

PROCESS BOOK

Capstone Project
Karam Ramadan



Battelle Design Brief

Battelle

Battelle Biomedical Engineering team are developing a new wearable technology (taking the form of a sleeve) supporting people who lost arm functionality following a stroke. While the technology is proving efficient there is still a long way to go for this product to be made available on the market. Several design specific issues, pertaining to implementation, remain to be addressed. In this project students will be challenged to provide insights into ways to help bridge the gap from the lab to daily life of stroke recovering patient.

Keyword: Biomedical Design, Wearable, R&D, UX, Implementation

Initial Research Plan

GOALS

- Extensive Research of patients, Tech, solutions
- Understand partner's goals
- Define a problem
- Design Brief

METHODS

- Site Visit
- Interviews with stroke survivors, caretakers, Physicians, etc.
- Ethnography/Observation
- Independent Research

Research

Primary

- Meetings with the Battelle team
- Battelle visit
- Zoom meeting with OT Annie
- Survey

Secondary

Newspaper exploring the following categories:

- Focus
- Science & Tech
- Business
- Art

First meeting with Battelle

When the Battelle NeuroLife sleeve is on it continuously measures muscle activity and when a movement intention is detected the electrodes deliver functional electrical stimulation to muscles across the area, which is believed to improve a variety of hand movements

The goal is to

- daily independence to be attainable
- help the patients stay home instead of nursing houses and rely on themselves as much as possible
- Encourage patients to do the therapy at home by reinforcing them with the right tools
- Help patients feel achieved
- Improve the patients' recovery

Things to consider:
(challenges) Transition from clinic to home

- How it can be used in a home settings
- How to put the sleeve on without the help of a caregiver with the correct alignment of the electrodes
- Comfort
- Cleanliness
- The different sizes of sleeves
- IS a sleeve the right package for this technology or not?

Meeting with OT Grad Student Annie Stankivicz

Insurance stop you when patients reach the time limit and they send them home. 20 years ago the average of stay used to be 30 days, now it's 10 days.

Due to insurance some people are unable to get good and long care. Medical professionals have to work around insurance since it dictates what you can and can't do

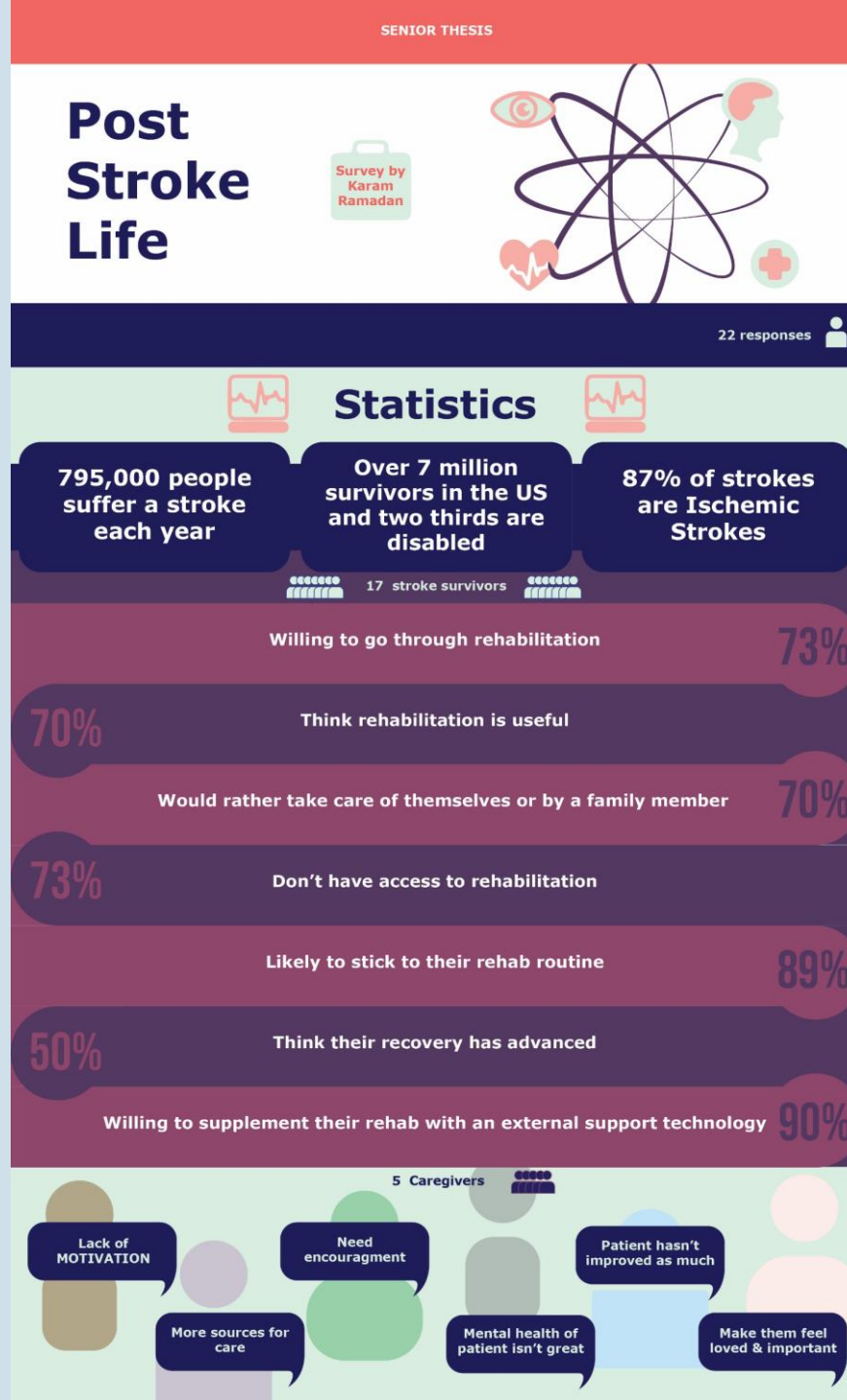
Most people are willing to use new technologies if we say it will help you. Especially post injury they are always willing to try new stuff if it helps

Survey

Patient & Caregiver

1. How old were you when you had a stroke?
 2. Are you in any rehabilitation program? if yes name the program
 3. Are you willing to go through rehabilitation? and WHY?
 4. How do you feel about rehabilitation?
 5. Who would you rather have taken care of you?
 1. family member
 2. caretaker/physician
 3. yourself
 4. other
 6. How accessible rehabilitation is for you? (scale)
 7. Are you willing to supplement your rehabilitation with an external support device/technology?
 8. What kind of rehabilitation have you been receiving?
 - inpatient rehabilitation
 - outpatient units
 - skilled nursing facilities
 - Home-based rehabilitation programs
1. How likely are you to stick to your home-based rehabilitation routine?
 2. How long have you been doing rehabilitation?
 3. How often do you go to a rehabilitation facility?
 4. On a scale of 1 to 10 how much do you think your recovery has advanced? (scale)
1. What is your relation to the patient?
 2. What would you say the main problem you encounter when dealing with the patient?
 3. How do you deal with the patient you're taking care of when they don't cooperate?
 4. How much do you think the patient you're taking of has improved since you started?
 5. How do you encourage people to keep up with rehabilitation?
 6. How would you describe the mental health of the patient?
 7. It's a huge burden on you to take care of a stroke survivor patient, we understand how difficult it is, so if you have any suggestions to help you (caregivers) please write it down below.

Infographic



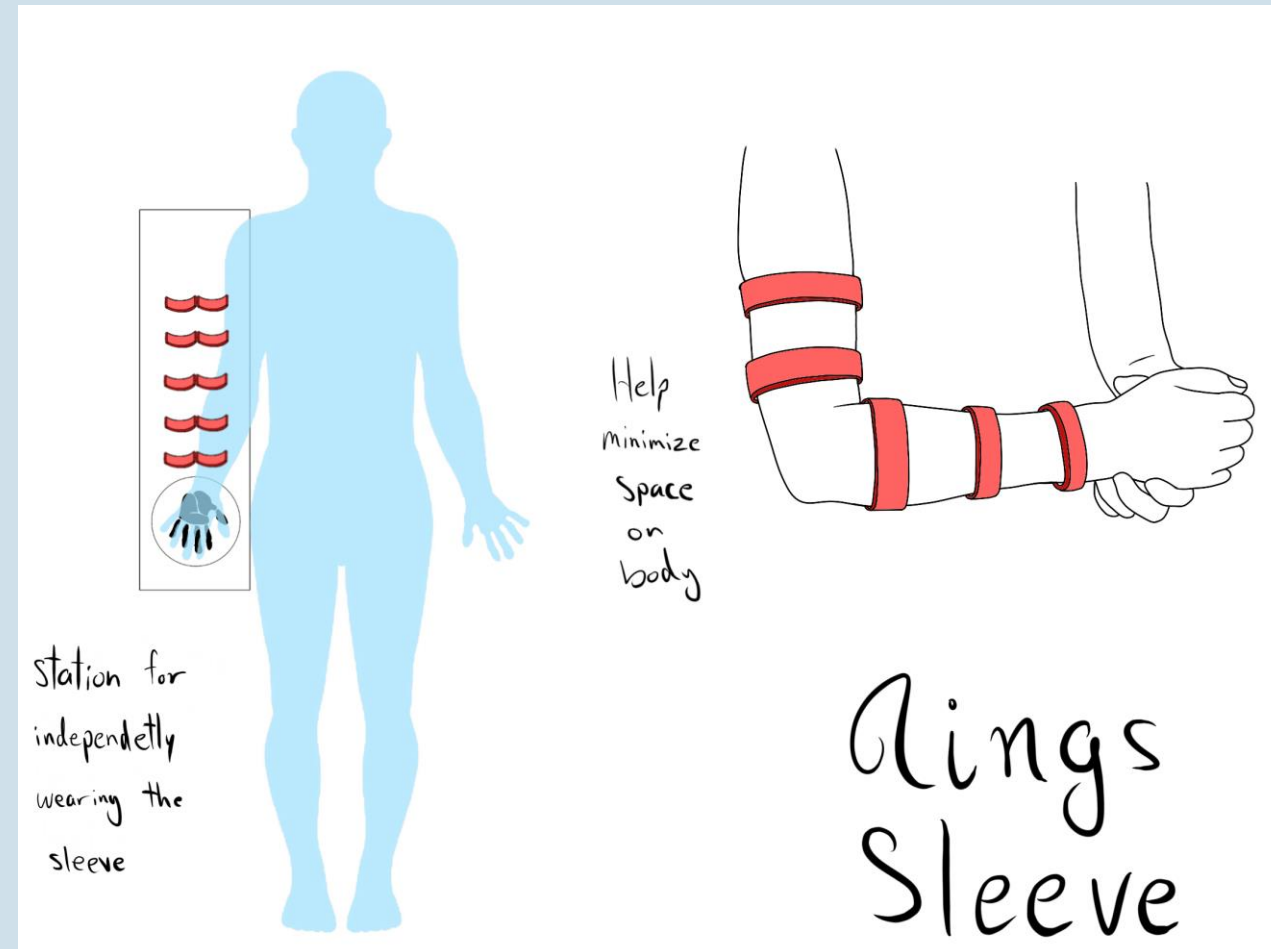
Newspaper

Science & Tech

Outcomes:

- Home-based technologies offers equivalent rehabilitation quality as conventional therapy
- Wearable technology can allow flexibility of use during the daily routine of patients
- Smart clothing can be very beneficial in monitoring the patients' heart rate, blood pressure, oxygen, etc. to avoid future diseases and look out for symptoms

Conjecture



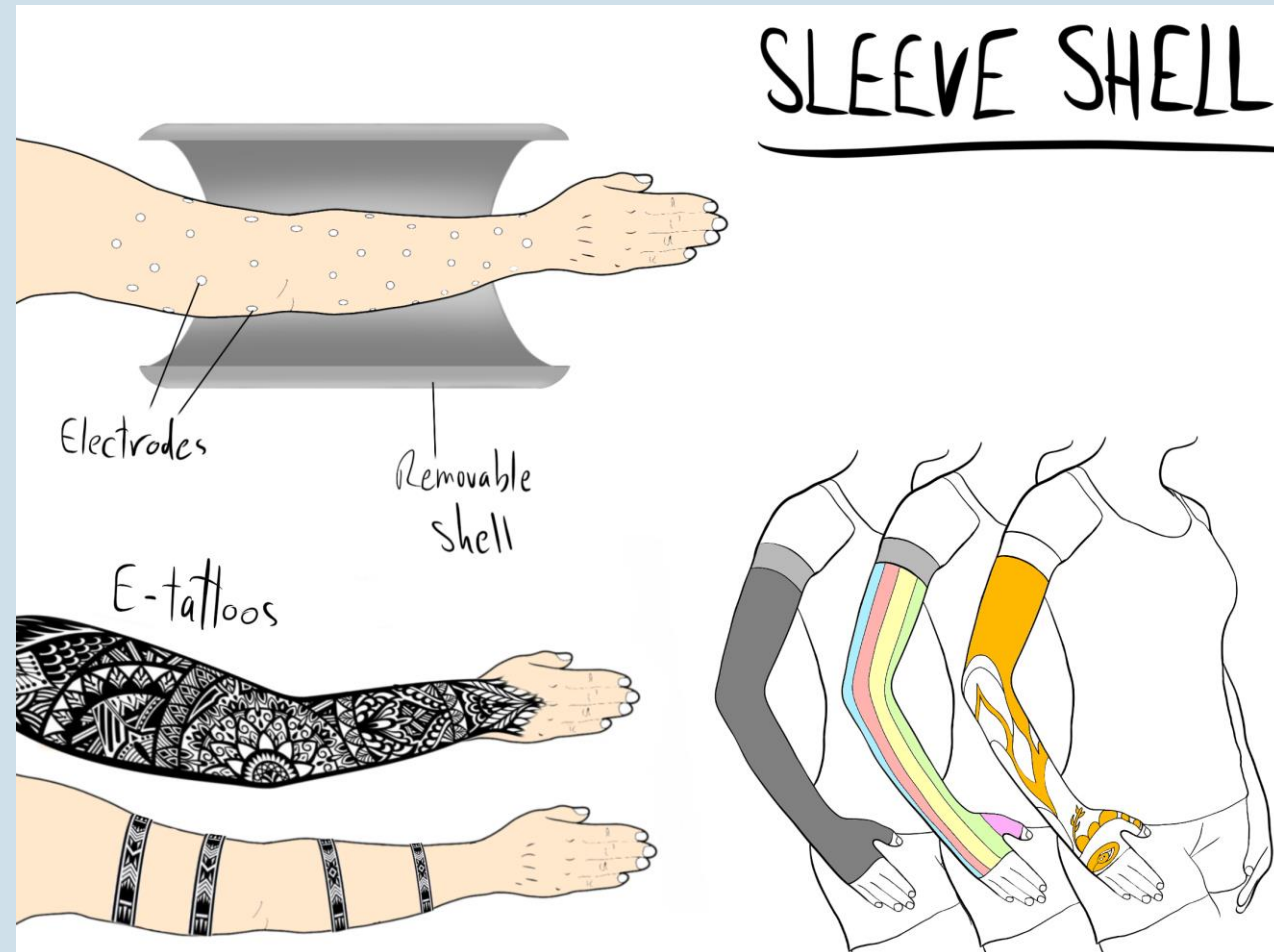
Newspaper

Art

Outcomes:

- Art therapy can improve communication, concentration, and help reduce feelings of isolation. It also increase self-esteem, confidence, and self-awareness.
- E tattoos are a promising medical monitoring way for patients to feel less invasive and the need to change their looks. it's a customized, flexible, and easy to use method to help monitor patients.

Conjecture



Newspaper

Business

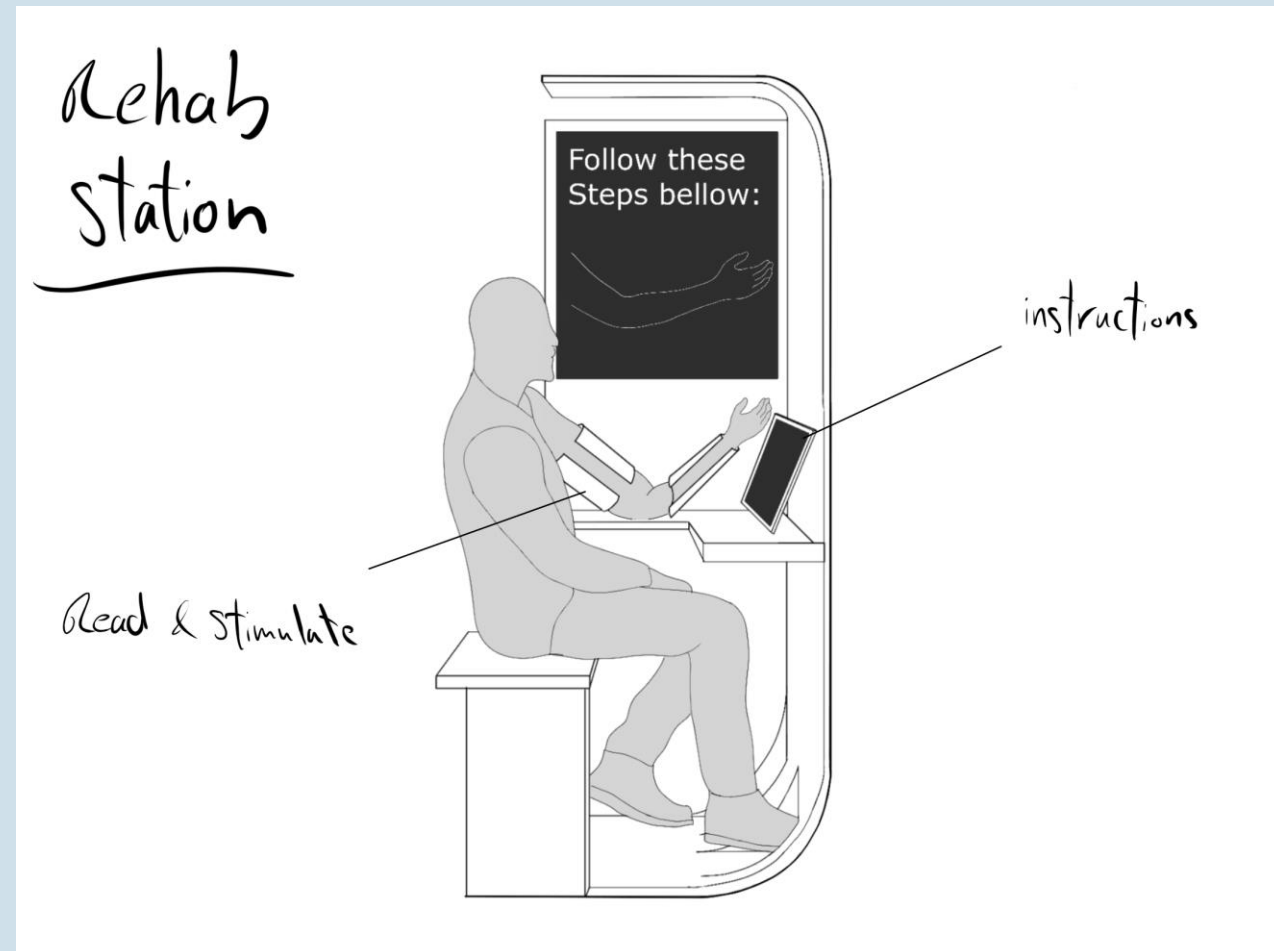
Outcomes:

- There is a huge lack of awareness about medical treatments in our society which causes patients to rely less on home-based therapy.
- The change in patients' life post-stroke push them to change the way their home environment is set. Which is some of the furniture companies are trying to design pieces specifically for people with disabilities

Focus conjecture is a combination of all (can be viewed in the newspaper here:

<https://desis.osu.edu/seniorthesis/index.php/karam-ramadan-battelle/>

Conjecture



End of Research Phase

GOALS

- Make the rehabilitation process more accessible and affordable
 - Bringing rehabilitation to the patients
- Improve the quality of life
 - Considering the mental health of patients
- Support the recovery of patients' arm impairment
 - Improving patients' arm functionality to achieve daily independence

Strategies

- Relying on home-based rehabilitation- Reduce hospitalization and treatment costs.
- Providing the best suitable devices for patients' recovery
- Designing a medical device to help recover arm impairments
- Find ways to make the rehabilitation activities routine easier- Integrate social and mental aspects into the project.

Summary

- This project aims for the improvement of patients' long-term recovery to independently be able to go through daily routine activities. While considering the mental health and social life of stroke survivors which will make them feel more motivated to do rehabilitation activities and bring the community together.

Outcomes that led to design concept

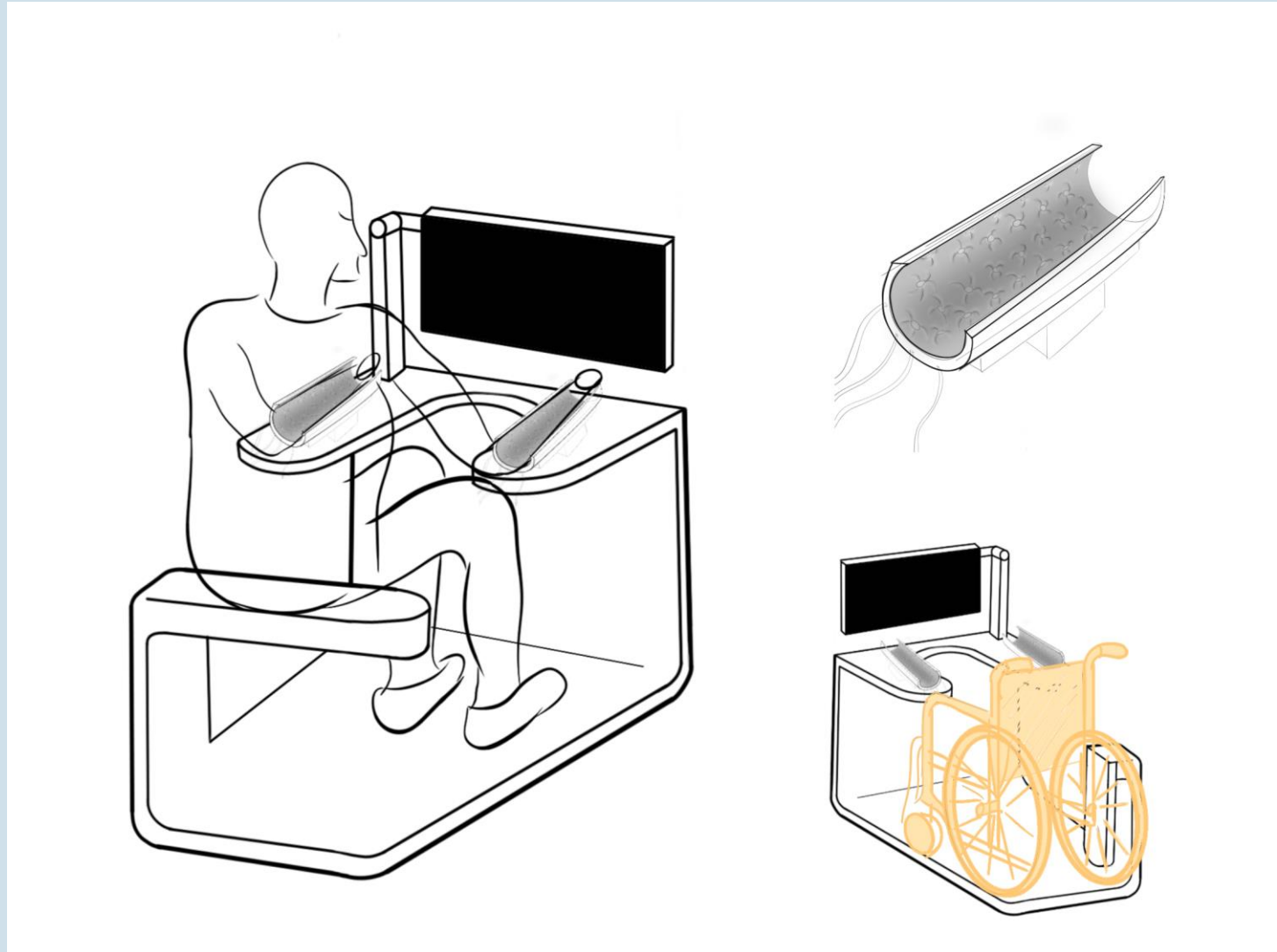
Building on the business conjecture exploration:

- People who can't practice at home
- Brings the community together
- Motivate people to do rehab
- Therapy hospitals might not have the staff
- Provide access to rehab in a less intimidating environment & more accessible
- When rehab is more personal and customized it can help with neuroplasticity of the patients' brains which can improve recovery

Design Concept

Rehab Booth

An accessible rehabilitation device for stroke survivors to practice their rehab activities in a way that's more affordable and brings the community together.



Layout

Things to consider

Right & Left Arm

Moving arm sleeve

One fixed centered sleeve - moveable seating

One for right arm one for left arm

How would patients place their arm in the sleeve section, considering the early stages of arm placement

Accessibility

What if the patient can't move both arms?

Navigating through voice?

Buttons around the feet area?

System automatically walk through the process?

What if the patient wants privacy? (photo booth) does that contradict with bringing the community together?

The software is the medical device?

DONE

Completing rehab activities gives patients points/rewards for the store the booth is placed in

System operated by occupational therapists / download and update patients' data

MAYBES

Design a system

include an avatar in the system that can be customized to guide through the rehab exercises

Connect it to other health care spaces inside the store

TO DO LIST

Touchable PDF

Talk to an OT about the system ask about the process / pain point / comfort / etc.

Consider the thumb area on the sleeve

Cleaning after usage

Shrink wrap

Evaluative Research

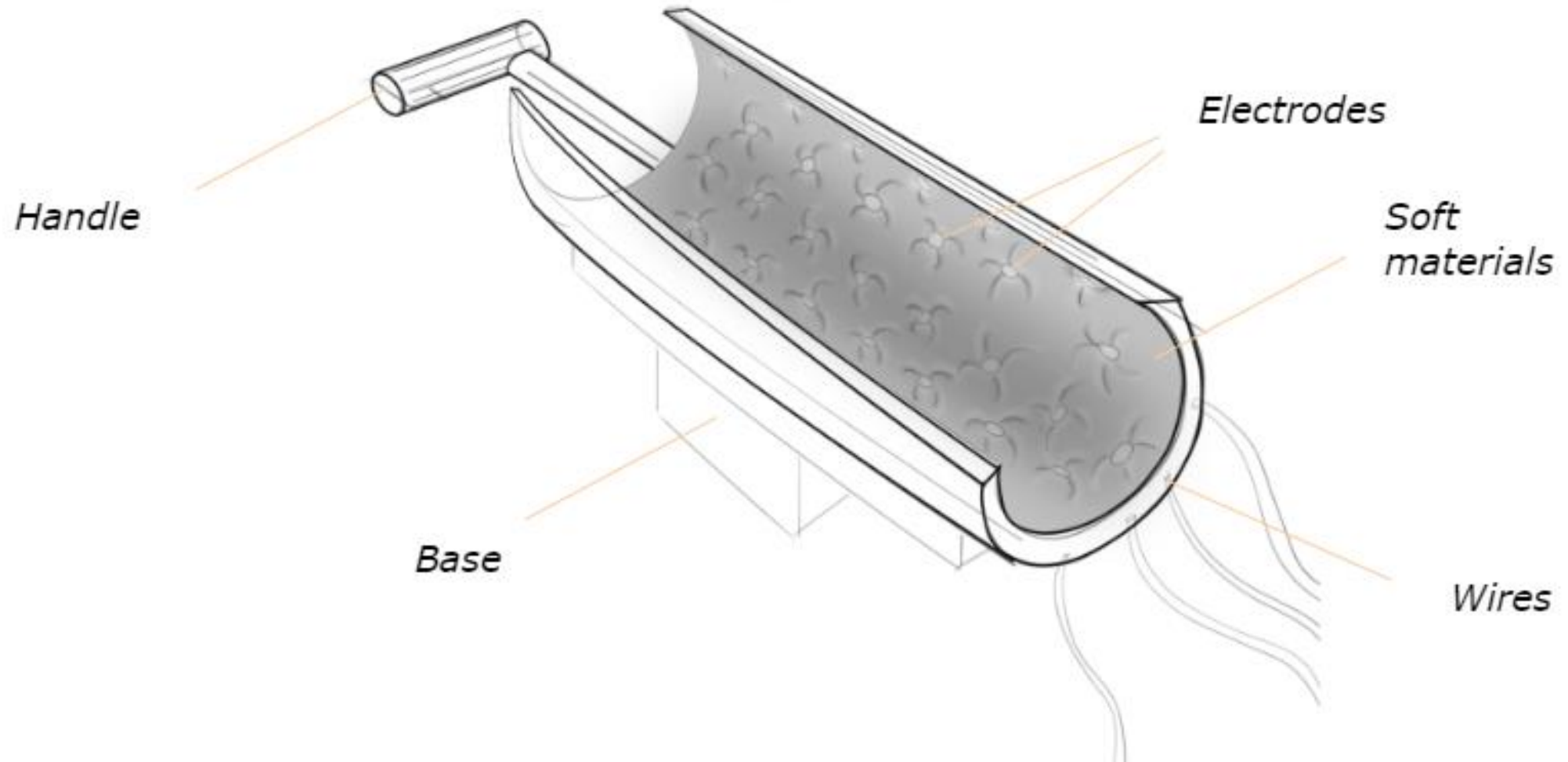
Sleeve Section (Technical):

I wanted to know if it's possible for the sleeve to work for all patients when it comes to size (how it can fit the different forearms sizes). Also how to give patients the movement required to achieve the goal of rehab activity.

It is possible to make an inflatable sleeve that fits all sizes:

- Electrodes can get as close as possible but shouldn't touch
- Electrodes can be shut off when not touching the skin
- Electrodes have a specific direction (which means there might be a need for right/left sleeve)

Initial sleeve concept



Evaluative Research

Privacy (Attitudinal experience):

I wanted to know if patients would like to have the option of privacy while practicing the rehab activities, or if this being a public device that gives the opportunity to bring the community together makes privacy gets in the way of that or not.

After looking back at the research and talking to an OT during the Battelle meeting i came to the conclusion that it's better not to include the option of FULL privacy to keep the following goals:

Social aspect

Bring the community together

Evaluative Research

Accessibility (Ethical):

I want to make this booth accessible for patients who might have lost motor movement of the bottom half of their body.

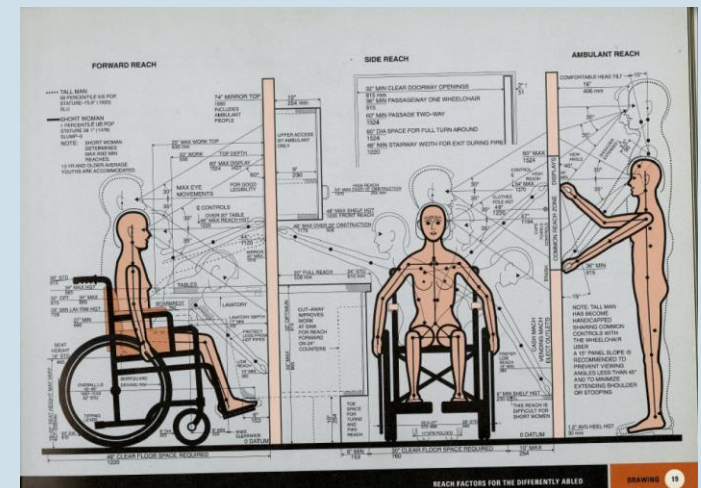
Book “The Measurement of man and women” by Henry Dreyfuss. The book has information about the range of movement of a wheelchair and the right height a table should be.

34" inches height

20" full reach

46" max over 20" obstruction

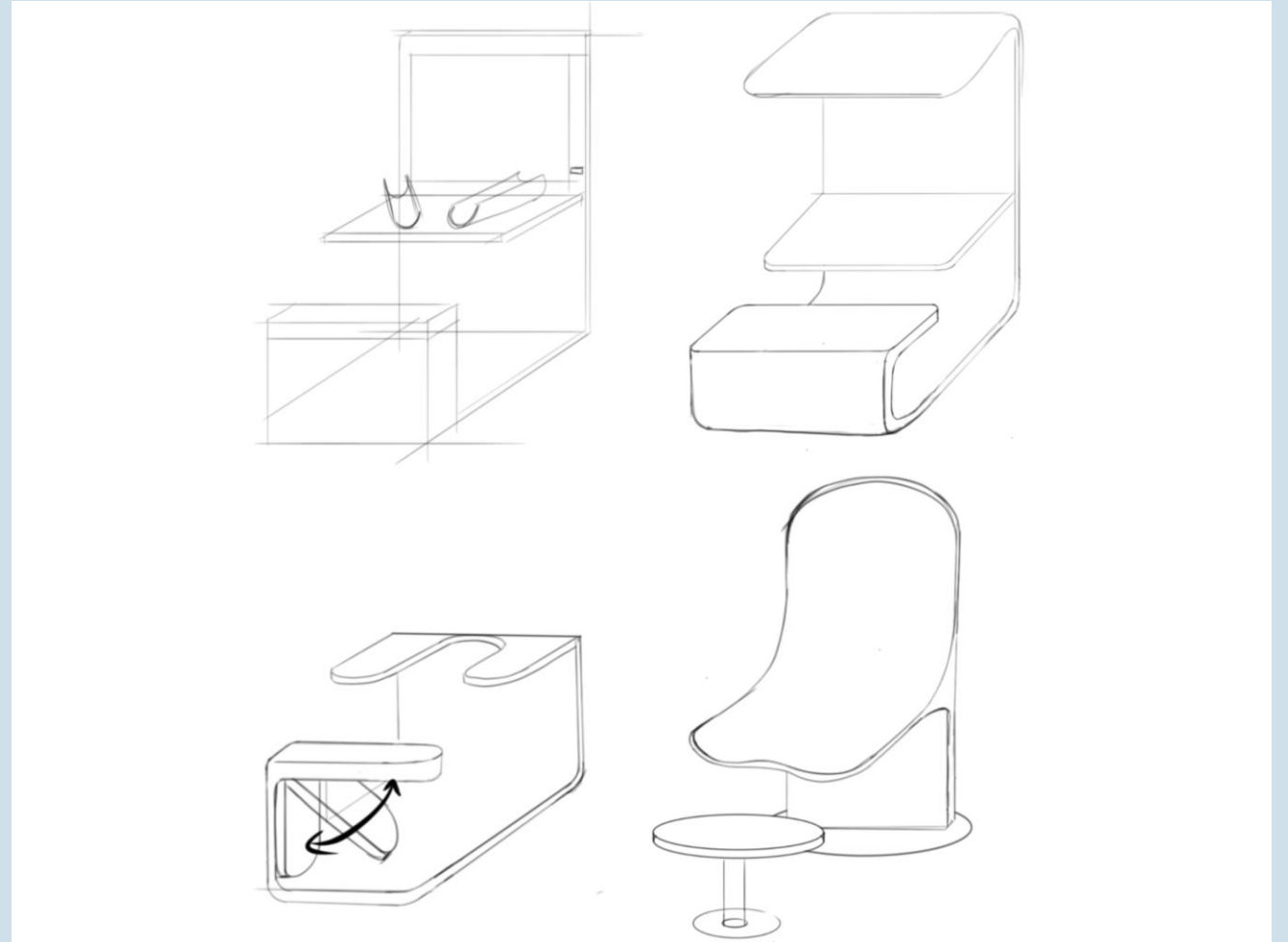
60" max display



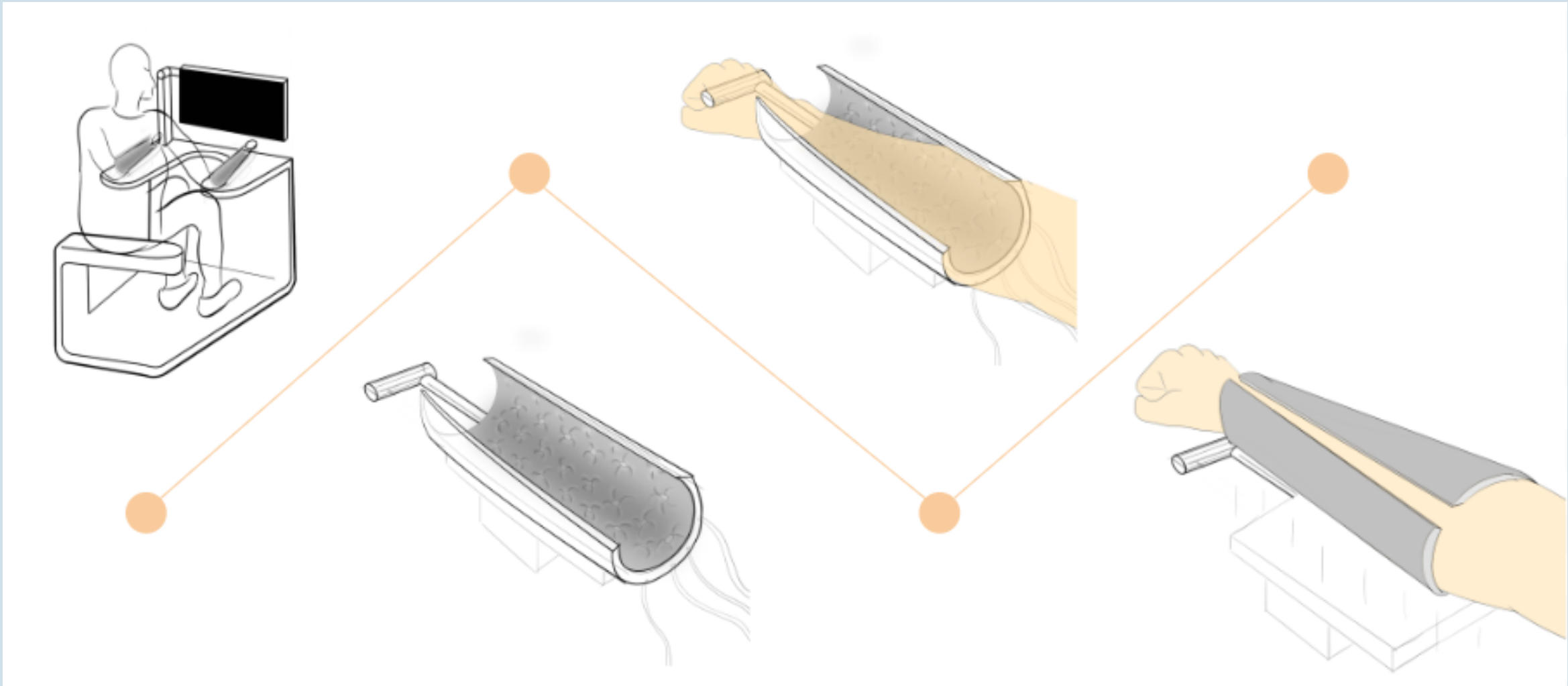
Initial Booth exploration

Booth includes:

- Seat
- Touch Screen
- Sleeve area
- one or dual sleeve
- QR code scanner



User Scenario



Updated Design Brief

A medical system that brings the community of stroke survivors together by providing them with the opportunity to independently practice rehabilitation with an accessible and affordable way using the technology developed by the Battelle Team.

Meeting with Battelle Engineering Team & Occupational Therapist

Sleeve Mechanics

Bar to help align the arm

Mirror arms

Start with the smallest arm and then go for the bigger forearm

Measuring Performance and arm size while they go through the activity

Goal is 15 mins for setup, therapy around 45 mins, total of an hour

First session will take longer for calibrating

(calibrating will be done once in the clinic prior starting therapy / one time only)

Electrodes tech

- We can get electrodes as close as possible but not touching
- 12mm wide for disk
- 20-25mm apart (stick to that range)
- you can turn off certain columns of electrodes
- Keep the same direction of electrodes (according to muscles)

System & Usage

- Consider palm down position
- Sensor can sense where the hand is placed in space
- You can reuse calibration patterns for something called historical data
- An electrode check can be done to make sure the sleeve is working

Aesthetics Board for Booth



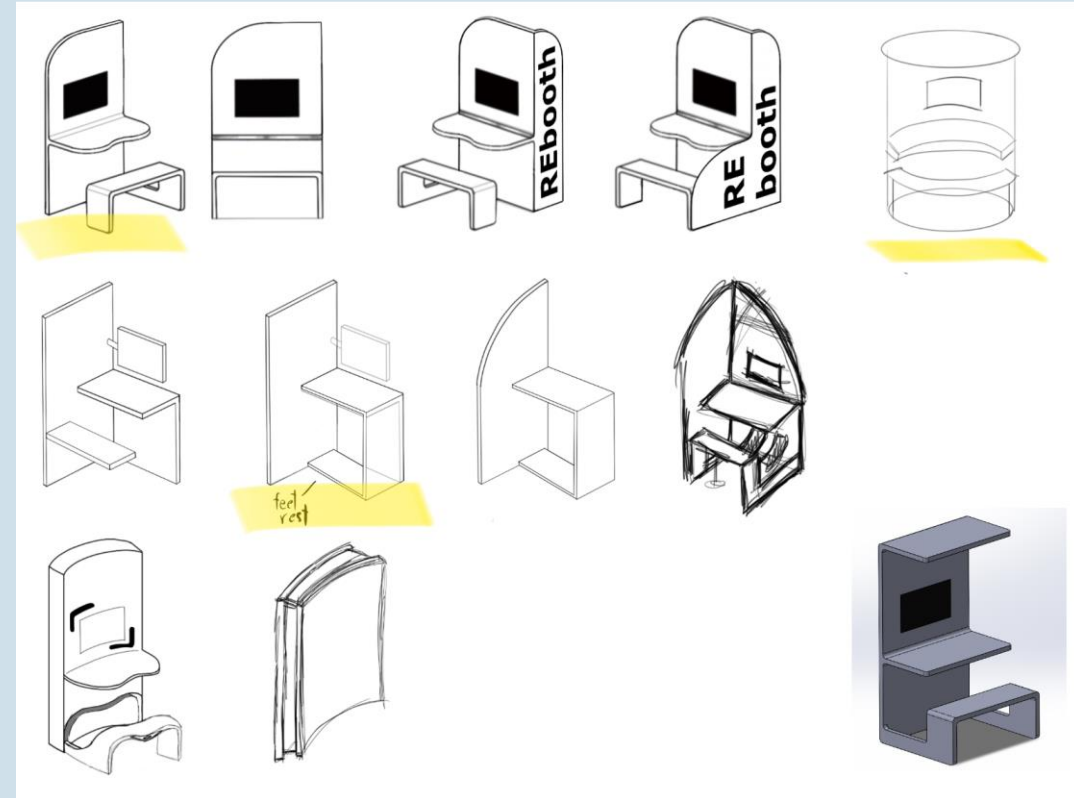
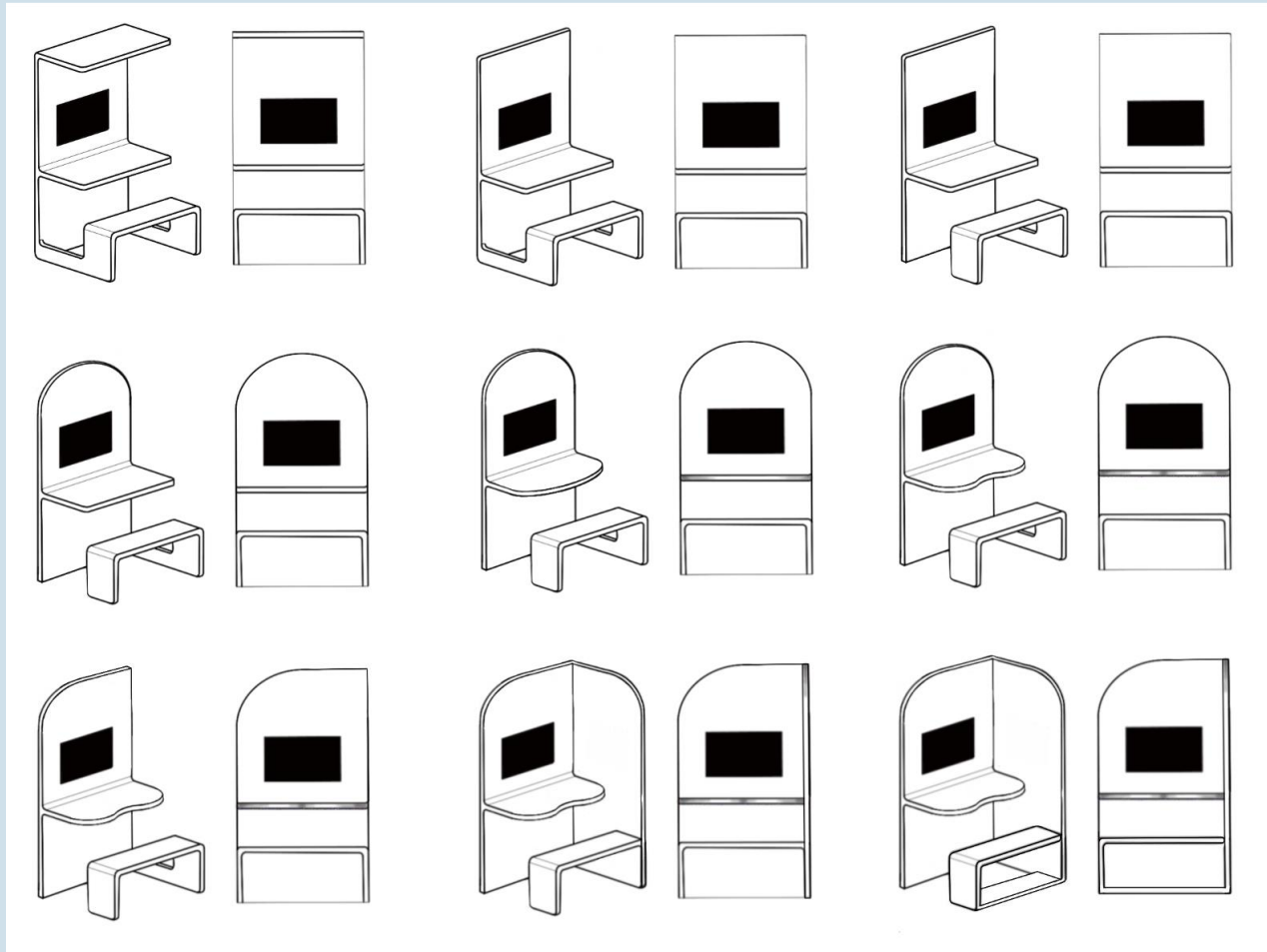
Non-medical



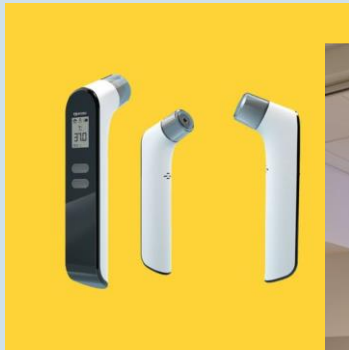
Aesthetics Goals

- Aesthetics:
- Welcoming
 - balance between curves and straight lines
 - Light (not bulky)
 - Transparency or negative space
- Framing around the navigation
 - Screen
 - Sleeve
 - Seat
 - Foot area
- Material overlapping
- Brings the community together but somehow gives a feeling of privacy

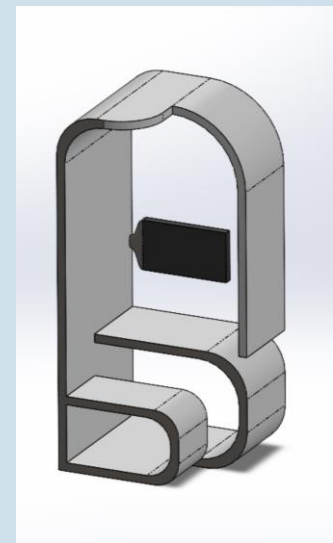
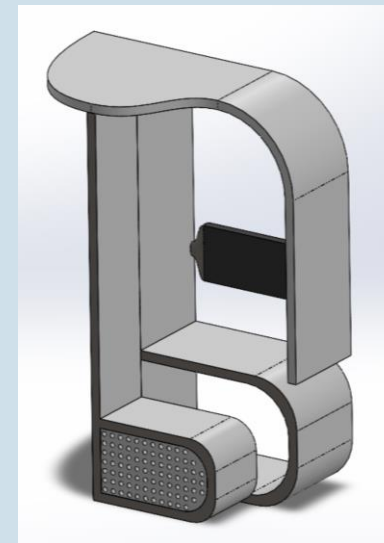
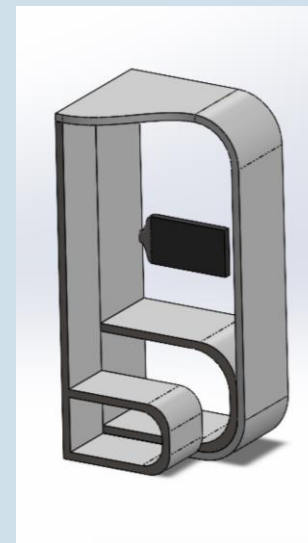
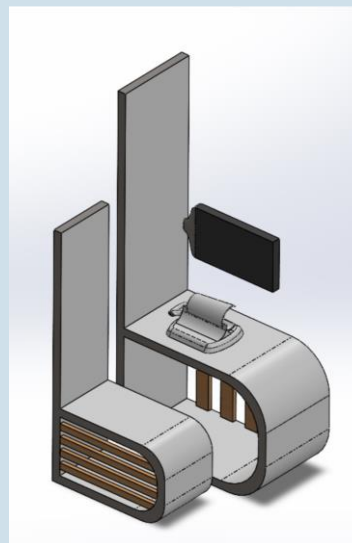
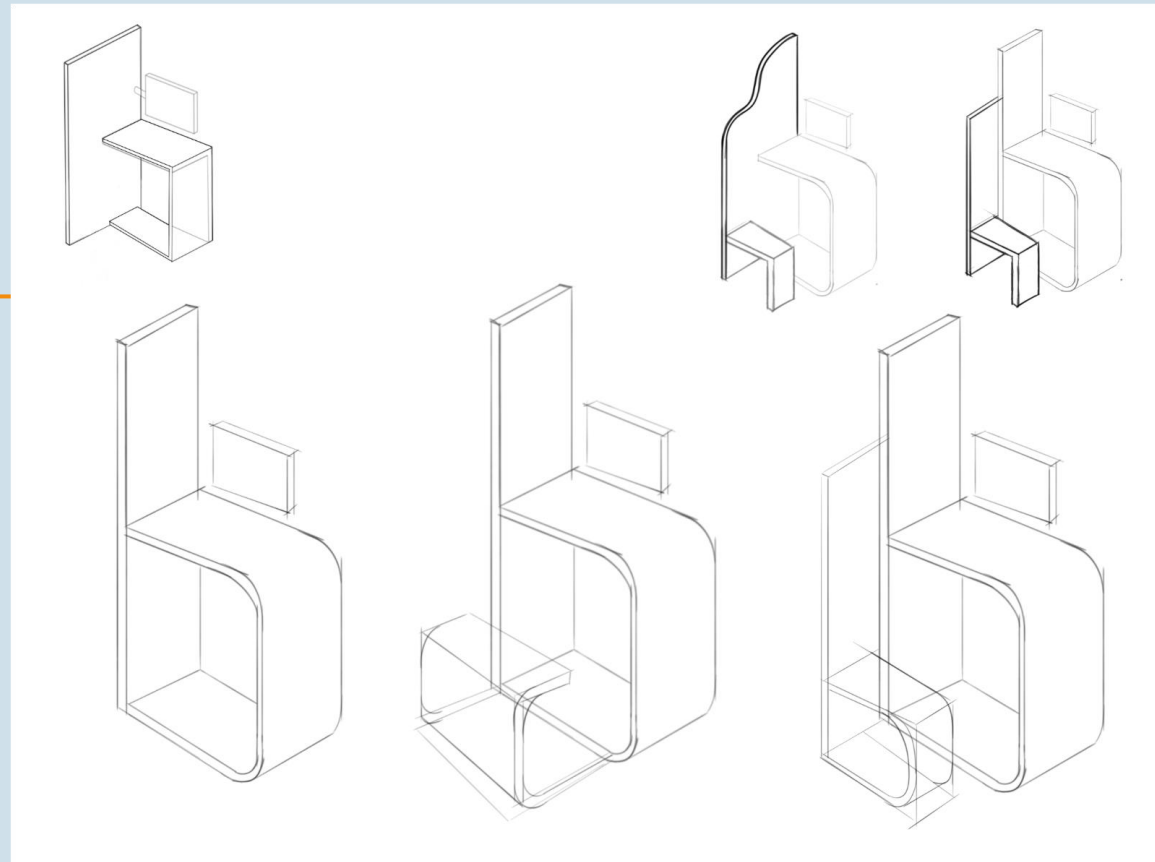
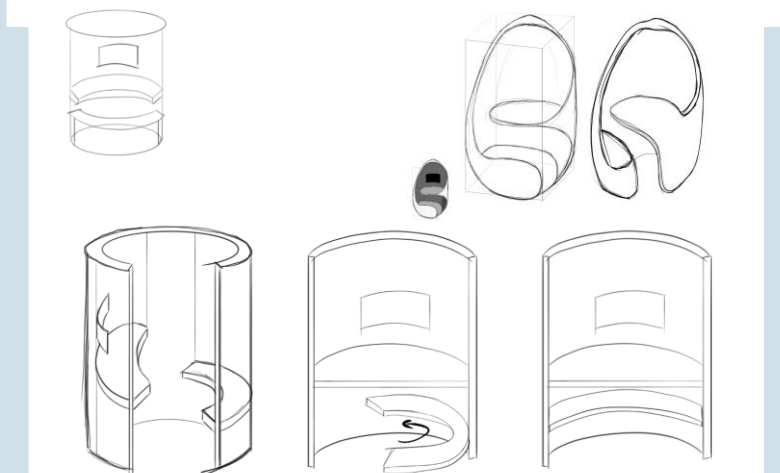
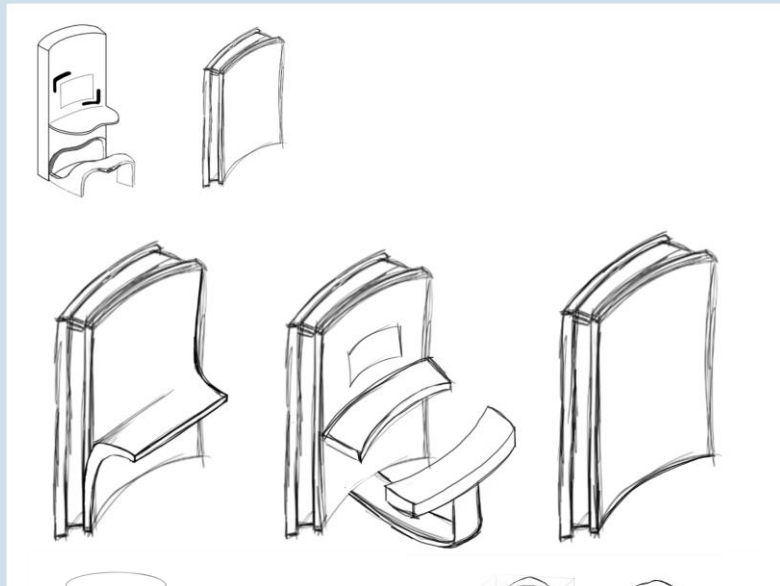
Booth Iterations



Shapes inspirations



Further Iterations

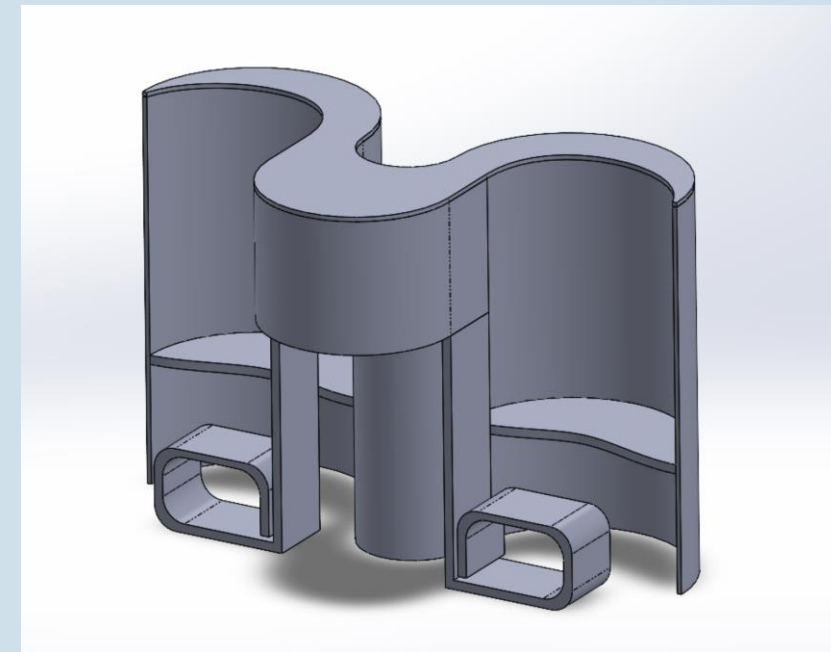
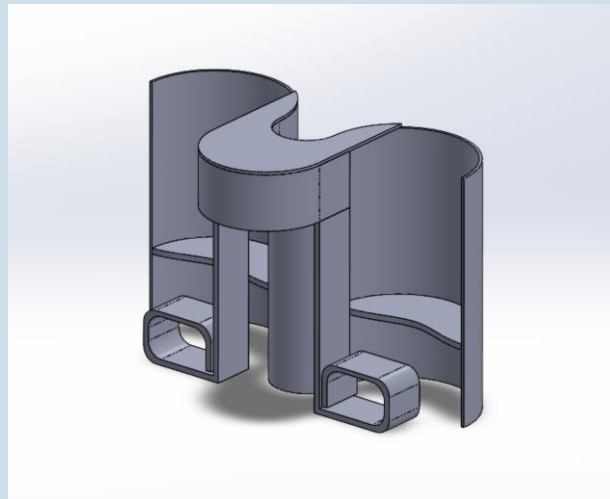
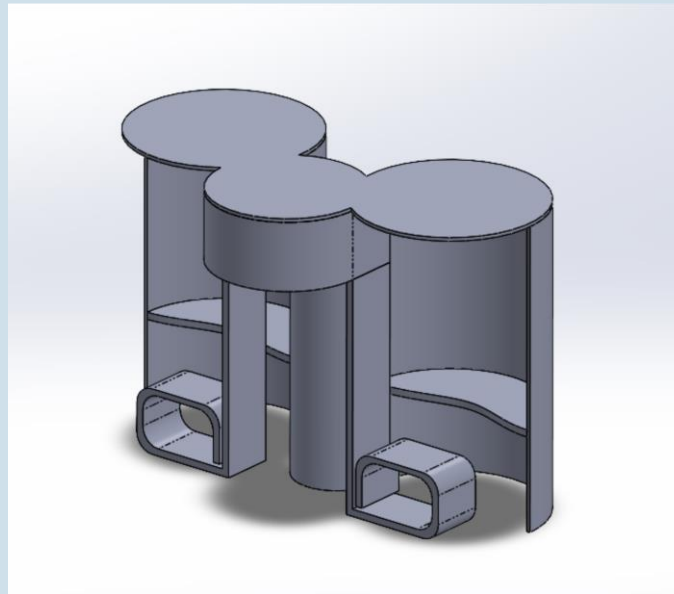
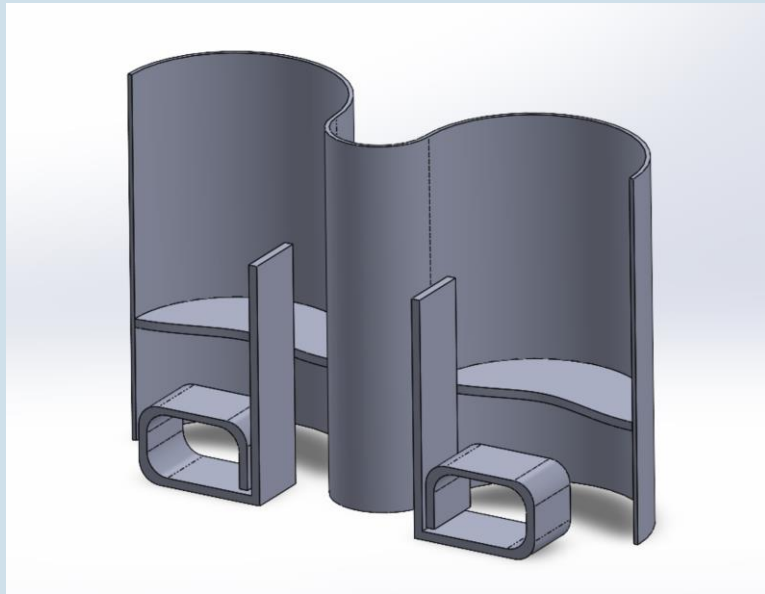


Booth inspiration in space

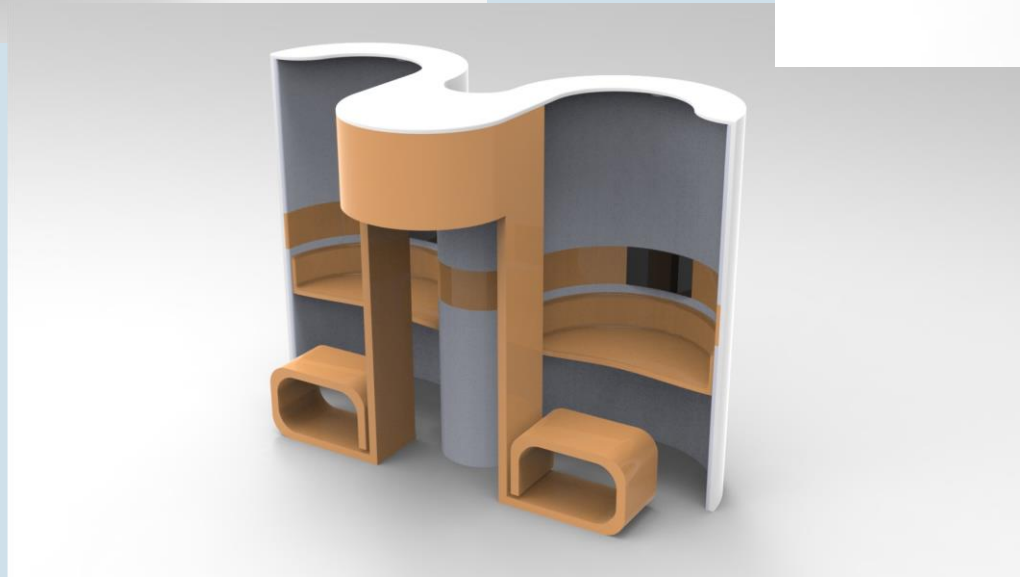
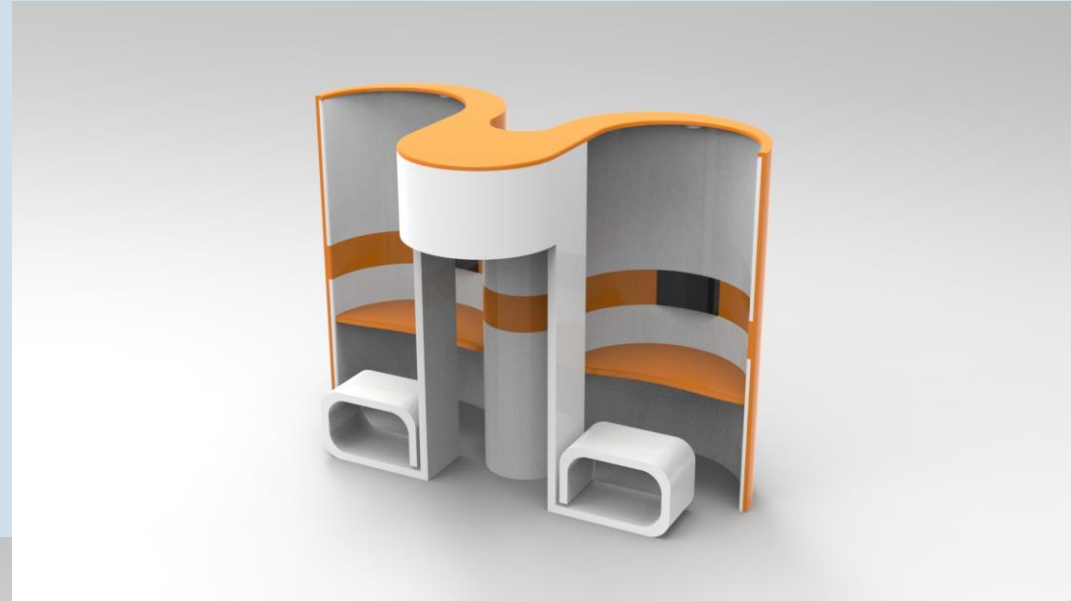
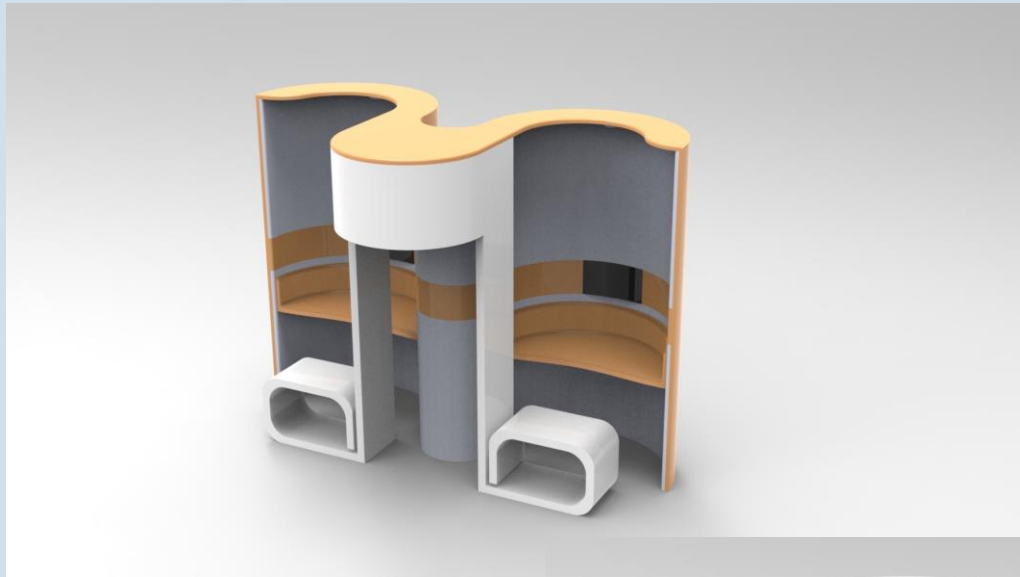


Dual-Booth

To emphasize social interactions



Finalizing shape & color



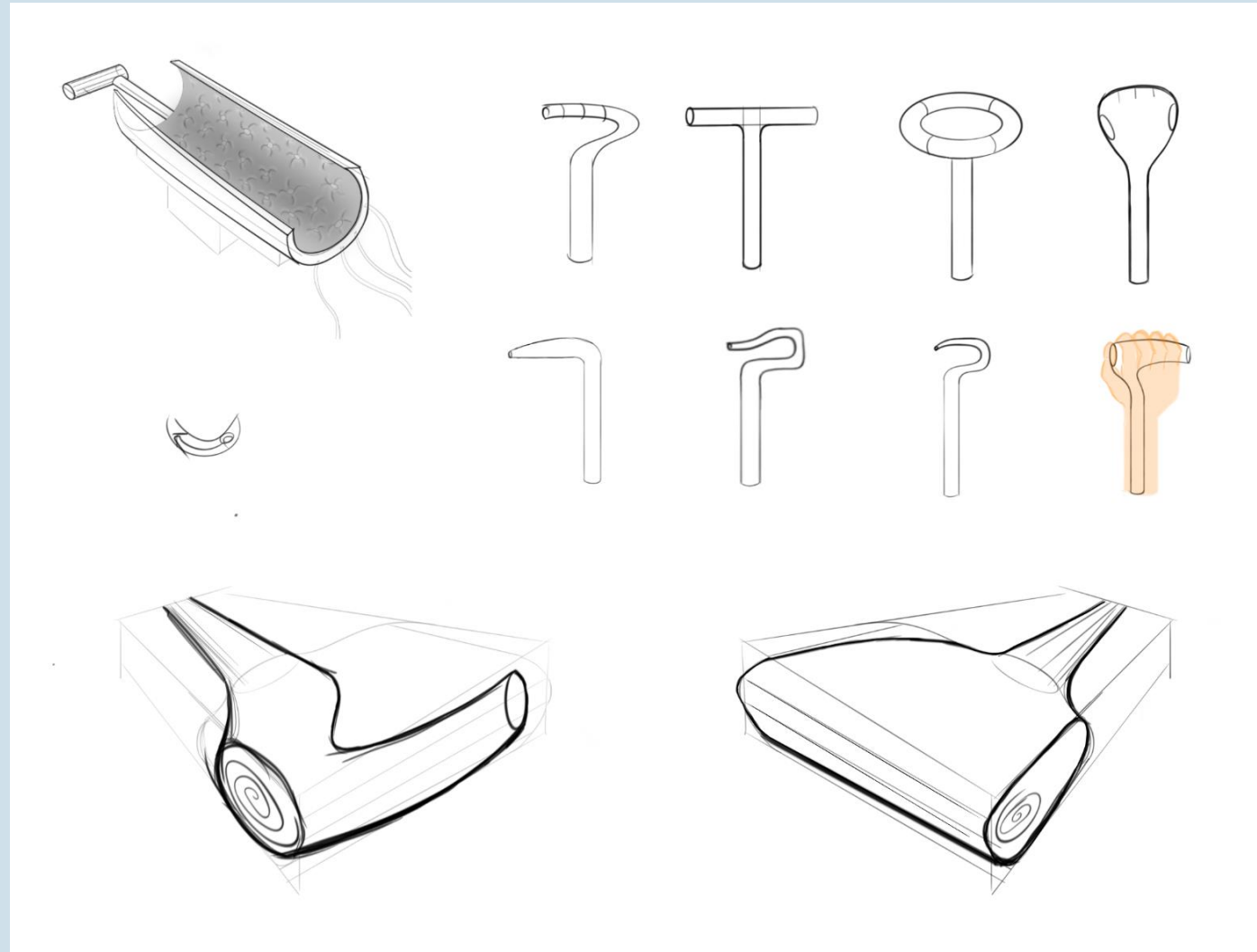
Aesthetics Board Handle



Handle Iterations

Handle shape goals

- Easy to slide
- Accommodate grip of stroke patients
- Doesn't require opening or all fingers to slide



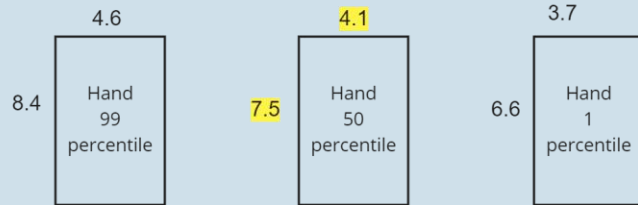
Handle dimensions

Forearm:

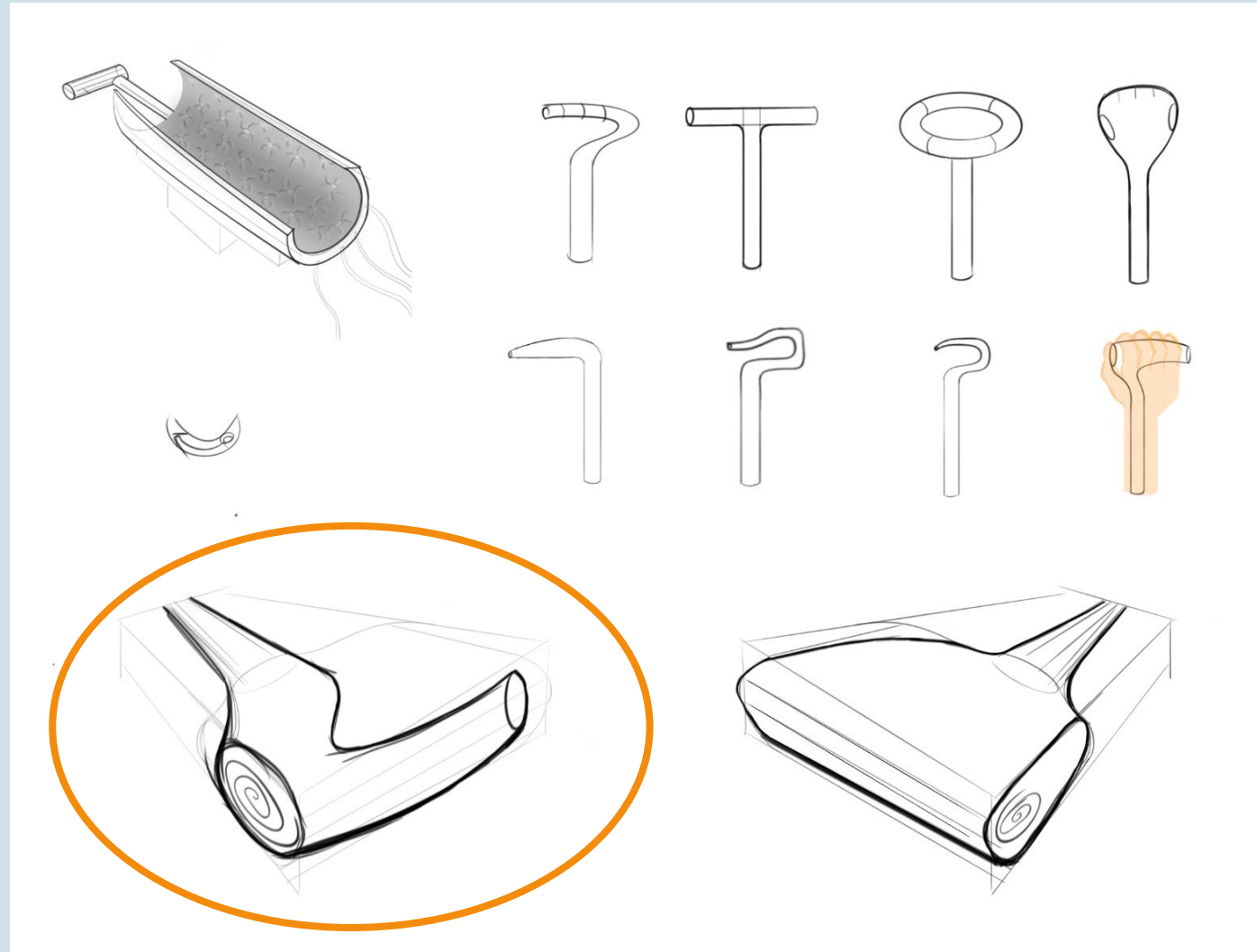
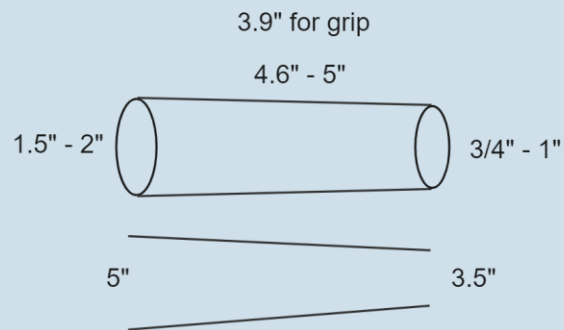
- length:
 - smallest 9.2"
 - average 10.1"
 - Longest 10.11"
- Width
 - narrowest 3.7"
 - average 4.1"
 - Widest 4.7"

Distance to palm

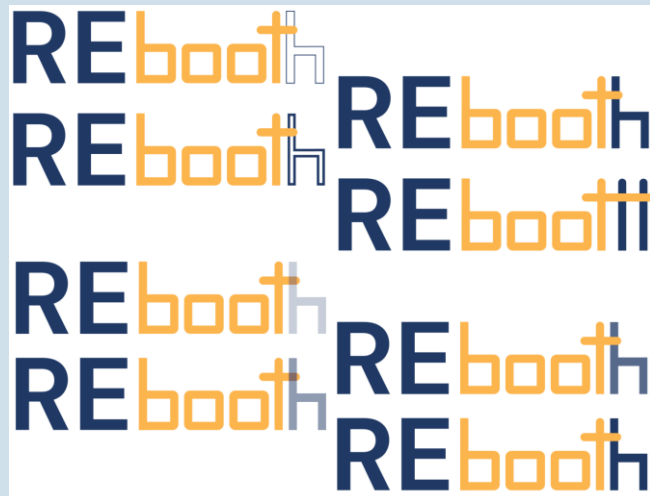
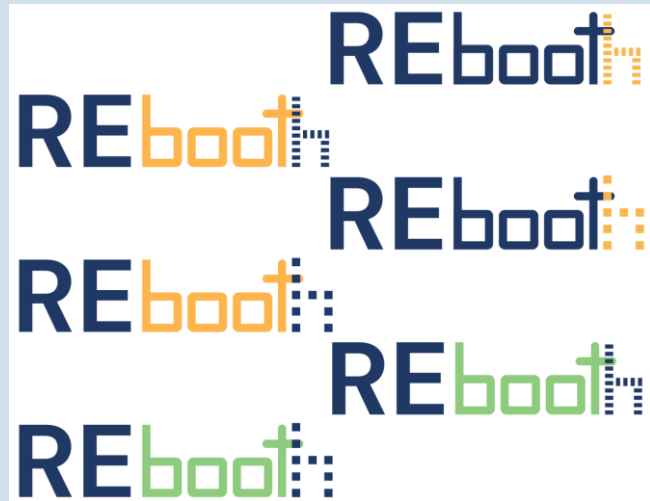
- 2.7"
- 3"
- 3.3"



3.2 widest wrist



Logo iterations



Scale model



Capstone project

Karam Ramadan







Reboot is a medical system that aims for the improvement of stroke survivors' long-term recovery by providing them with the opportunity to independently practice rehabilitation. In the form of a rehabilitation booth that supports patients who lost arm functionality by accommodating their needs outside the clinic and home environments.

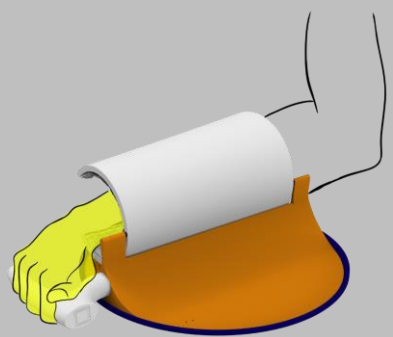
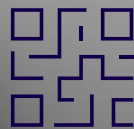
Location

- Local pharmacies
- Grocery stores
- Local clinics

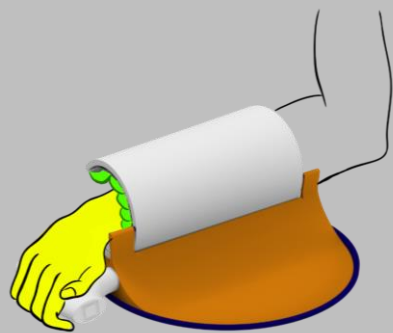


User Scenario

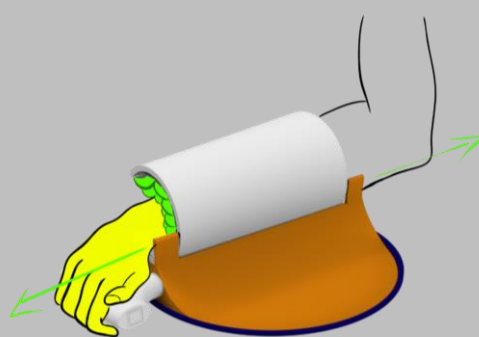
Scan



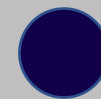
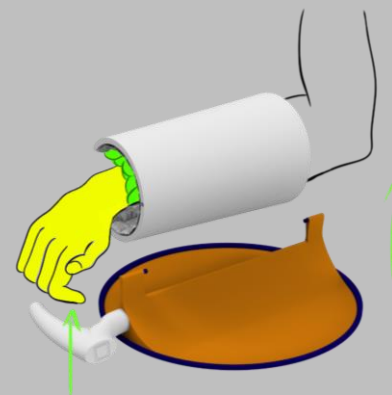
Grab handle



“Sleeve inflates”



“Sleeve unlocks”



Lift

Follow the
instructions
on the
screen.

Estimate per
session:

30min-45min

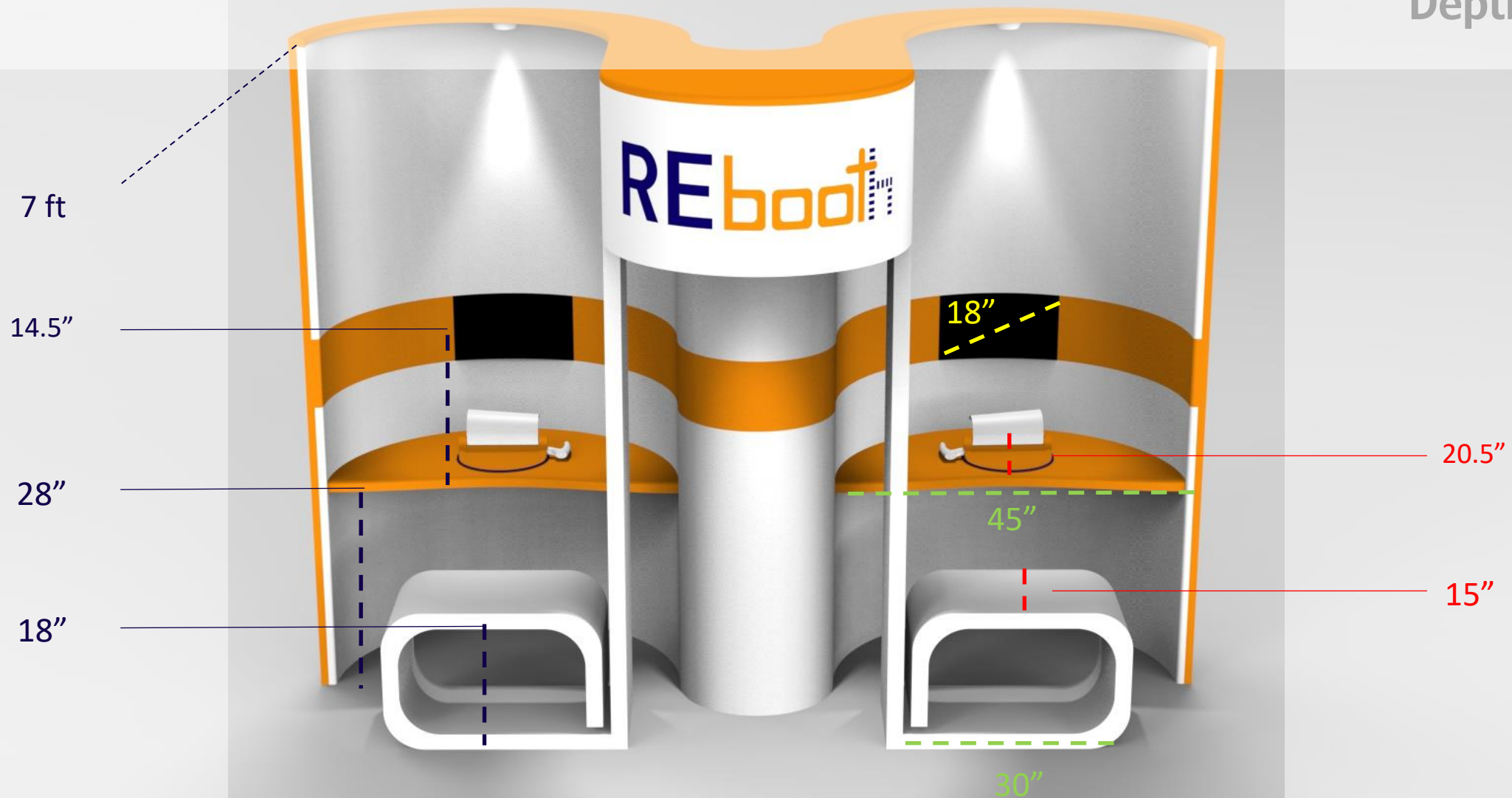
Cleaning supplies
provided



Dimensions

Width
&
Depth

Height



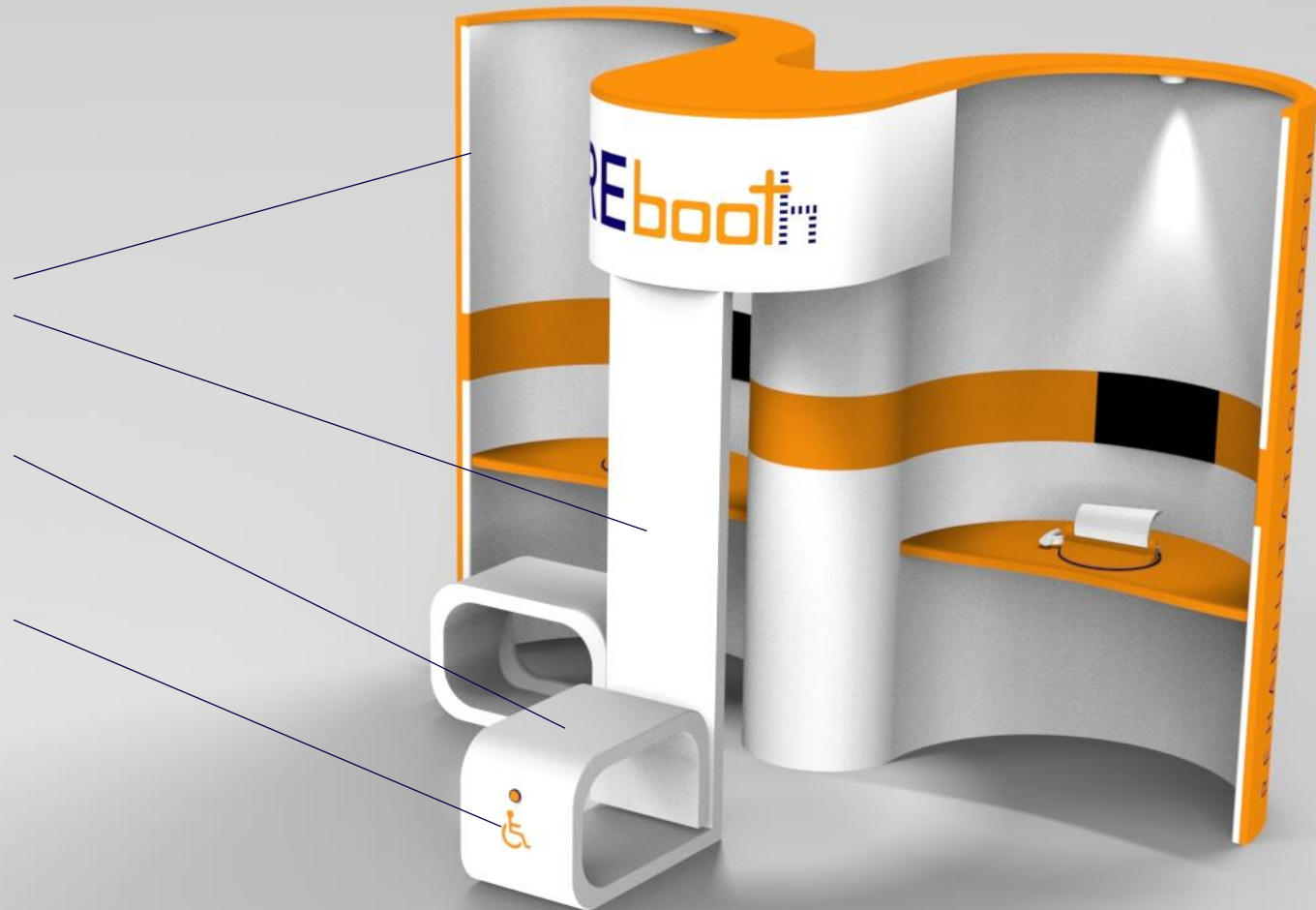
Shape

- Welcoming
- Private
- Social
- Spacious
- Wheelchair accessible
- Curves and straight lines
- Soft edges

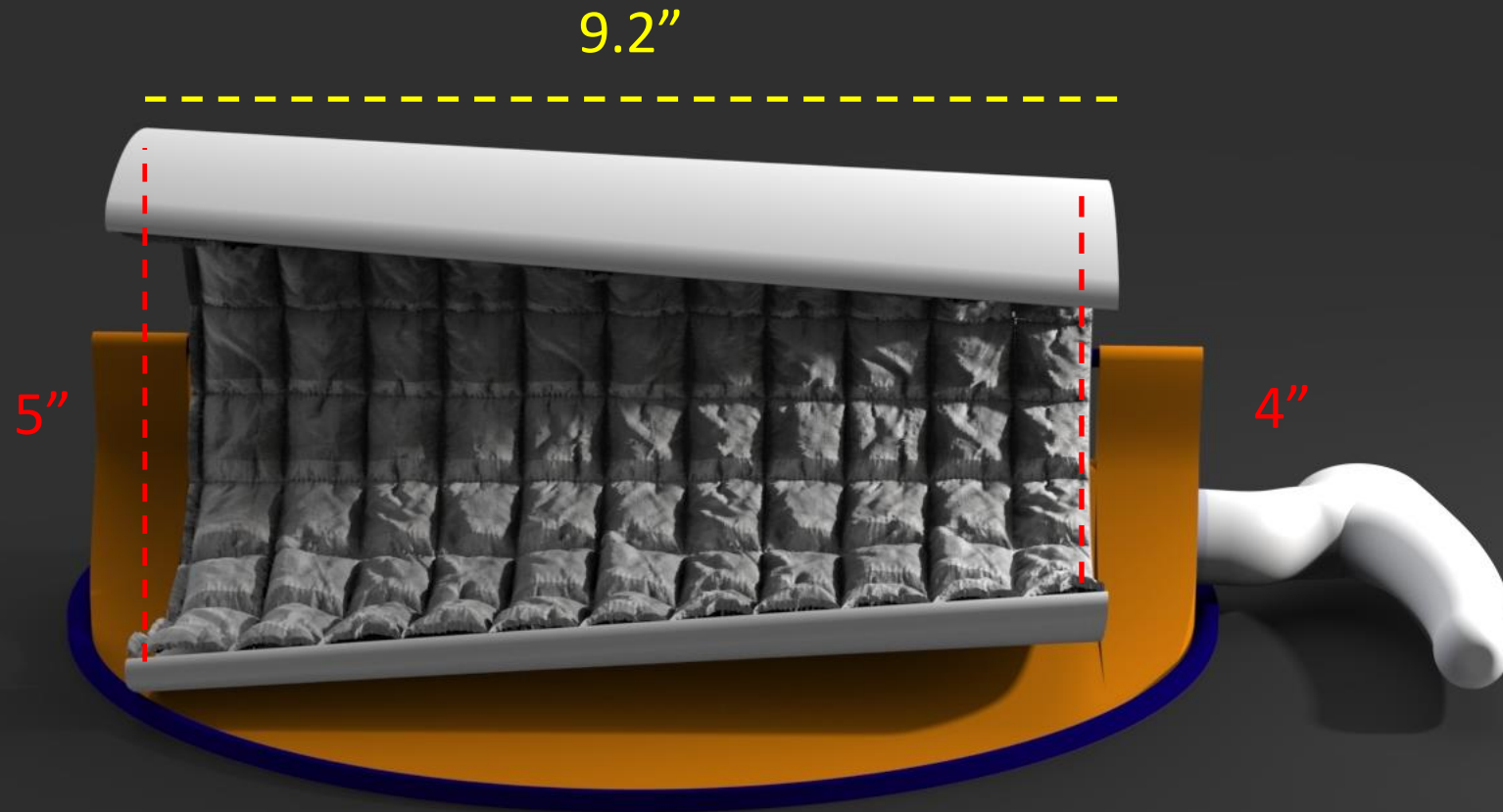


Materials

- Bent Plywood
- Foam (seating)
- Plastic

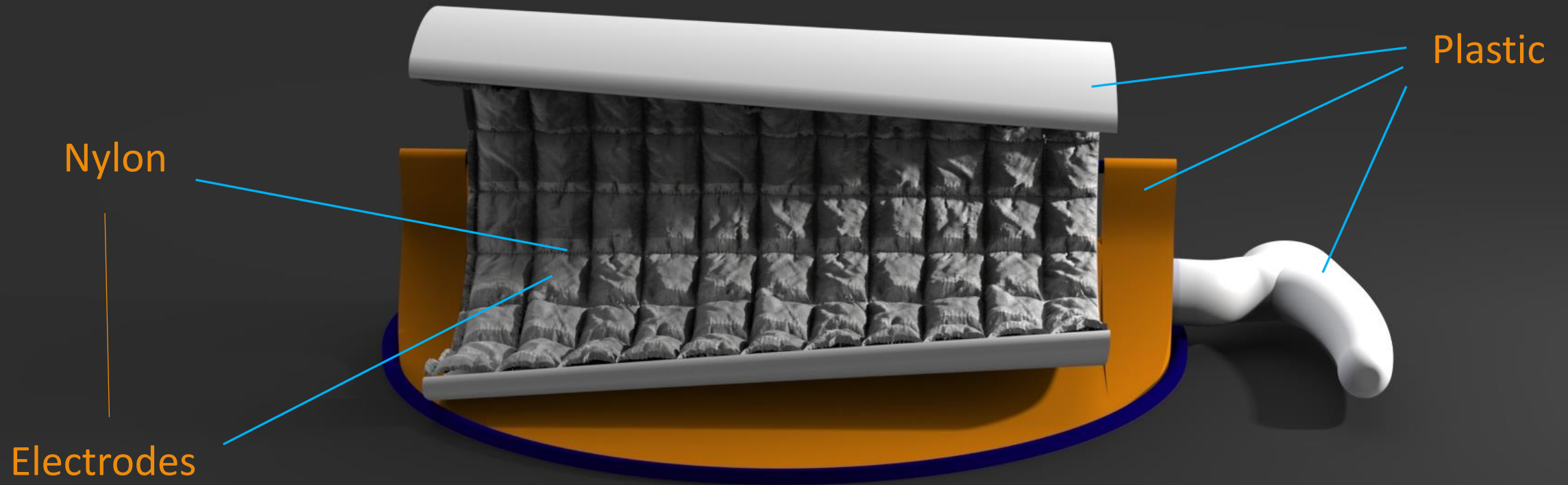


Sleeve



The opened area lines up with the ulna bone where there are no muscles

Sleeve



NeuroLife Tech

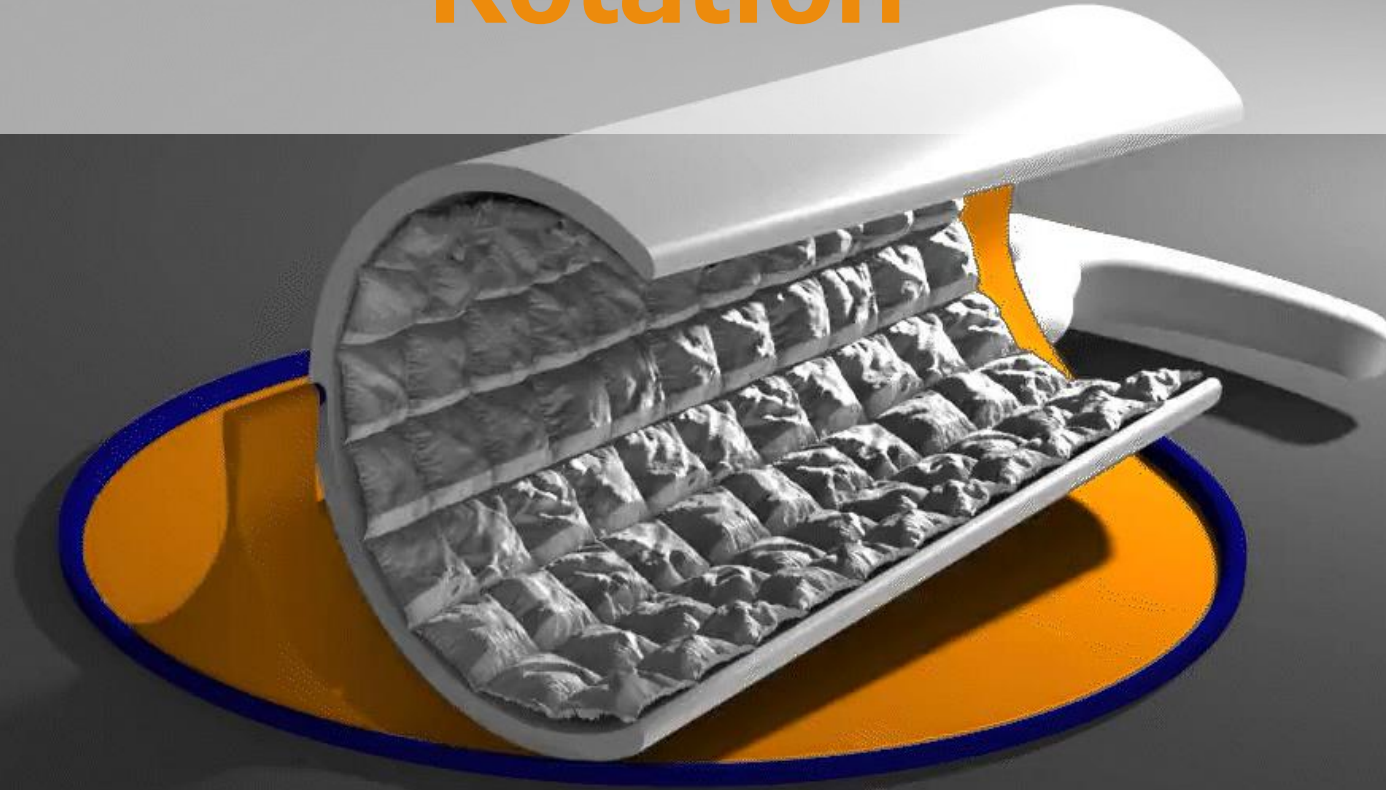
Turn electrodes & air **ON** or **OFF** to match forearm size



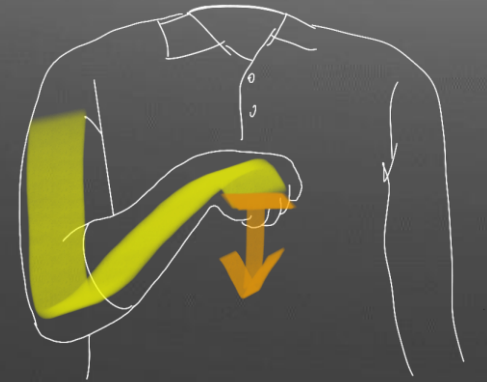
Rotation



L



R



The Sleeve rotates to accommodate with the arm position of stroke patients since they can't fully stretch their arm all the way.



System

- Patients go through training/tutorials prior to the last therapy session or them leaving the hospital.
- Patients' data would be set in advance by occupational therapists.
- Each activity's progress would be reviewed and evaluated.
- Cooperating with REplay for sessions' activities.

Research

Key points:

- Stroke survivors are willing to go through rehabilitation but don't have access.
- Patient's mental health is a huge burden in recovery.
- Insurance prevents patients from getting good and long care.
- Patients are willing to supplement their rehab with an external support technology.

Project Impact

Accessible

REbooth offers a more accessible way to practice rehab.

Affordable

Insurance won't determine the longevity of rehabilitation.

Human-centric

- Recovery
 - REbooth helps patients with arm and hand impairment recover.
- Mental health
 - Practicing rehabilitation independently eases off the pressure on patients and caregivers.
- Social aspect
 - REbooth helps the patients get together to practice as a community.

Thank you!

