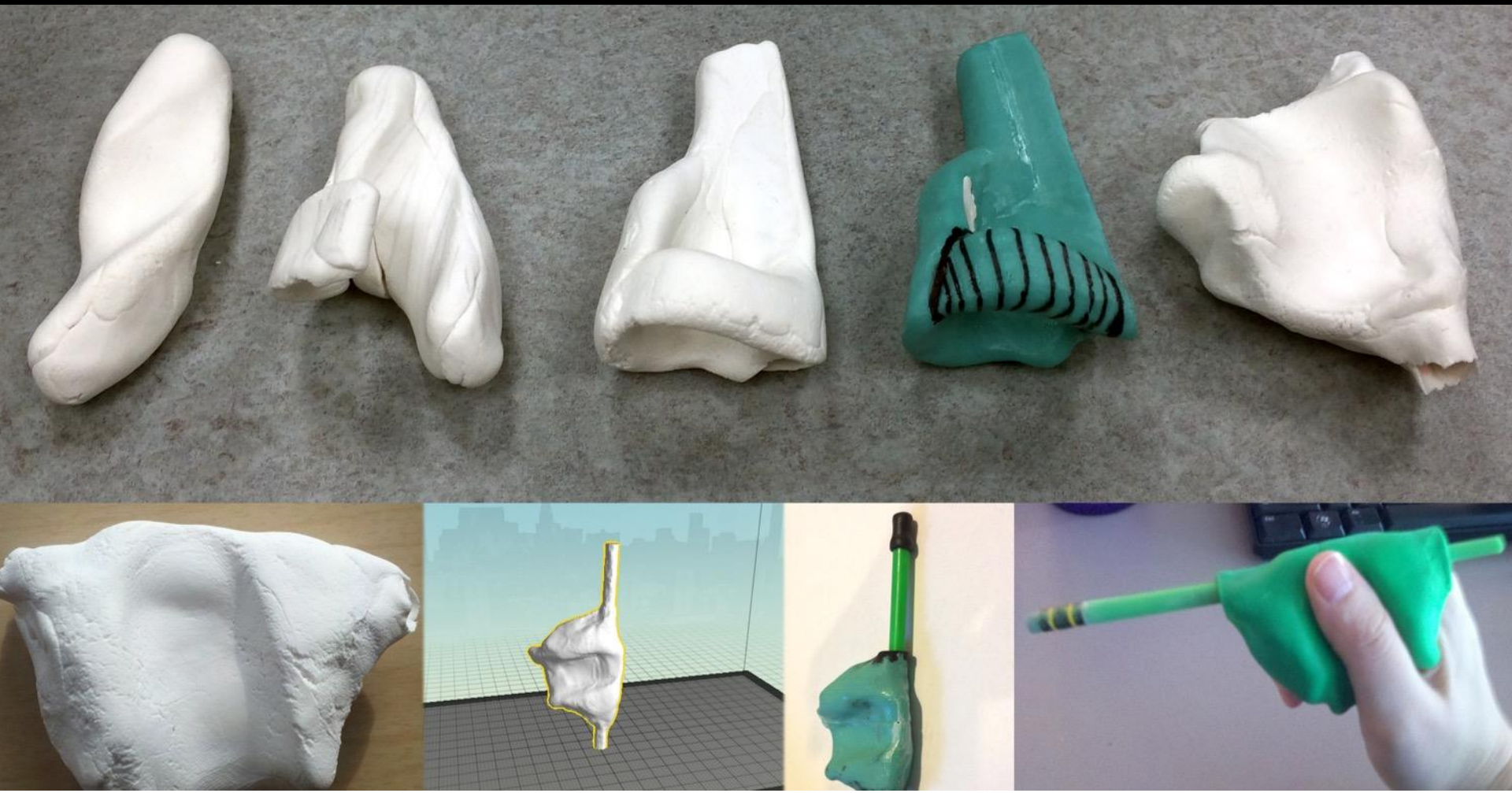
# Time is Most Expensive Resource



[ASSETS 2014, TACCESS 2015, ASSETS 2016]

# Design with Familiar Tools

[ASSETS 2016]

# Anticipate a Steep Learning Curve

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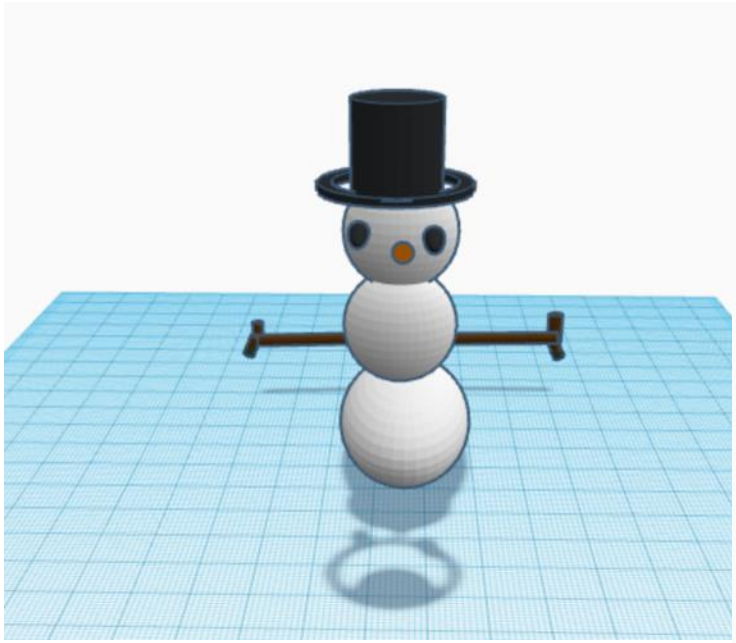
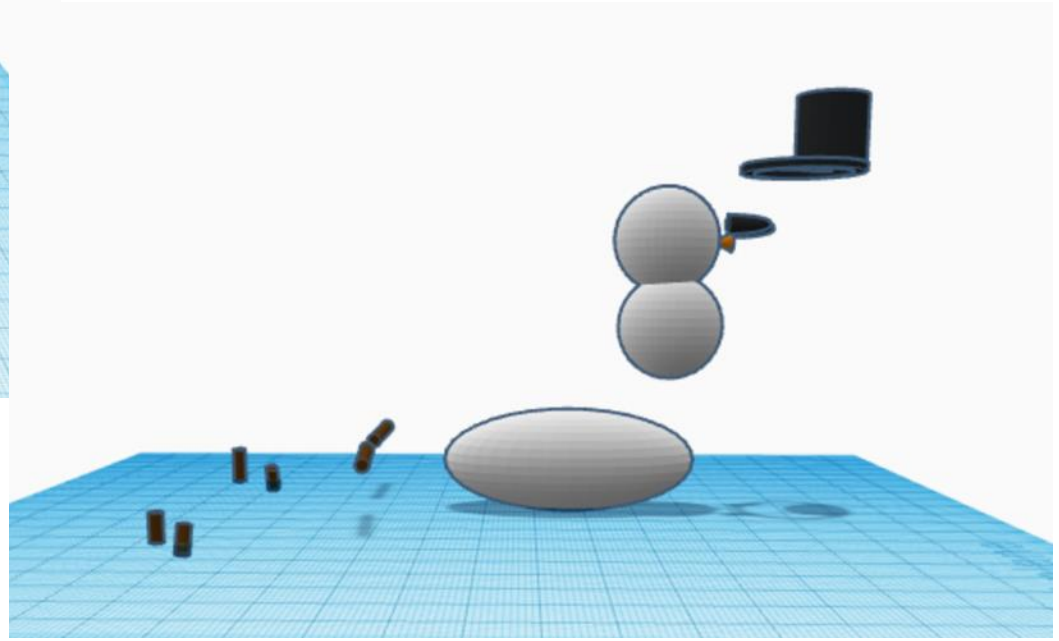
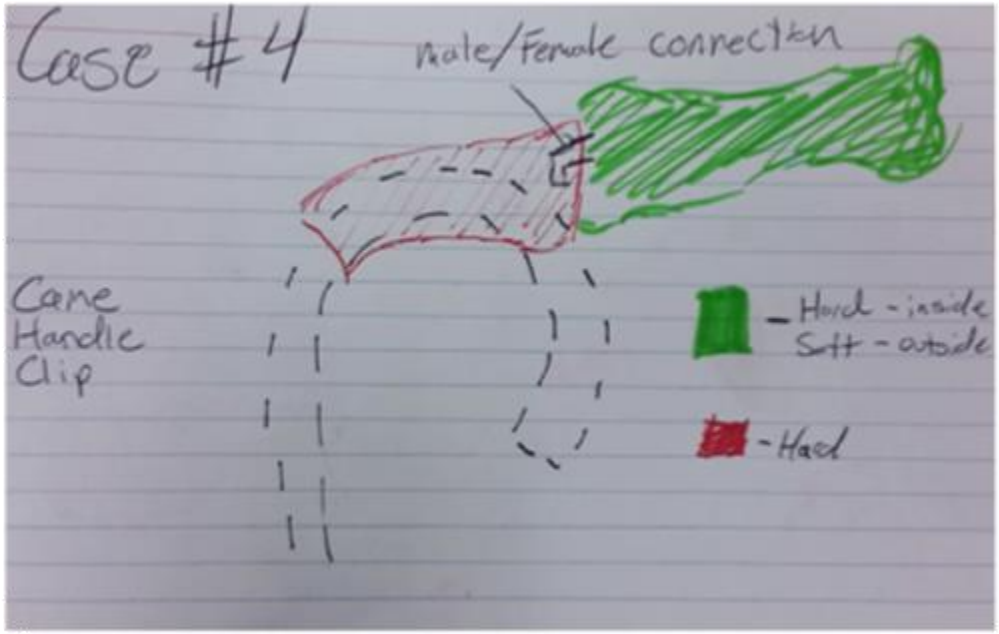


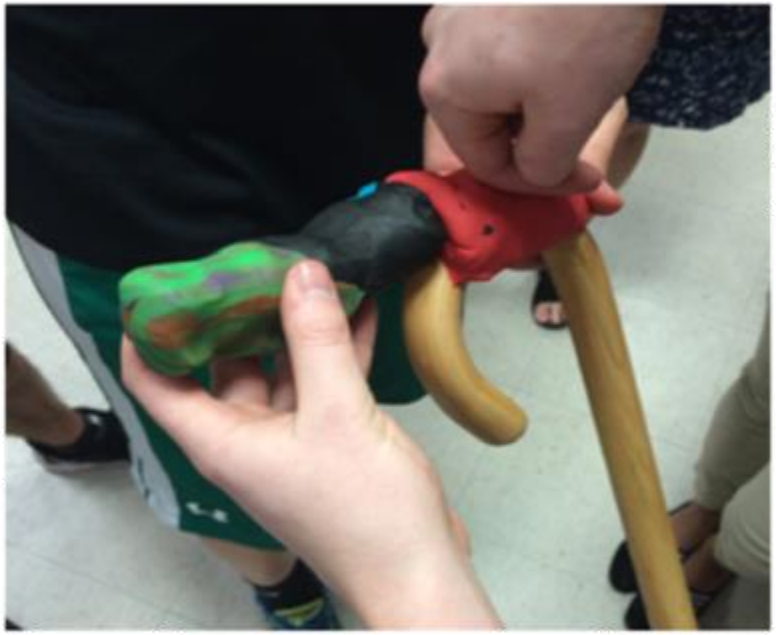


[ASSETS 2016]

# 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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