# Project Documentation 2

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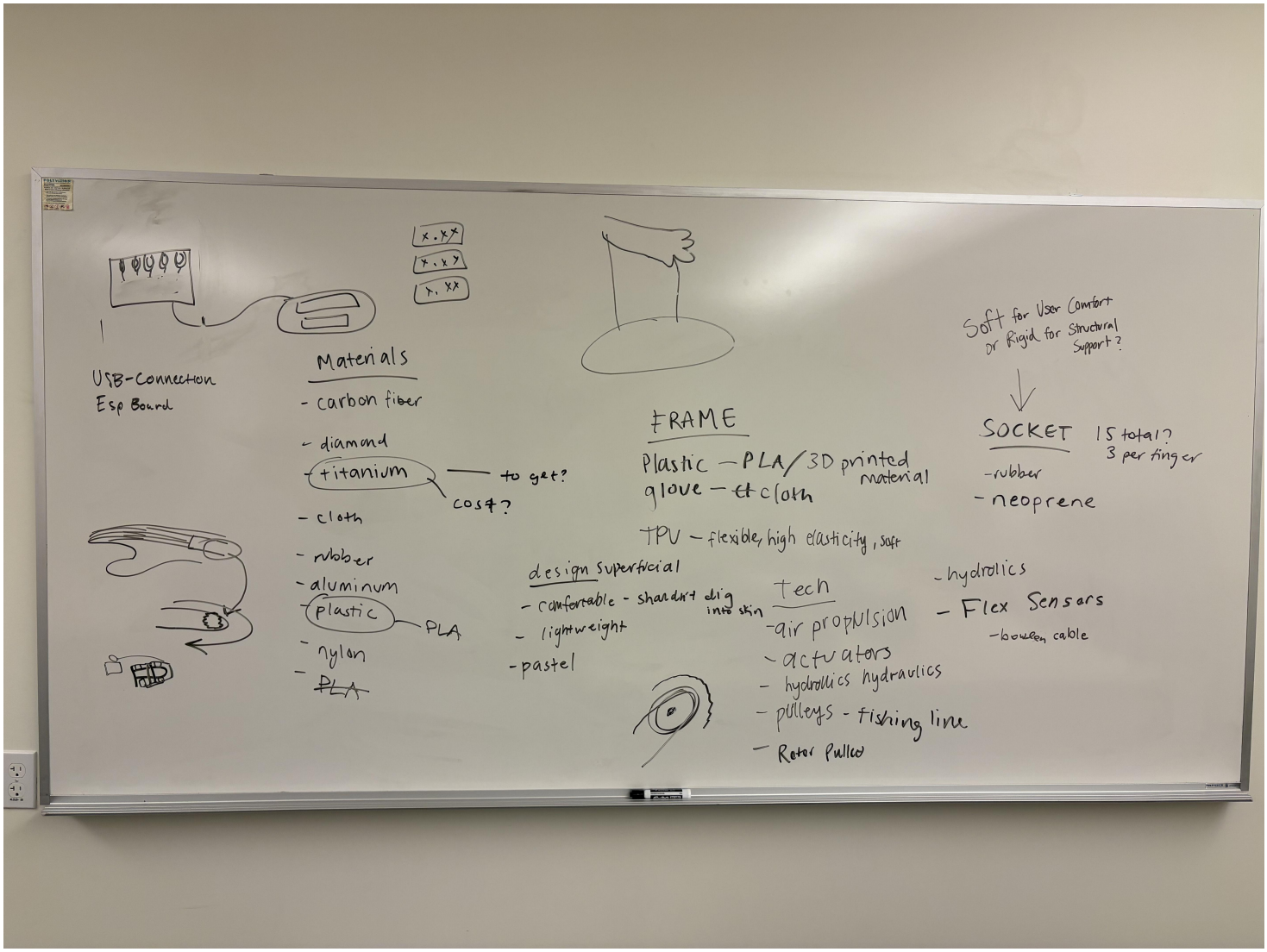
**February 17 2025**

# 1 Conceptualizations

## 1.1 Brainstorming


USB-Connection
Esp Board
Materials
- carbon fiber
- diamond
- titanium
to get?
cost?
- cloth
- rubber
- aluminum
- plastic
PLA
- nylon
- PLA
FRAME
Plastic – PLA/3D printed material
glove – et cloth
TPU – flexible, high elasticity, soft
design superficial
- comfortable - shardrt cbig into skin
- lightweight
- pastel
tech
-air propulsion
- actuators
- hydrollics hydraulics
- pulleys - fishing line
- Rotor Pulley
- hydrollics
- Flex Sensors
-bowden cable
Soft for User Comfort or Rigid for Structural Support?
SOCKET 15 total? 3 per finger
-rubber
- neoprene

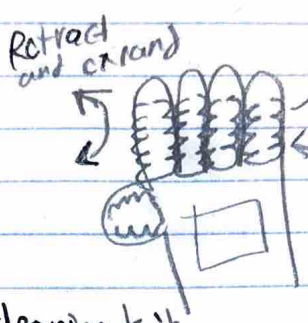
## 1.2 6-3-5 Method

Uhaanny Uribe

## Idea #1


- add sensors to track pulley line movement

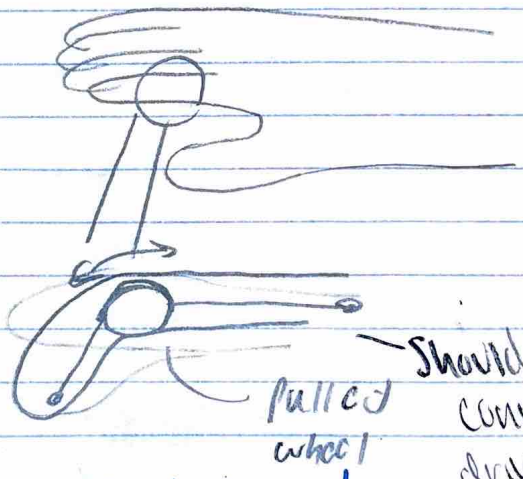
## Idea #2




May be bulky but will have features to limit pressure to allow for swelling reduction but not loss of blood flow or injury

- cleaning kit to prevent air leakage from degradation

## Idea #3




Should have electrical connection to driving device, so wires included

Hand-Cranked hand rehab device

Single finger device should be compand pull from the bottom:


- Could add resistance ∆ strength training

If we had a way to rotate these from a distance, could be a good way to move hand

Program device from app to allow quick changes, contain all parts to the finger itself

one pulley? for each finger ~~them~~ and the ~~joints act~~ separate joints help the finger move with naturally with one pulley

Use Apple M1 chip for the device, maybe a RTX 5090?

- use esp/Arduino for device

hold in multiple fingers with latex glove that houses any additional hardware flat beneath the fingers
- fit in flex sensors beneath fingers
- add a compartment on the glove to house pulley system
- will be easy to transport when electronics are held inside, wires can easily be inside or outside glove depending on comfort.
- maybe not latex... but cloth! or a breathable cloth that doesn't feel to warm / make the user overly heated... a thin glove? But the material should be strong enough to hold ~~att~~ the device....
↖ we could have an encased part of the glove so that sanitization could happen easily during a visit to the therapist

Create an app to monitor usage, progress, and allow patients to communicate with therapists

- we can implement our potential app software into existing healthcare apps like MyUCDavis or EPIC
- Make it like a game
- Can be remotely viewable by physical therapists so they can view progress remotely.
- being able to communicate with the therapist with the device is a great idea. That way they don't need to make a visit if they have any questions/ progress check

This is a great idea. There could be a license doctor view and a patient view of the app. Making it a game feels unnecessary...

Very high weight to strength ratio to make it a safe and effective rehab option
- Use hypoallergenic & biodegradable materials to provide comfort, hardware will add weight

- Create program to set comfortable ranges for fingers
- Maybe a calibration system upon first use that can variably change overtime.
- waterproof glove.

↑ Comfortability and wearability should be crucial

# r: Akash Srinivasan

maybe a charging station so it charges during routines or overnight?

- Use supercapacitors & batteries in conjunction so batteries work for longer
- Could keep the device constantly powered and make it a stationary device
- Prolonged battery life could allow for the user to not need to charge the device, only recharge during therapy sessions.
  - I agree it would be best if it isn't something that needs to be re-charged often, hopefully though the basic mechanics of the glove doesn't need too much battery to function
  - solar powered? batteries? ← solar powered was an idea I had at one point but it wasn't practical after some testing
- AR/VR interactivity
- track improvements from device using an app
- helps user visually track change in performance. Or help visualize work that needs to happen
  - yes. helps with consistency as well.

Need more information?

could use animations and app-trackable progress

Charge with USBC for convenience

Use a durable, soft leather like NuLuxe for each part in contact with the hand

- Step Motor or Servo
- Pneumatic air valves
- Multiple electronic servos may be needed for full finger movements.
  - yes. - one for each finger?

might get power intensive?

Might be least noisy option?

Would servos make too much sound? Maybe we need to suppress the sound to not inconvenience user

1) Object that keeps the hand off of the table (elevated).
↳ this is a good point because they might want something to rest their hand on while they do the exercises and not want to hold it up (fatigue, can get in the way of things?), or if they can't?

~~Maybe~~ oh wait this is for putting it on ... nvm.

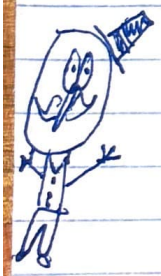
↳ Maybe a platform to rest their hand on?


Weighted plate to add for stability

need to increase stability of device across multiple surfaces

↖ potential display and/or power source/recharging station?

2) Glove that houses electronics like flex sensors and wires, which attaches to mechanics.



could increase stability with watch-like band of components

like this. it could ~~be adjustable~~ green and yellow or blue and pink maybe even red and black like spiderman

Different colors for each wire to track progress easier?

How to deal w/ people who have irregular joints

Make it waterproof
↑
Sweatproof / Breathability

New idea:

Different material wires for fingers depending on condition?
↳ more variety and accessibility

difference in progress, human variability, etc. we need separately finger functionality


↖ Thumb is worse than index

should introduce a calibration exercise for new users to determine these "Natural States"

REMOTE which shuttles between exercises

Contain within glove for simplicity and

1. Flex sensor to measure the bend of the fingers.

These should be located under the finger to properly detect angle and range.

yes I agree

It could be attached using hot glue

Flex sensors could determine "Neutral State" or position at which the hand starts at

2. External connection to battery and microcontroller for lighter weight.

This should have a hub so it can be easily transferrable.

yes

something like this?


I feel like it should not only be the hub but also have a display screen for basic readings like from the actuators + setting the range

3. Perform simple therapeutic exercises for fingers.

Maybe these should be pre-adjustable routines with set patterns of movement.

yes I agree

diff basic poses they can choose but you can also customize your own (i.e the physical therapist can make some themselves for the patient)

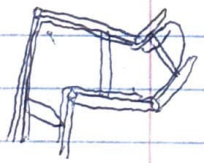
Incremental adjustments to finger movements during practice routines?

Maybe various different exercises like a massage chair

Jarvis

Maybe it could be voice controlled to accomodate more users?


1 Finger may need to bend in two directions simultaneously, use pairs of pulleys top and bottom

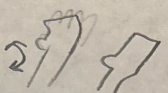


2 Waterproof to allow hot-cold therapy

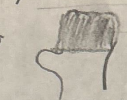
Use real-life hand rehab exercises & simulate those thru glove


3 Material that needs to be sanitized and not washed

Mitten design

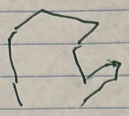


Eliminate grip?

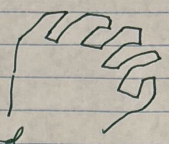


prosthetic hand w/ joint on wrist? ↳ movement on wrist seems too ~~instead~~ instead of separate fingers its all joined (except the thumb) out of scope

this



instead of



Grip would be a challenge

this could be for more ~~me~~ getting the general movement back instead of bigger fundamental issues like paralysis. As in someone who just wants to regain strength after ~~taking~~ taking off a cast

mitten design allows for it to be lighter weight, but may lower effectiveness

individual fingers are often casted or splinted with another for support, perhaps the strength of other fingers alone is enough to trigger more mobility

multiple pulleys? since we would want to be able to move all the fingers separately as well.

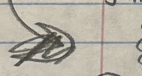
↳ is there another way without pulleys?

individual hinges so force across certain joints can be controlled

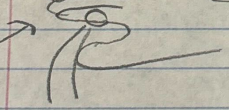
~~diffe~~ how would one big pulley work?

↳ something instead of a pulley... idk.)

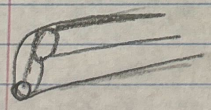
Could recruit easier gripping motion



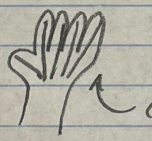
webbed fingers?



Bend phalanges and pull finger tips



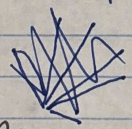
converge on palm?



fingers are small

one pulley seems unpredictable though convenient. I think we need to think about the hand being able to open AND close, and that one pulley will provide less control

Skeleton glove.
Think of a reverse fingerless glove.
Hand will be exposed but also hardware?

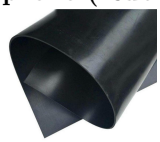


good for prototype, want to have aesthetic glove for final product

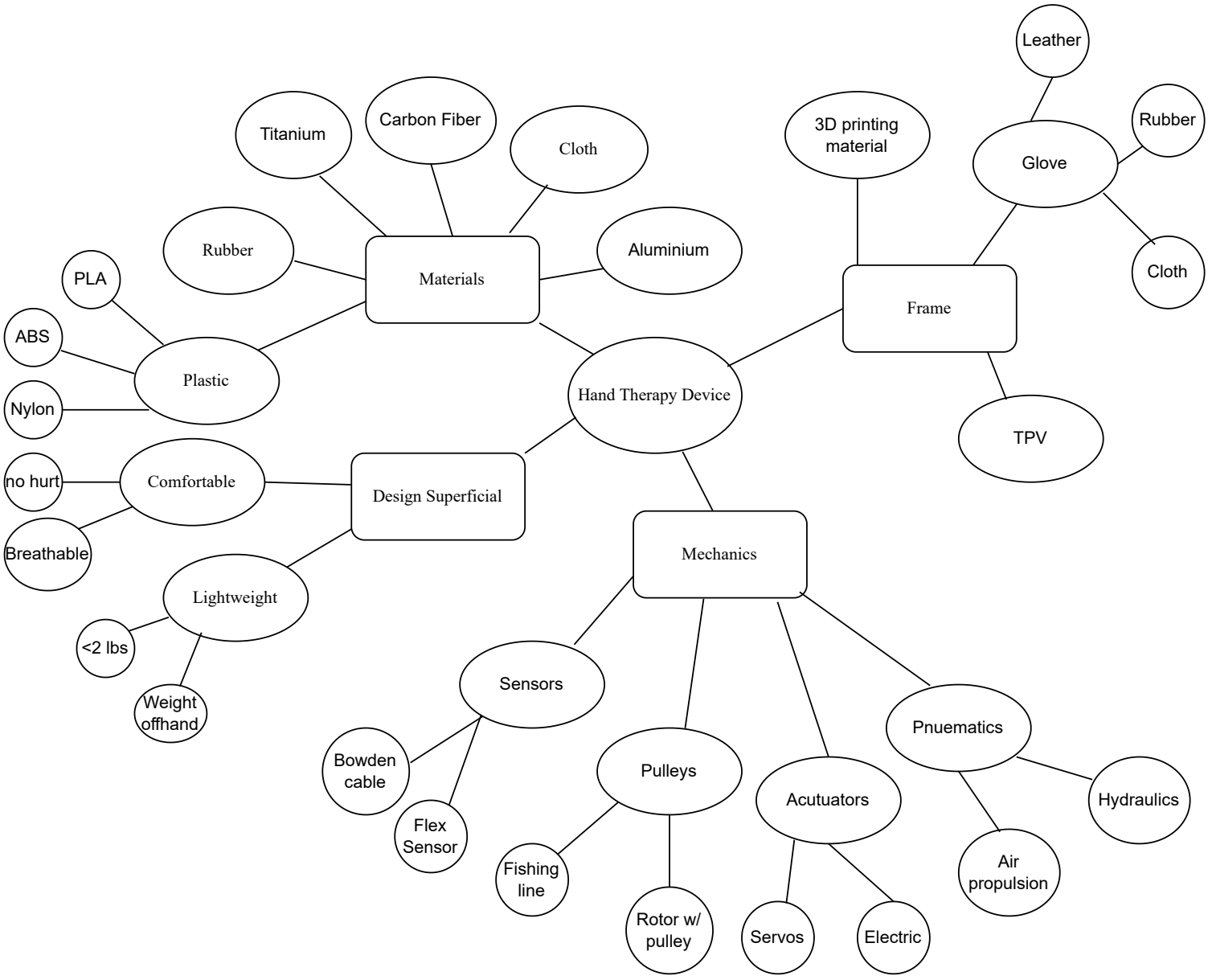
↑ Mini servos instead of 1 ~~giant~~ normal servo handling one pulley

Use Andy for human experimentation ???

## 1.3 Morphological Chart

| | | | | |
|---|---|---|---|---|
| **Velcro Straps**  | **WSL/Ubuntu**   | **Wooden Hand**  | **Fishing Line**  | **Rotor Pulley**  |
| **Gloves**  | **Raspberry Pi**  | **Silicone Hand**   | **Bowden Cable**  | **Air Tubes**  |
| **Hot Glue Gun**  | **ESP32-C3**  | | | **Plastic (PLA)**  |
| | **Arduino**  | | | **Actuators**  |
| | | | | **Neoprene (Rubber)**  |

## 1.4 Mind Map


Hand Therapy Device
Materials
Titanium
Carbon Fiber
Cloth
Rubber
Aluminium
Plastic
PLA
ABS
Nylon
Frame
3D printing material
Glove
Leather
Rubber
Cloth
TPV
Design Superficial
Comfortable
no hurt
Breathable
Lightweight
<2 lbs
Weight offhand
Mechanics
Sensors
Bowden cable
Flex Sensor
Pulleys
Fishing line
Rotor w/ pulley
Acutuators
Servos
Electric
Pnuematics
Hydraulics
Air propulsion

## 1.5 Decision Tables

| **Criteria** | **Weight (%)** | **Design 1 (Attached Fingers)** | | **Design 2 (Prosthetic Hand)** | | **Design 3 (Pneumatic)** | |
|---|---|---|---|---|---|---|---|
| | | Raw | Weighted | Raw | Weighted | Raw | Weighted |
| Wearability (person) | 20 | 8 | 160 | 7 | 140 | 7 | 140 |
| Cost | 30 | 9 | 270 | 6 | 180 | 3 | 90 |
| Damage Likelihood (device) | 10 | 8 | 80 | 6 | 60 | 5 | 50 |
| Power Consumption | 5 | 10 | 50 | 8 | 40 | 6 | 30 |
| Weight | 15 | 9 | 135 | 5 | 75 | 4 | 60 |
| Functionality | 20 | 6 | 120 | 9 | 180 | 10 | 200 |
| **Total** | | | 815 | | 675 | | 570 |

| **Criteria** | **Weight (%)** |
|---|---|
| Wearability | 20 |
| Cost | 30 |
| Damage Likelihood | 10 |
| Power Consumption | 5 |
| Maintenance | 15 |
| Weight | 20 |

## 1.6 Gantt Chart

| WBS Number | Task Title | Start Date | Due Date | Completion (%) |
|---|---|---|---|---|
| 1 | Planning | 01/23/25 | 02/07/25 | 100% |
| 1.1 | Work on Assignment 1 | 01/23/25 | 02/03/25 | 100% |
| 1.1.1 | Establish problem/need statements | 01/23/25 | 01/23/25 | 100% |
| 1.1.2 | Develop personas, LaTeX document | 01/27/25 | 01/27/25 | 100% |
| 1.3 | Brainstorm design ideas | 01/29/25 | 01/29/25 | 100% |
| 1.3.1 | Submission 2, Acquired materials | 02/03/25 | 02/03/25 | 100% |
| 1.3.2 | 6-3-5 Method, Decision Table | 02/05/25 | 02/05/25 | 100% |
| 1.3.3 | Morphological Chart, Gantt Chart, Mindmaps | 02/10/25 | 02/10/25 | 100% |
| 2 | Prototyping | 02/12/25 | XX | 5% |
| 2.1 | CAD designs, 3D printed objects, flex sensors | 02/12/25 | 02/12/25 | 100% |
| 2.2 | TBD | - | - | 0% |
| 3 | Testing | - | - | 0% |
| 4 | Refinement | - | - | 0% |

Table 1: Gantt Chart Table