

# PROCESS BOOK

INDUSTRIAL DESIGN SENIOR CAPSTONE | ANNIE ROO

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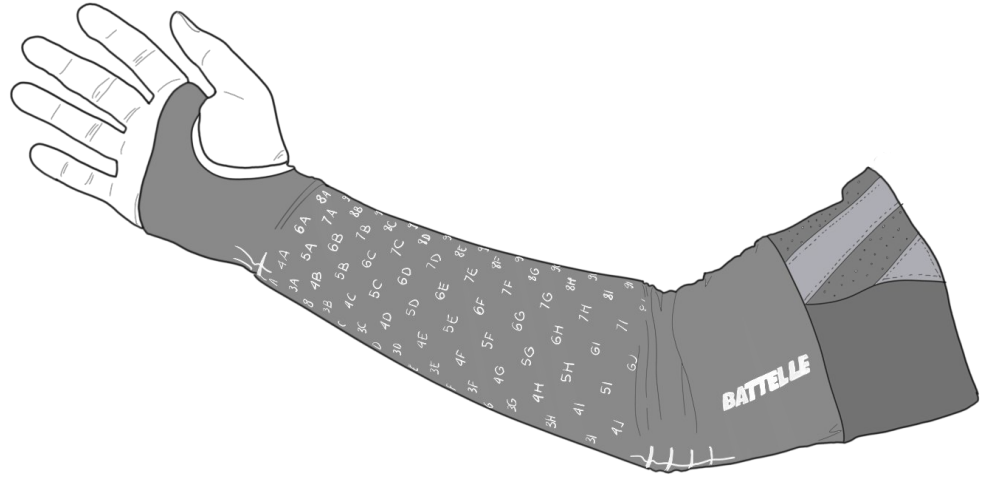
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# SANDBOX PREMISE

Battelle has developed its third-generation Neurolife sleeve which uses a combination of electromyography (EMG) and functional electrical stimulation (FES) to read muscle activity to decipher intentions to move and stimulate muscles to act accordingly. The potential and application of this technology is pivotal to pioneering the means of recovering limb functionality for stroke survivors and can serve as a means of functioning or facilitating means of professional intervention.



# SECONDARY RESEARCH

I began research into my sandbox premise initially focusing on understanding what a stroke was, what was stroke recovery, and what was the Neurolife sleeve.

Once that base understanding in the “focus” category was established, I went and explored other research ventures in different categories such as arts, science & tech, and business.

Through looking at and analyzing articles in this section, these investigations gave me a variety of conjectures or preliminary ideas for what I can do with this sandbox project.

The research articles used and their analyses are linked below:  
<https://desis.osu.edu/seniorthesis/index.php/annie-roo-battelle/>

## FOCUS

Stroke recovery and rehabilitation

## ARTS

Expressions of art and its applications in the medical field

## SCIENCE & TECH

Emerging technologies in rehab & healthcare

## BUSINESS

Business models of medical devices and healthcare

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# PRIMARY RESEARCH

## SURVEY

A survey was conducted with individuals who know of stroke patients (themselves, friends/family, and doctors/therapists).

A series of contextual questions and questions to obtain insights into the perceptions and attitudes surrounding stroke were asked and below are some key insights:

- Stroke survivors care about rehabilitation even in the latter stages of the process
- There are discrepancies between how stroke rehabilitation is perceived by stroke survivors and medical professionals

## NUMBERS POSTER LINK:

<https://desis.osu.edu/senior-thesis/index.php/2022/09/20/the-perceptions-attitudes-of-stroke-rehabilitation/>

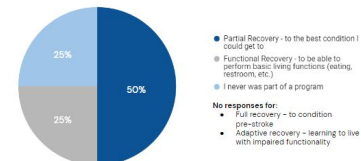
## LINK TO SURVEY (CLICK BOTTOM RIGHT EDIT ICON FOR SURVEY BREAKDOWN):

[https://docs.google.com/forms/d/e/1FAIpQLSePYzAJWPeAlOyXfJB\\_i4VEDOAz66RkONsCFoxCOBBLsIVDFA/viewform?usp=share\\_link](https://docs.google.com/forms/d/e/1FAIpQLSePYzAJWPeAlOyXfJB_i4VEDOAz66RkONsCFoxCOBBLsIVDFA/viewform?usp=share_link)

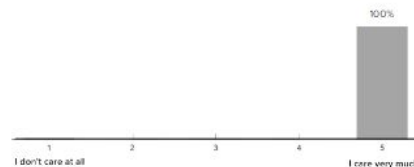
 Stroke Survivor  
n=8

All stroke survivors in this survey had a stroke over 2 years ago and are not actively enrolled in a rehabilitation program.

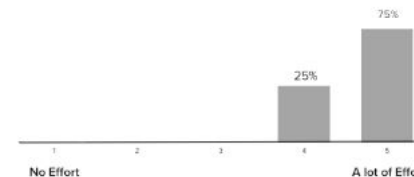
What is the aim of the rehabilitation that you engage in?



How much do you personally care for rehabilitation?



How much effort do you put into rehabilitation?



# PRIMARY RESEARCH

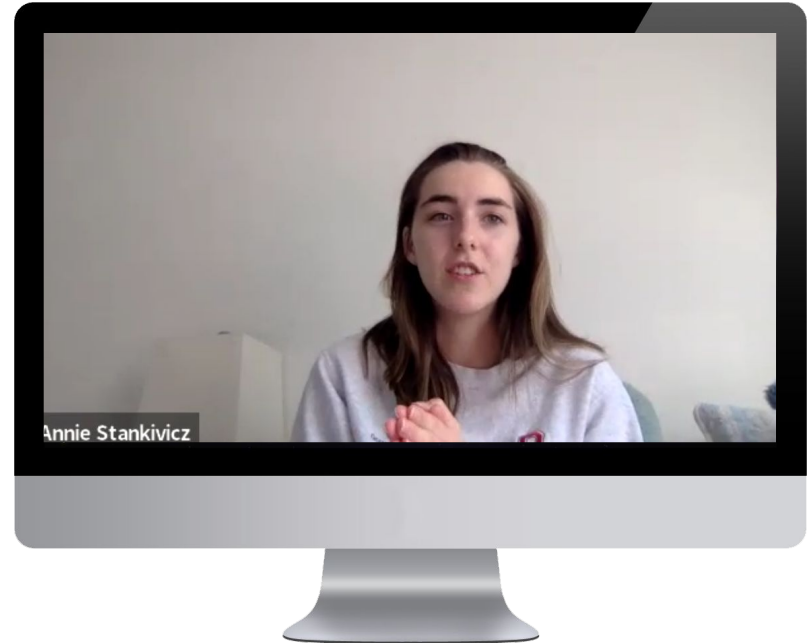
## INTERVIEW WITH OCCUPATIONAL THERAPY GRAD STUDENT

In addition to the survey, I conducted an interview with a 3rd year occupational therapy student at OSU and found the following insights from our conversation:

### Professional oversight can help alleviate difficulties in Rehab at Home:

- Cognitive Impairments
  - Unable to remember hours-long rehab sessions and how to do certain exercises
- Feedback to correct exercises in real-time
- Adaptive - give new or altered exercises based on changing conditions

Full interview link:



# PRIMARY RESEARCH

## OBSERVATIONAL STUDY AT BATTELLE

Following and ongoing with efforts in secondary research, my primary research entailed going to Battelle several times to observe a working session of a patient using the Neurolife sleeve and doing a Q&A session with a cross-disciplinary team of engineers, occupational therapists, designers, and business in order to understand various details and visions surrounding the Neurolife sleeve.

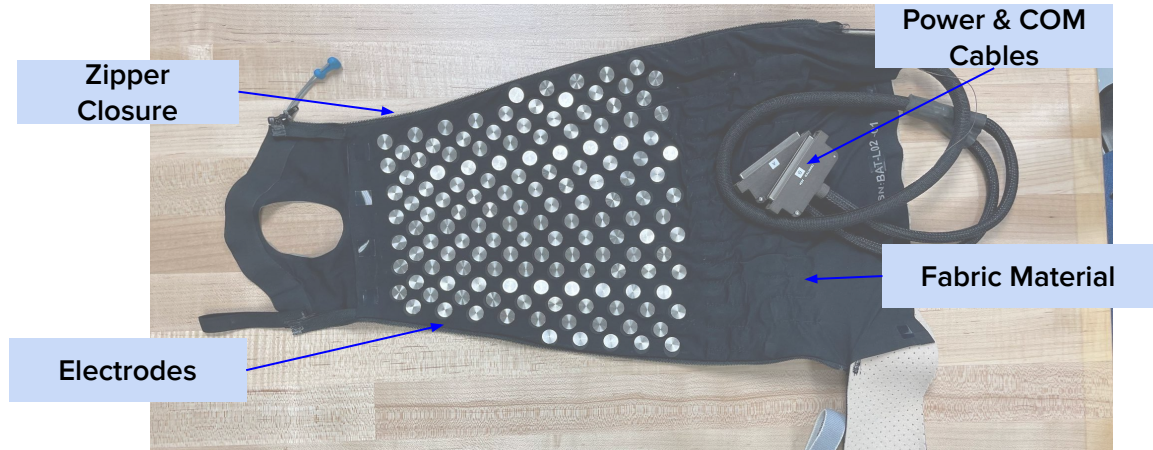


# PRIMARY RESEARCH

## OBSERVATIONAL STUDY AT BATTELLE

One of the many key elements emerging from the various observational studies is an artifact analysis of the Neurolife Sleeve.

The image to the right shows a high-level annotation of the primary sleeve components.

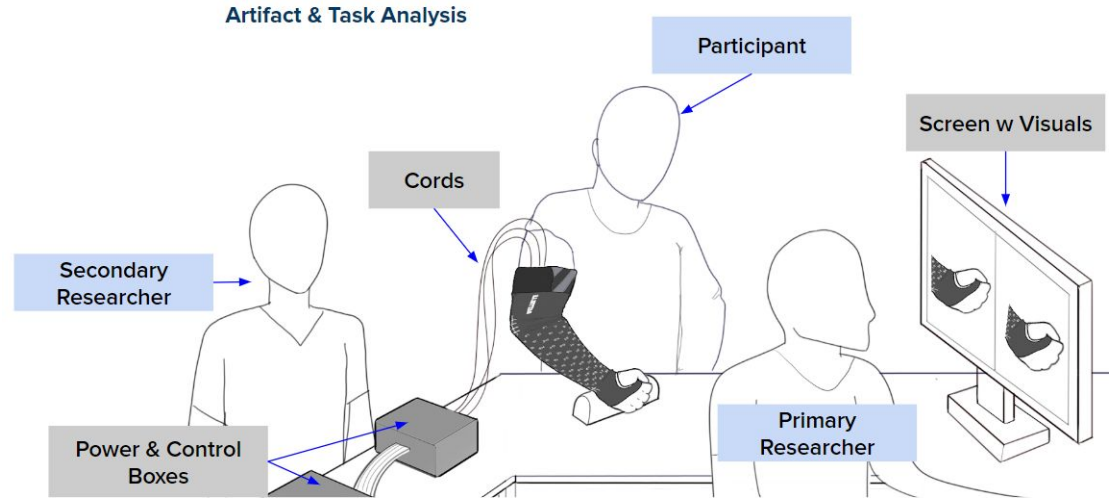


# PRIMARY RESEARCH

## OBSERVATIONAL STUDY AT BATTELLE

For the task analysis, there are two other researchers, or professionals, intervening in this instance. In this specific study, to put on the sleeve required the help of both with difficulties and troubleshooting as the electrode placement on the arm needed high precision.

It cannot be put on independently due to electrode placement sensitivity and limited mobility in the patient to do so well themselves, there is a large effort in the calibration and coordination for setting up the device, and there are a long list of instructions and procedures that need to be done before the sleeve can start the actual rehabilitation process.



# PRIMARY RESEARCH

## OBSERVATIONAL STUDY FINDINGS

From these observational studies and the knowledge that the sleeve is still undergoing research, engineering, and design changes, insights from this showed the need for some professional assistance in handling and using the sleeve.

There will be a need for:

- Help for the user to learn how to put on the sleeve
  - A calibration process for the sleeve
  - Some means of help, assistance, or oversight for the sleeve use
-

# OP-ED & KEY FINDINGS

## OP-ED:

A summative explanation of my key findings from research are presented in my op-ed - <https://desis.osu.edu/seniorthesis/index.php/2022/09/29/op-ed-how-can-the-battelle-neurolife-sleeve-facilitate-professional-intervention-points-for-the-process-of-stroke-recovery-and-rehabilitation/>

## KEY FINDINGS:

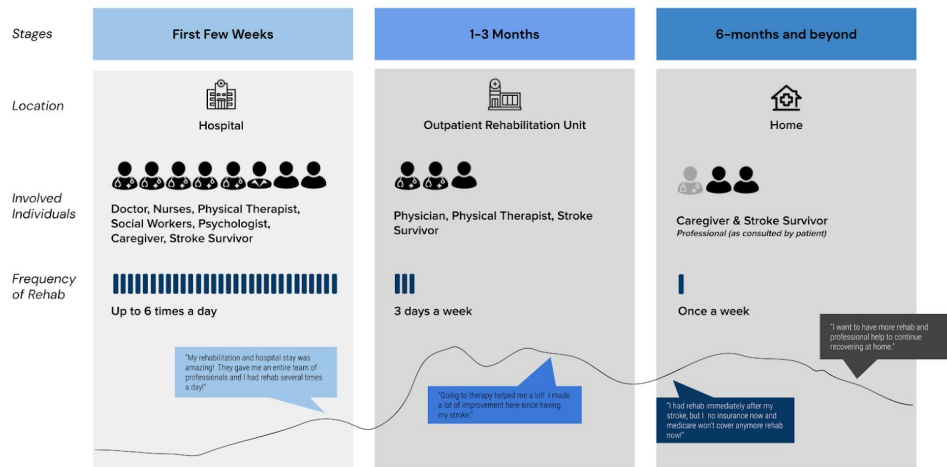
- Decrease in professional oversight & guidance as time goes on
- Patients care a lot about rehab even in the later stages of rehab
- Medical oversight & guidances helps patients greatly in rehab progress

## STROKE SURVIVOR REHABILITATION & RECOVERY JOURNEY MAP



**Susan Sparks**  
Susan is a 65-year old woman who has a stroke. Her impairments are severe with weakness and upper extremity loss. She was enrolled in an outpatient rehab unit before her insurance discontinued her coverage there and is now living at home with her spouse.

- Expectations:**
- Regain functionality to the best point she can
  - Receive help, care and support when needed



# DESIGN BRIEF

- Provide a means of communication between a patient and occupational therapist
- Guides patients through therapy
- Promotes fun and engaging rehabilitation sessions
- Simplistic/Minimal in the interface design for easy use

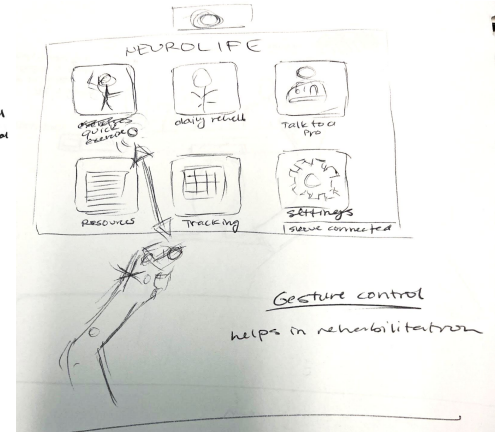
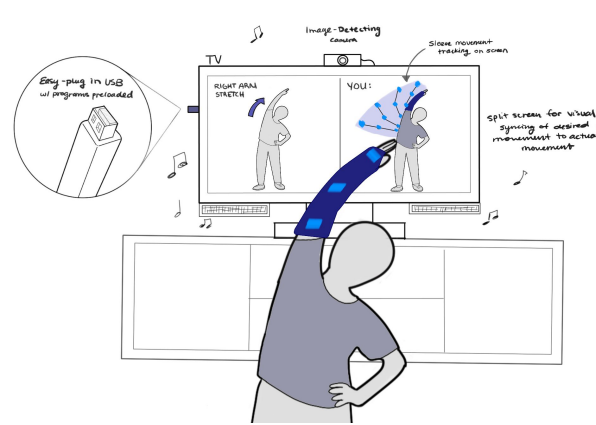


# INITIAL IDEATION SKETCHES

One of my initial design conjectures was a digital program that utilized a camera system and AI technology to prompt and guide users through therapy.

I took this initial idea and started to ideate outwards on this concept and refine it as I investigated more into rehabilitation and the NeuroLife sleeve.

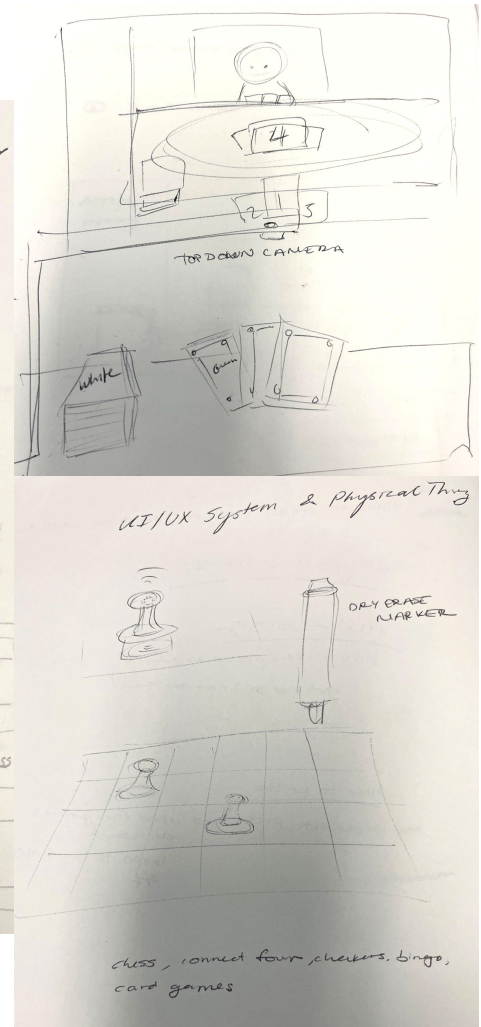
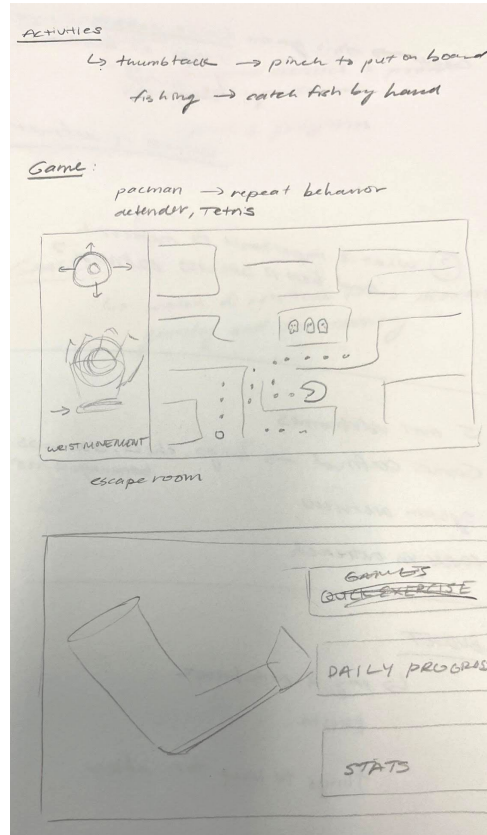
One item that I had originally wanted to include, but couldn't as stroke patients wouldn't be able to do it, was gesture control so that patients can move their arm around to interface with the screen rather than using a remote.



# SYSTEM IDEATION

My original intention was to feature games that a patient can engage in such as pac-man, bingo, chess, uno, etc. so that they could play with themselves or with other patients as to foster a sense of community and belonging.

Since these games have a variety of pieces and would actuate a variety of fine motor skills, I had wanted to do this game idea for the final, and this was also where my idea of having a toolkit came in.





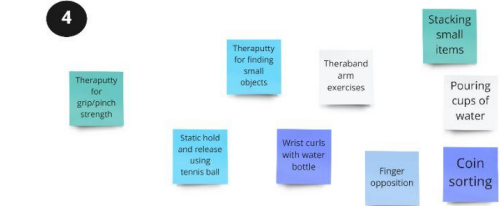
# FORMATIVE ASSESSMENT

In order to determine the nuances of the activities and the digital rehabilitation system, I conducted a codesign with several occupational therapists in order to find out the various exercises needed for stroke rehabilitation, how to measure the success of the exercises, and what they thought about my concept so far.

From the codesign, my original intention of focusing on games such as bingo, chess, etc. needed to be pivoted as a lot of the exercises and activities that the occupational therapists had chosen to do and speak on was in the realm of gardening and cooking.

And so, alongside with the information to make exercises for the system, I also came out of this pivoting from designing games for the rehabilitation system to designing gardening activities.

The necessity of the toolkit was also determined in this codesign as I had a one-on-one codesign with an occupational therapist who walked through and helped critique my idea and design.

	<b>Jane Smith</b> 70-80 years old, Female	<b>Living Circumstance:</b> Living at home with husband
<b>Impairment Severity</b>		
<b>Moderate</b>	<ul style="list-style-type: none"><li>• 1 month out from stroke with residual deficits</li><li>• Left sided weakness in arm and hand (left side dominant)</li><li>• Decreased grip and pinch strength in left hand</li><li>• Difficulty with endurance of tasks (hand/arm fatigues easily with repetitive tasks)</li><li>• Difficulty manipulating small objects (buttons, zippers, etc.)</li></ul>	
<b>What activities/hobbies does your persona like to do?</b>		
	<b>WHAT UPPER EXTREMITY MOVEMENTS DOES MY PERSONA STRUGGLE WITH IN ENGAGING WITH THEIR HOBBY?</b> (ex. difficulty picking up paintbrush) <ul style="list-style-type: none"><li>• Difficulty pruning (squeezing tool together and using both hands to complete task)</li><li>• Difficulty carrying bags of soil and fertilizer</li><li>• Picking small vegetables (beans and peas)</li></ul>	
<b>What upper extremity exercises would you recommend for this persona?</b>		
<p>4</p> 		

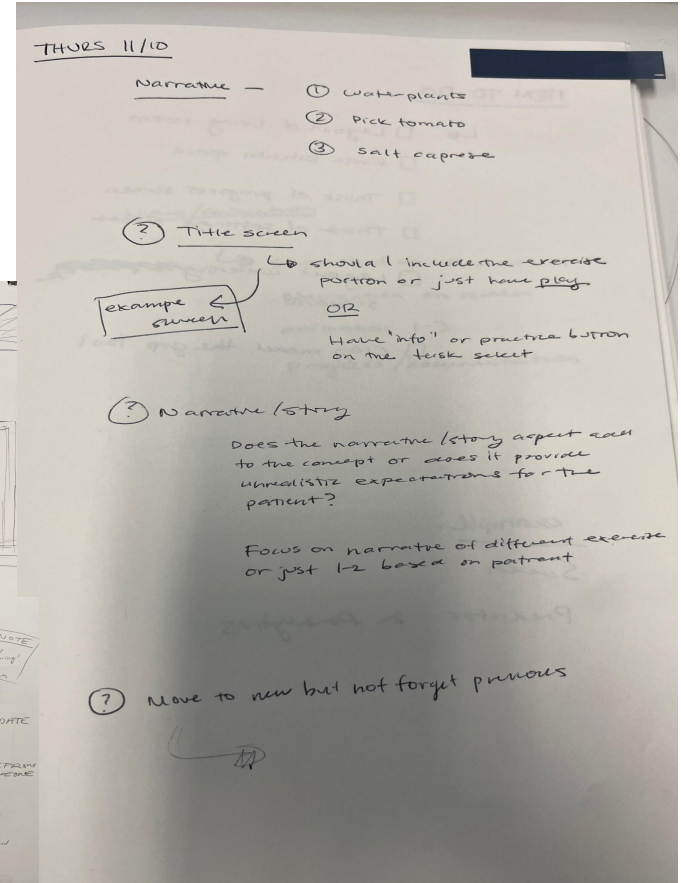
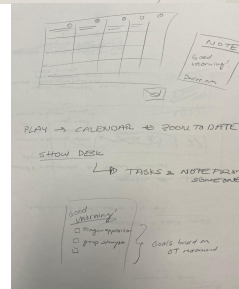
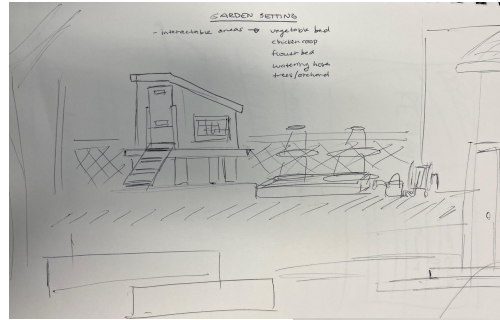
# UI/UX CONCEPT

## Early Narrative Concept

I explored a variety of potential exercises and game layouts in order to make the rehabilitation program more fun and engaging for patients.

One aspect that I had wanted to explore, but did not get the chance to was the concept of a calendar system and narrative. Patients would be rewarded on daily log-ins and engagements as well as be able to feel accomplished in engaging with a game that has a narrative. Ex. planting seeds, caring for the plants, and making a floral arrangement to send to a friend and display in their virtual living room space.

Unfortunately, I didn't get a chance to fully design this concept as I wasn't afforded the time to flush out this idea.



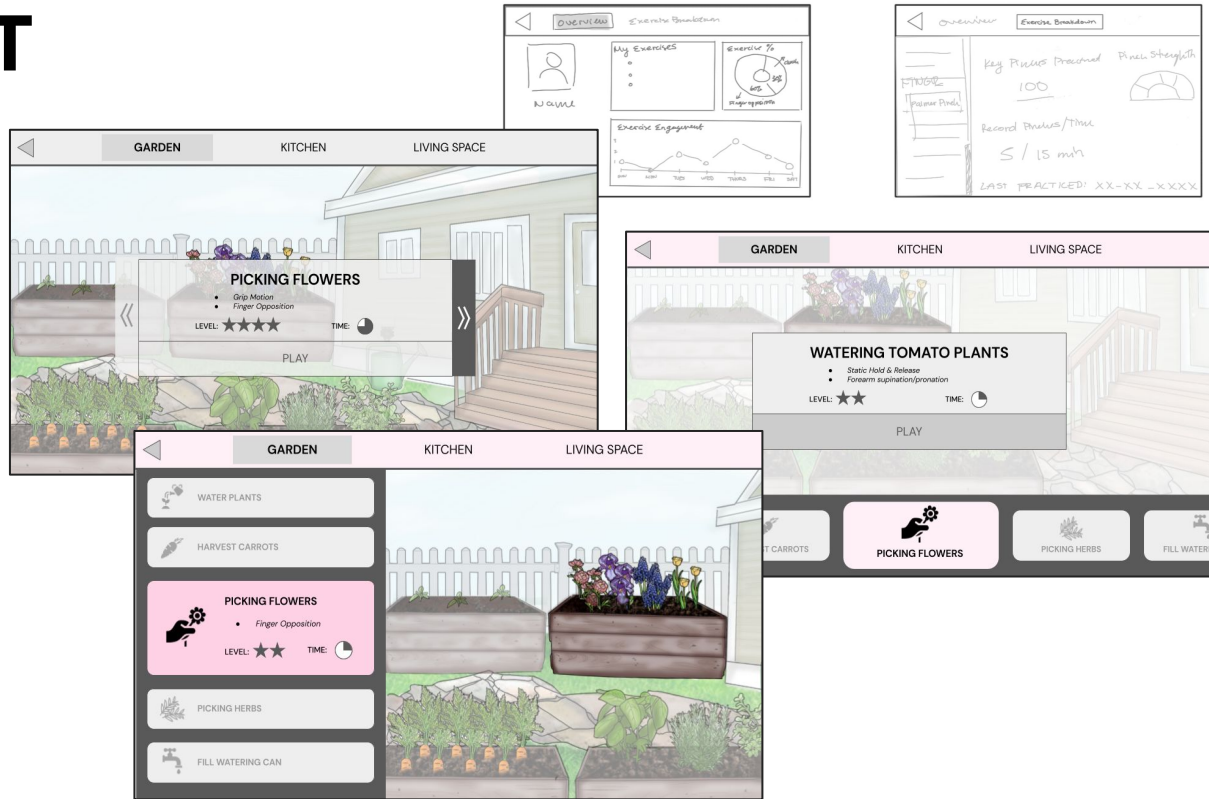
# UI/UX CONCEPT

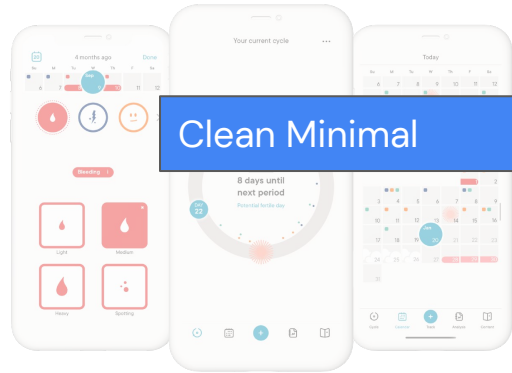
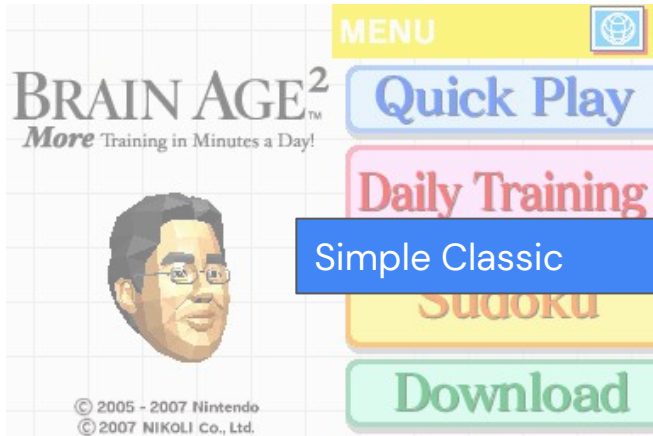
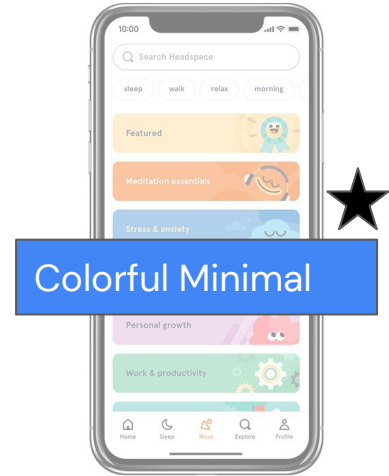
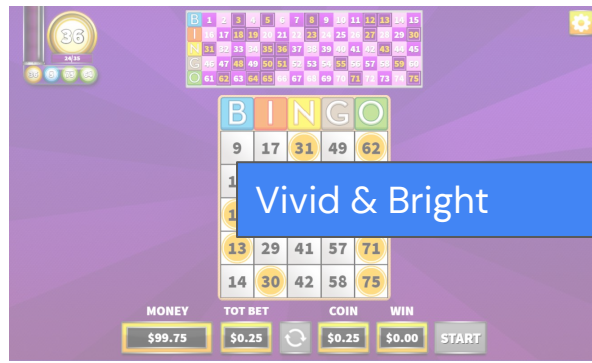
## Layout Development

For the time allotted on this capstone, I decided to focus only on showcasing the gardening activities in a list and at-will engagement system.

I did sketches and general layouts in Figma based on prior mental models of TV layouts. Here, I am showcasing three of the main layouts I had considered for the final:

- Center, simple selection
- Left side scroll selection
- Bottom center scroll selection

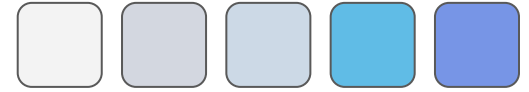




# UI/UX CONCEPT - AESTHETIC BOARD



# Preliminary Color Scheme Combinations



## Professional

Calm, orderly, productive, precise

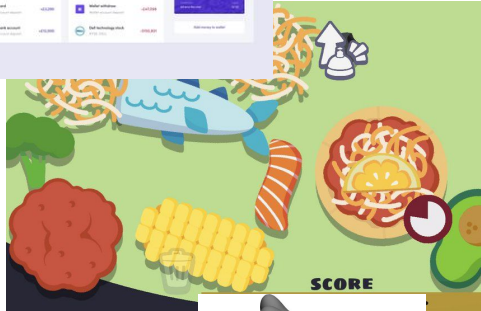
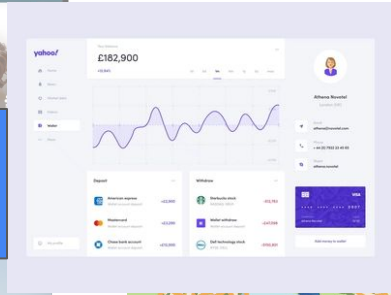
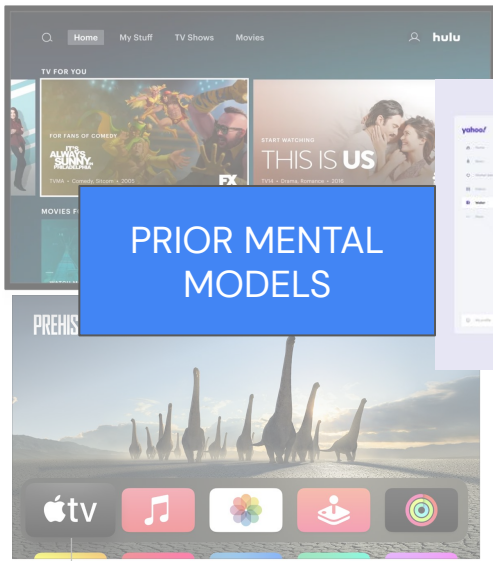


## Calming Growth

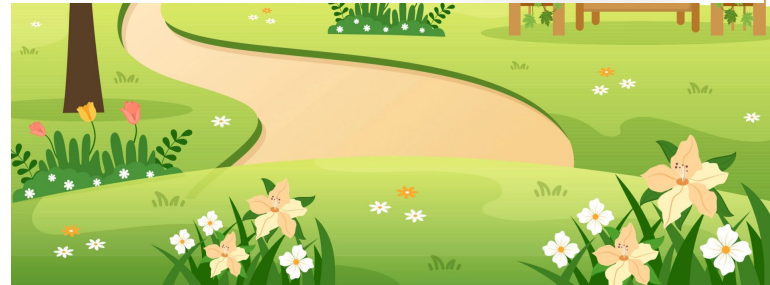
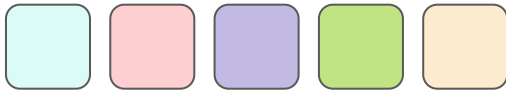
Trusting, energetic, growth



★ **Playful**  
Relaxing, energetic, inspirational



RE play





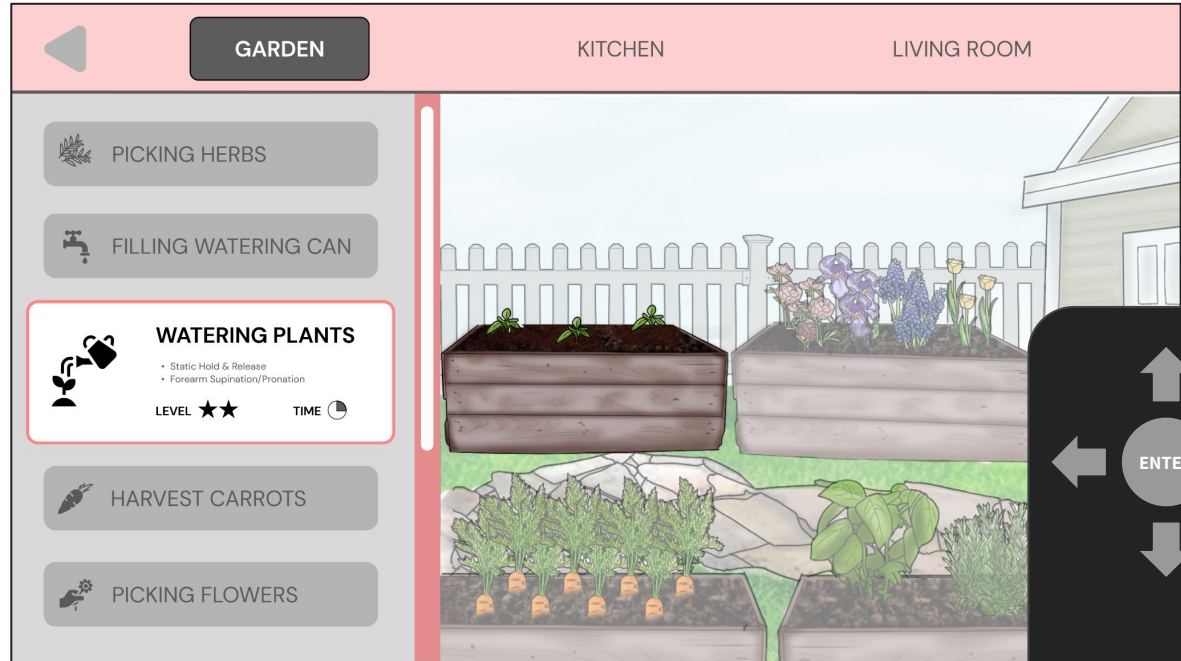
# UI/UX CONCEPT

I decided to proceed with the “playful” color palette and the left/scroll layout for the UI/UX layout and interface.

Here is my final play navigation page.

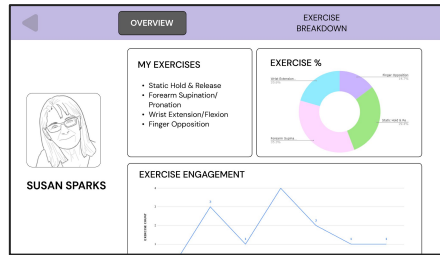
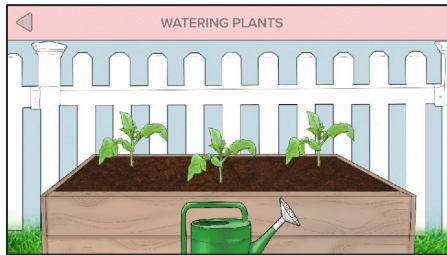
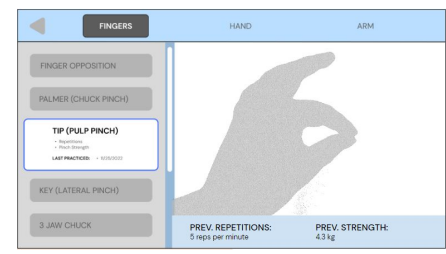
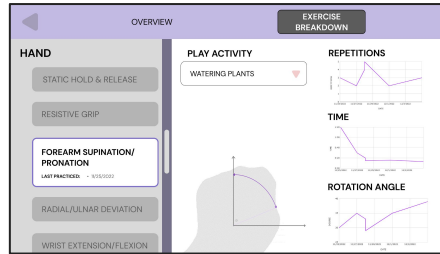
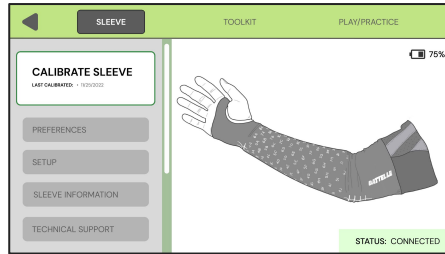
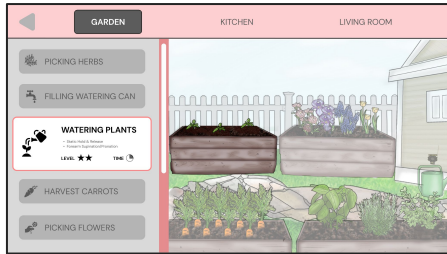
It relies on prior mental models for TV navigation layouts and uses a patient’s existing remote with only the directional buttons and enter key.

Activities are listed and highlighted in the environment and the exercises of each activity are listed alongside a level and general time estimate.



# UI/UX

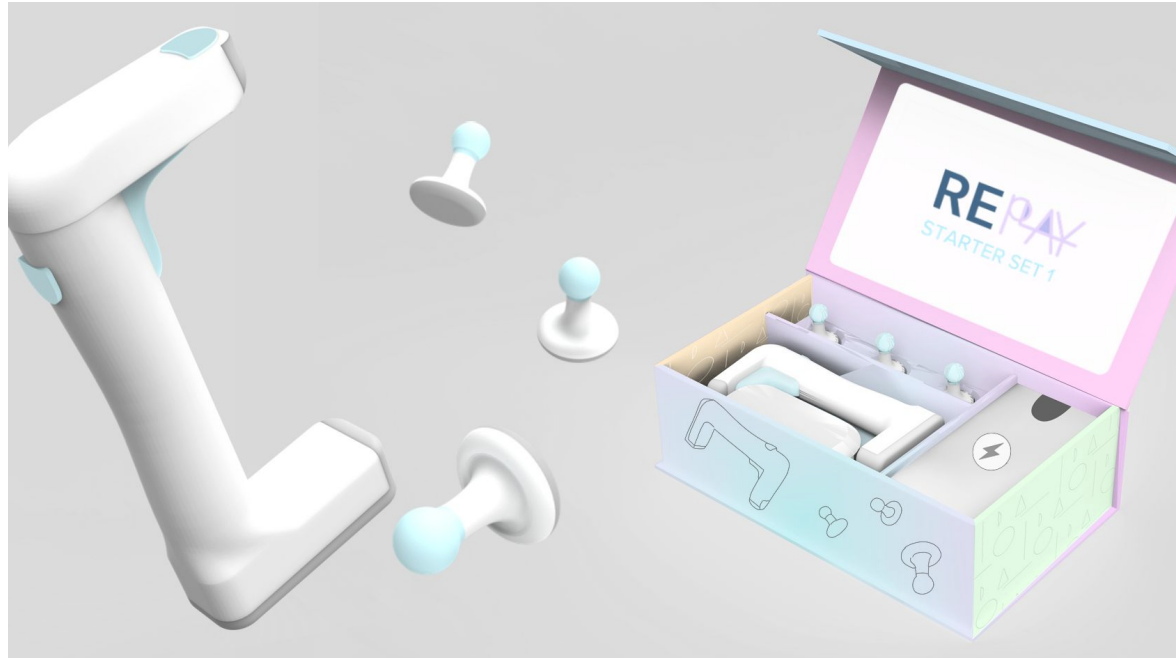
Below are screenshots of some interface screens that I have designed for REPLAY.



# TOOLKIT

The toolkit was originally intended as a secondary, nice-to-have design that was going to be a highlight of some possible tools that would be included for the system.

However, as I progressed through the midterm review, codesigns, and feedback sessions with Krista and Emily, the necessity of a toolkit was made clear and the aspect of having a toolkit that was versatile was needed.



# TOOLKIT

## AESTHETIC/MOODBOARD

For the aesthetic/moodboard of my toolkit, I took inspiration from a multitude of existing physical products and developed an aesthetic/moodboard with annotations and highlights of key takeaways for the development of my toolkit.

The following items were crucial parts of my board:

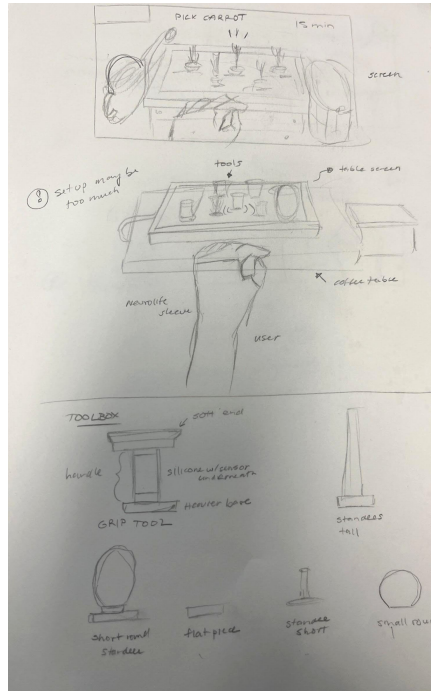
- Baby breast pumps (electronic medical device) - color placement and interaction points
- Accessible remote control and door handle- simplistic interface and silicone buttons, balanced form and easy to hold
- OXO products - forms for softness and easy for holding
- Stroke rehabilitation tools - exercises that the tools need to perform



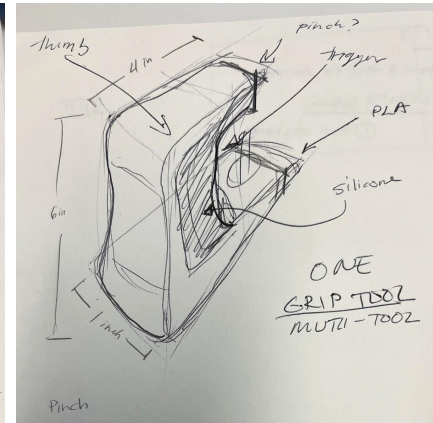
# TOOLKIT

My ideation sketches for the tools started off with ideating based off of what fine motor exercises were done in rehabilitation and what existing tools were currently in place to help with that.

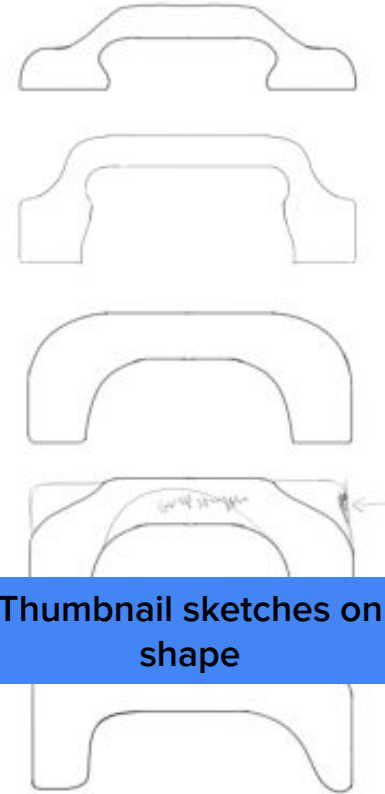
One of the main tools that I was ideating on was a grip tool for a static hold/release motion, and Krista gave me the idea and direction to make that tool into a multi-tool that was able to do a variety of functions and reduce the amount of tools since having several means that they can be misplaced.



Original Sketches w/multiple tools



Grip/Multi-tool ideation sketch



Thumbnail sketches on shape

# TOOLKIT

## CLAY MODELING

For the form development, I decided to create a clay model to determine general form, dimensions, and ergonomics.

Placement and color of the final toolkit were determined in this step. Here are the outcomes of this process:

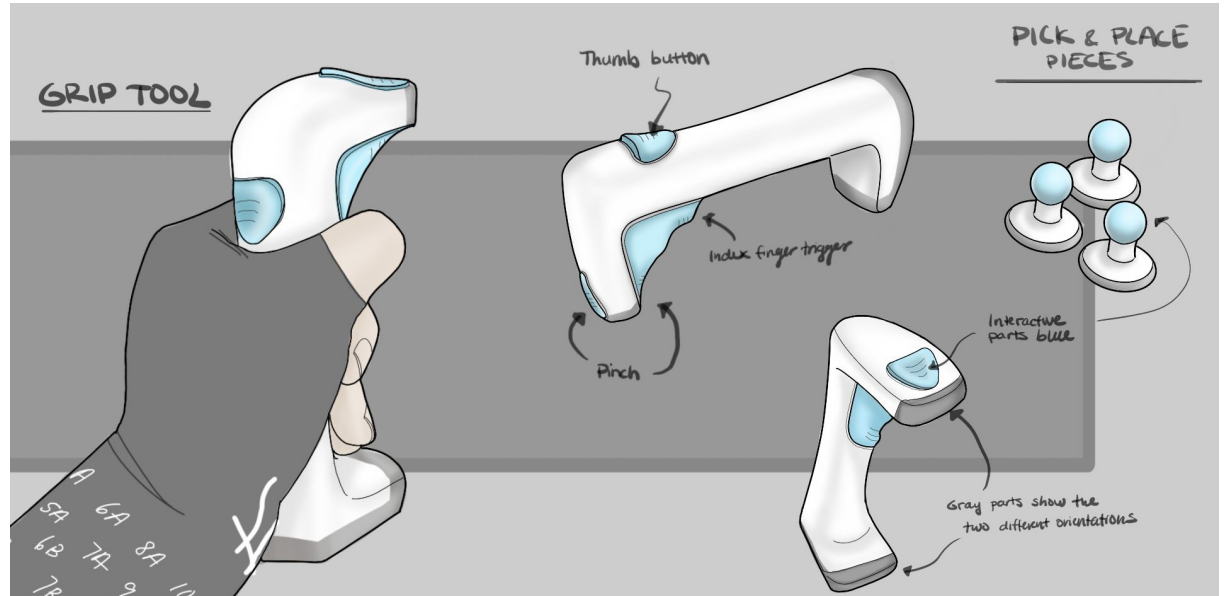
- Placement of the buttons
- Form of the tool - base is wider to be stable in its vertical orientation
- Dimensions



# TOOLKIT

## B-Sketch

I did a B-sketch to better call out and visualize the various aspects and components of my toolkit.

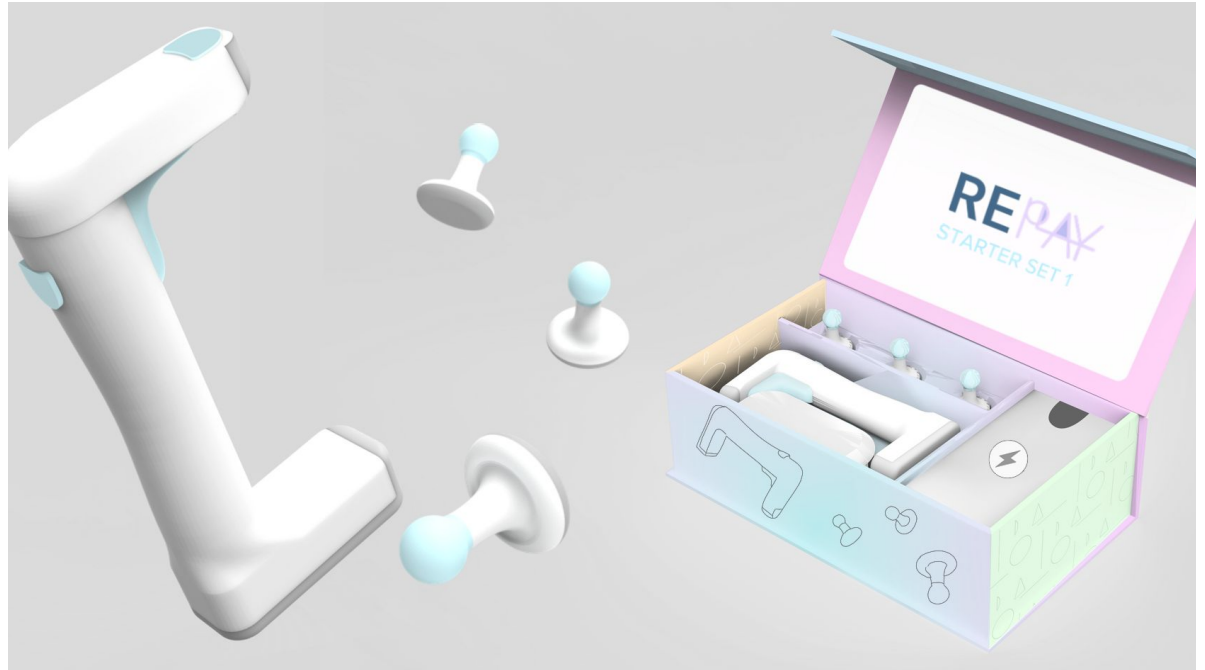


# TOOLKIT

## CAD

I then created various CAD models and renders of my toolkit in Solidworks and Keyshot.

Additionally, I created a packaging box that the patient would be sent home with housing the specific tools that a patient would be prescribed.





# TOOLKIT

## Advanced Prototype:

Once I had finished my CAD, I designed several molds for the touchpoints of my toolkit and did a 3D print and OMOO cast to assemble the advanced prototype of the toolkit.

I made a prototype of the multi-tool, pick pieces, and the wireless charger.

