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Dynamic Balance Device

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Overview

- Problem Statement
- Background
- Product Design Specifications
- Design matrices for each component:
 - Display Electronics
 - Adjustable Rod Materials
 - Handle and Controls
- Future Plans

Problem Statement

- Physical therapy is a pillar of stroke neglect rehabilitation [1]
- Current method our client uses
 - Yardstick
 - Colored dot on end
- Seeks a more professional and interactive method
- No competing design for this application



Figure 1: Functional reach test

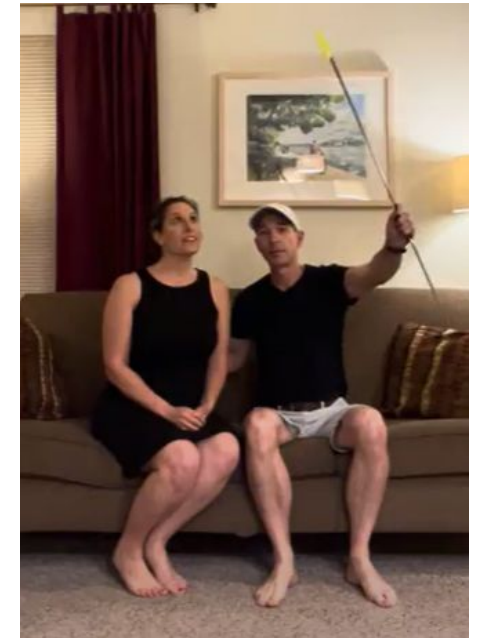


Figure 2: Static visual scanning

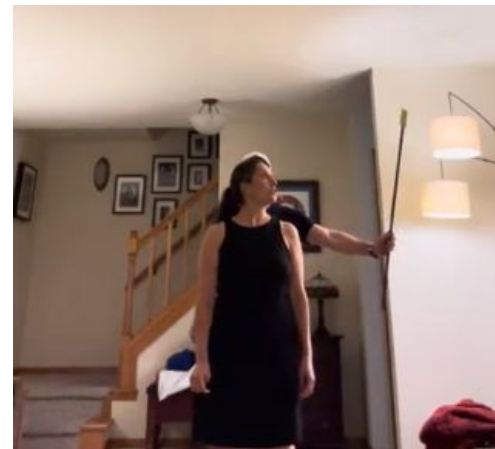


Figure 3: Dynamic visual scanning

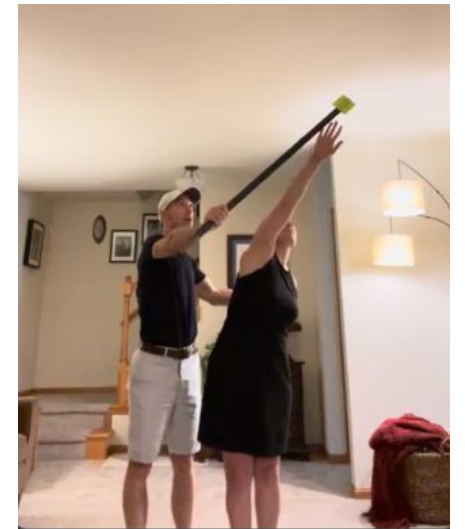


Figure 4: Dynamic scanning and reaching

Background

- Stroke Neglect or Spatial Neglect Syndrome
 - Unawareness of visual, tactile, auditory, or mental stimuli on one side of the body
 - Aphasia - speech difficulty
 - Lack of movement on contralesional side of body - left-side neglect more common [2]
 - Prevalent in 25-80% of stroke survivors [3]
- Dynamic Balance Training
 - Recommended for ALL stroke survivors
 - Improve motor skills, mobility, and range of motion [5]
 - Decrease risk of injury

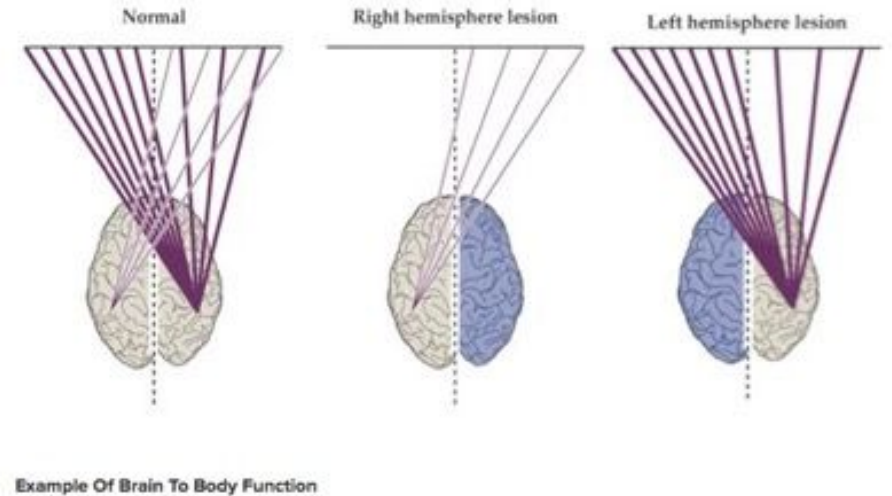


Figure 5: Effects of brain damage from stroke on brain activity by hemisphere [4]

Product Design Specifications

- Adjustable rod length
 - 3 ft max & 2 ft min
- 3" diameter display disk
 - Different colors and symbols
- Can be used with one hand
 - Controls on handle
 - Lanyard
- Measurements on side for functional reach test
- Sanitized after each use

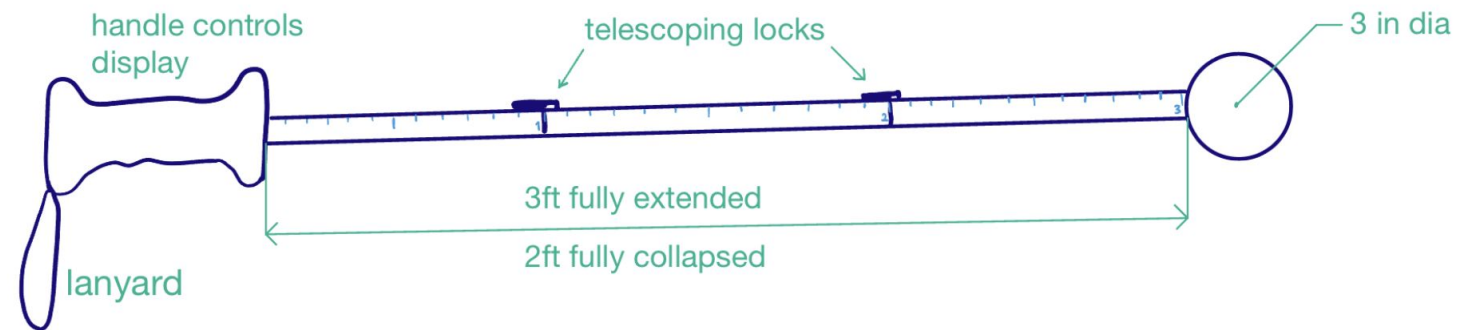


Figure 6: General design of device as per client requests
[drawn by Maggie LaRose]

7-segment display and LED strip lights - Design #1

- LED lights coiled around the 7-segment display
- 2 IR remotes necessary: 1 for LEDs, 1 for display
- 2 battery packs attached to disk
- 7-segment display: 1in x 0.6in
- May pose difficulty for patient to see display given brightness of LEDs
- Arduino compatible
- Display only able to show numbers
- Limited by # of buttons on remote



Figures 7-8: 7-segment display and LED lights [6-7]

LCD Touchscreen Display - Design #2

- Touchscreen eliminates need for remote
- 1.28" diameter display
- Clicker on handle to pair with display for ease of use
- 240x240 resolution
- Most difficult to fabricate due to software complexity
- Arduino and RaspberryPi compatible
- Immense variability in colors (65,000+), numbers, symbols
- Cheapest to fabricate



Figure 9: Waveshare LCD Touchscreen [8]

8x8 LED Matrix - Design #3

- 1 IR Remote paired with 8x8 matrix
- 2 in x 2 in matrix display, 1 battery pack required
- 16 million colors
- Matrix will have pixelated display
- Arduino compatible
- Limited by # of buttons on remote



Figure 10: SparkFun Lumini 8x8 Matrix [9]

Design Matrix: Electronics

Criteria (Weight)	7-segment display and LED string lights (2 IR remotes)		LCD touchscreen display (single button)		8x8 LED matrix (1 IR remote)	
Therapist Usability (Control Complexity and Weight) (25%)	2/5	10%	5/5	25%	4/5	20%
Patient Visibility (25%)	3/5	15%	5/5	25%	4/5	20%
Ease of Fabrication (Software and Hardware Complexity) (20%)	5/5	20%	2/5	8%	4/5	16%
Symbol and Color Variability (20%)	1/5	4%	5/5	20%	5/5	20%
Cost (10%)	3/5	6%	5/5	10%	4/5	8%
Total	55%		88%		84%	

Aluminum Adjustable Rod Model

- Lightweight material
- Easily accessible in telescoping form
- Inexpensive
 - No need for further fabrication
- Fairly resistant to stress
- Minor degradation from stronger cleaners

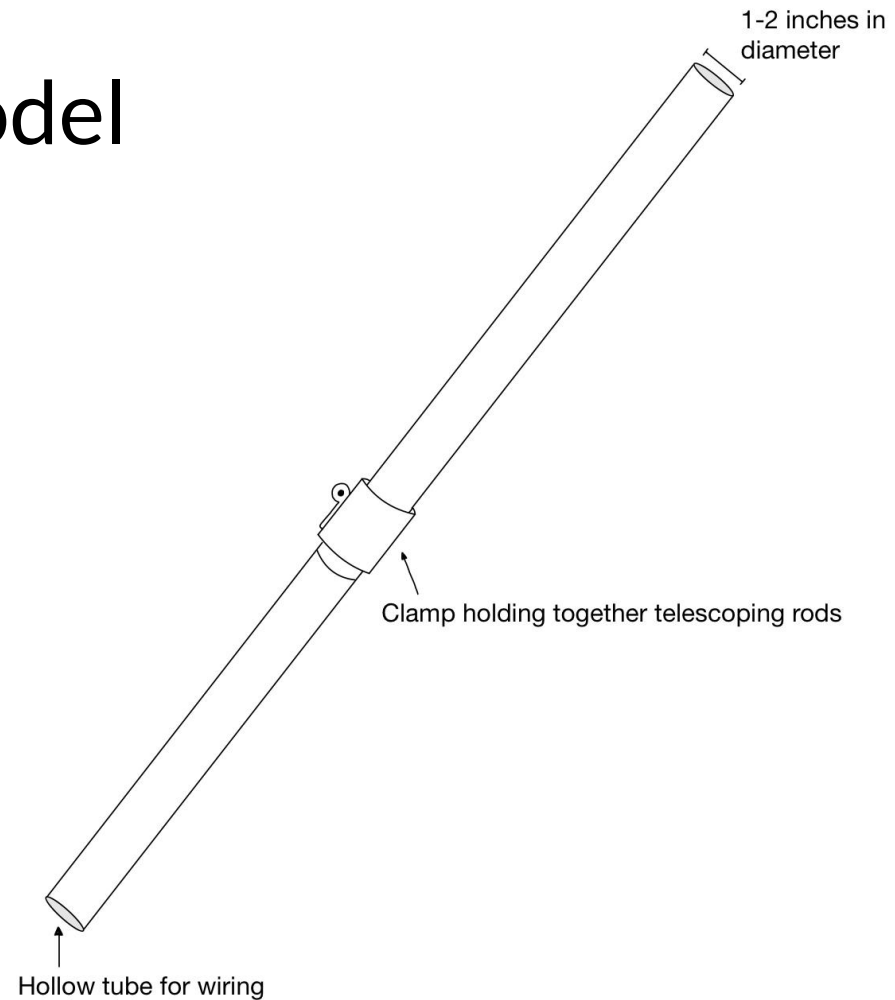


Figure 11 (left): Depiction of telescoping aluminum rod by Sarah Raubenstine



Figure 12 (right): Testrite Aluminum telescoping rod example [10]

Carbon Fiber Adjustable Rod Model

- Very lightweight material
 - especially in relation to tensile strength
- No degradation caused by chemical cleaners
- Extremely durable
- Higher relative cost
- Additional fabrication required for telescoping model

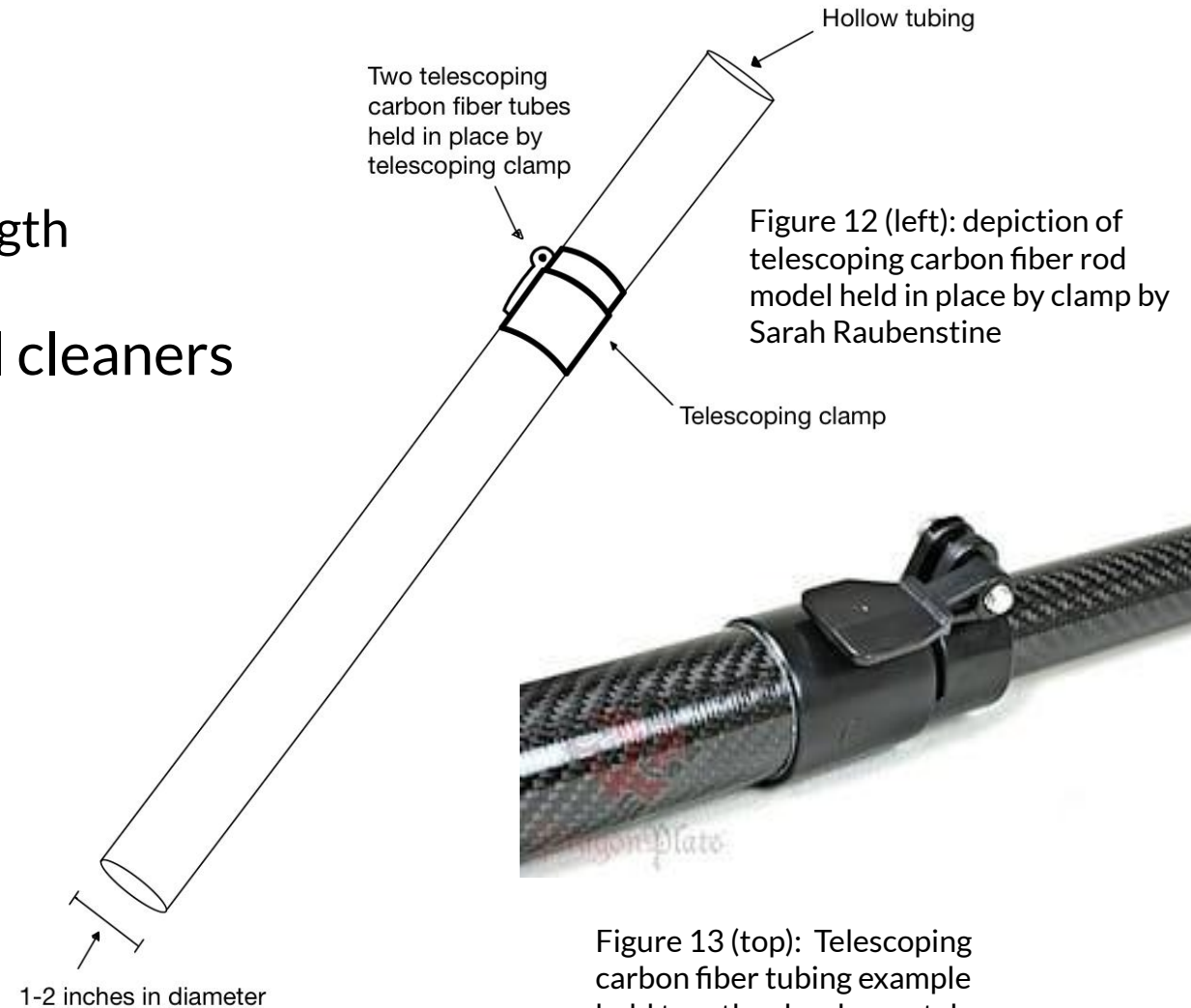


Figure 12 (left): depiction of telescoping carbon fiber rod model held in place by clamp by Sarah Raubenstine

Figure 13 (top): Telescoping carbon fiber tubing example held together by clamp style connectors [11]

PVC Plastic Adjustable Rod Model

- Attach 2 rods in a telescoping manner; more difficult to fabricate
- Very lightweight
- Inexpensive material
- Can break down with consistent cleaning
- Not very rigid

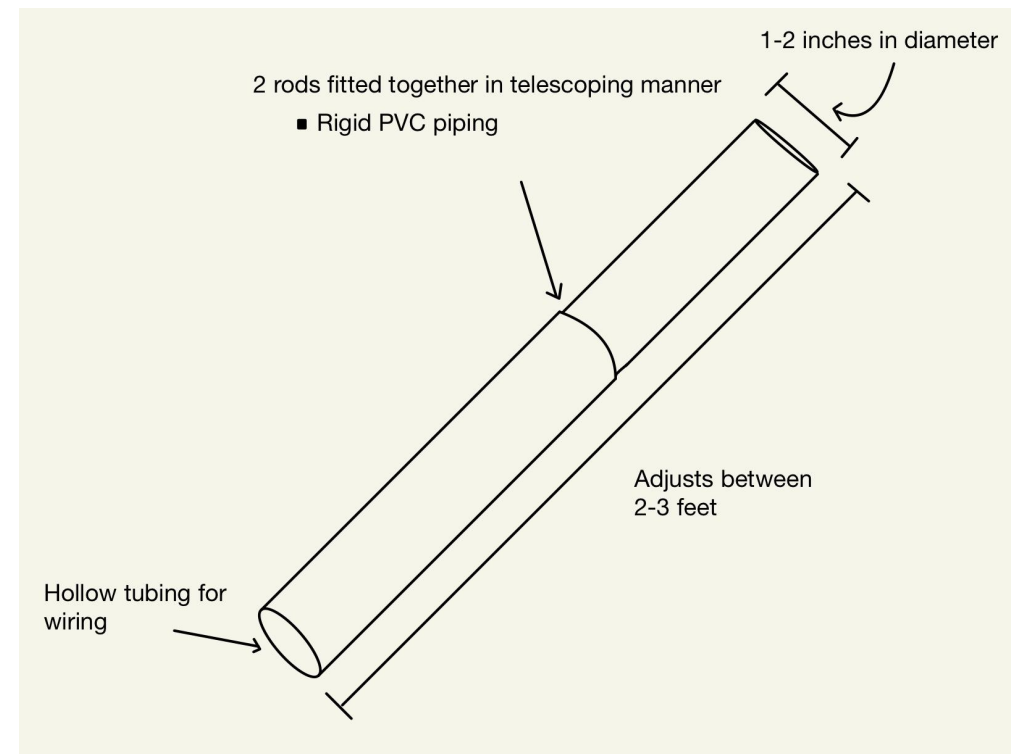





Figure 14 (above): Depiction of telescoping PVC rod drawn by Ella Lang

Figure 15 (above): Technomat Plastic Pipe Line, example of PVC material [12]

Design Matrix: Rod Material

Criteria (Weight)	Aluminum		Carbon Fiber		PVC Plastic	
						
Weight (30%)	3/5	18%	4/5	24%	5/5	30%
Durability/Tensile Strength (25%)	3/5	15%	5/5	25%	2/5	10%
Sterilizability (20%)	3/5	12%	5/5	15%	3/5	12%
Cost (15%)	4/5	12%	2/5	6%	5/5	15%
Ease of Fabrication (10%)	5/5	10%	2/5	4%	2/5	4%
Total	67%		79%		71%	

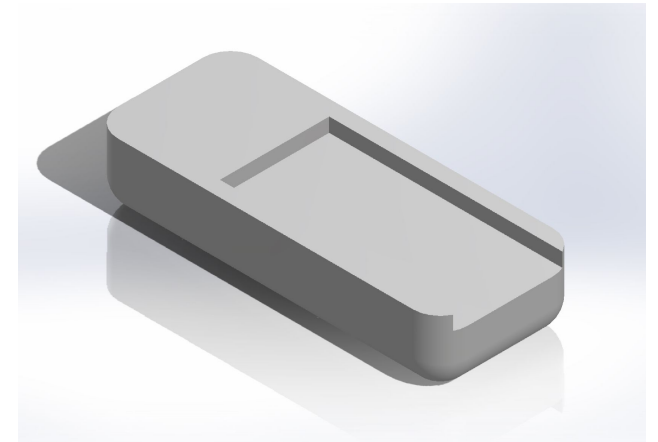
Rod Handle #1 - Remote Control Case

- Most compatible with an IR remote
- Formlabs Flexible 80A resin
- Not ergonomic
- Expensive



Figure 16 (above): Formlabs Flexible 80A resin product example [13]

Figure 17 (below): Remote Control Case SolidWorks drawing by Gianna Inga



Rod Handle #2 - Moldable Hand Grip

- Thermoplastic beads
- Reformable
- Hardening plastic
- Ergonomic



Figure 18 (above): 8 oz bag of thermoplastic beads (\$12.99) [14]



Figure 19 (above): Thermoplastic beads in their different forms [15]

Rod Handle #3 - Ribbed Gym Handle

- Manufactured gym grip
- Vinyl plastic
- Ergonomic
- Sturdy

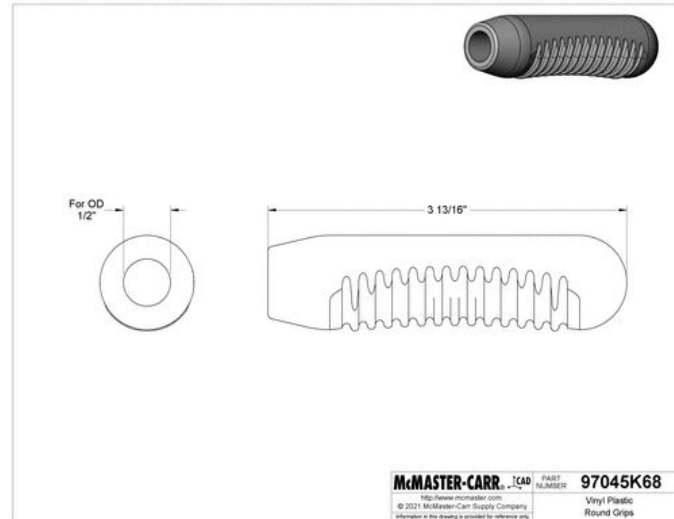
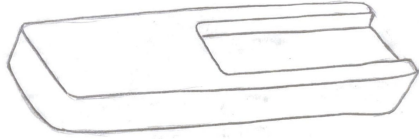




Figure 20: AutoCAD drawing of the product with dimensions [16]

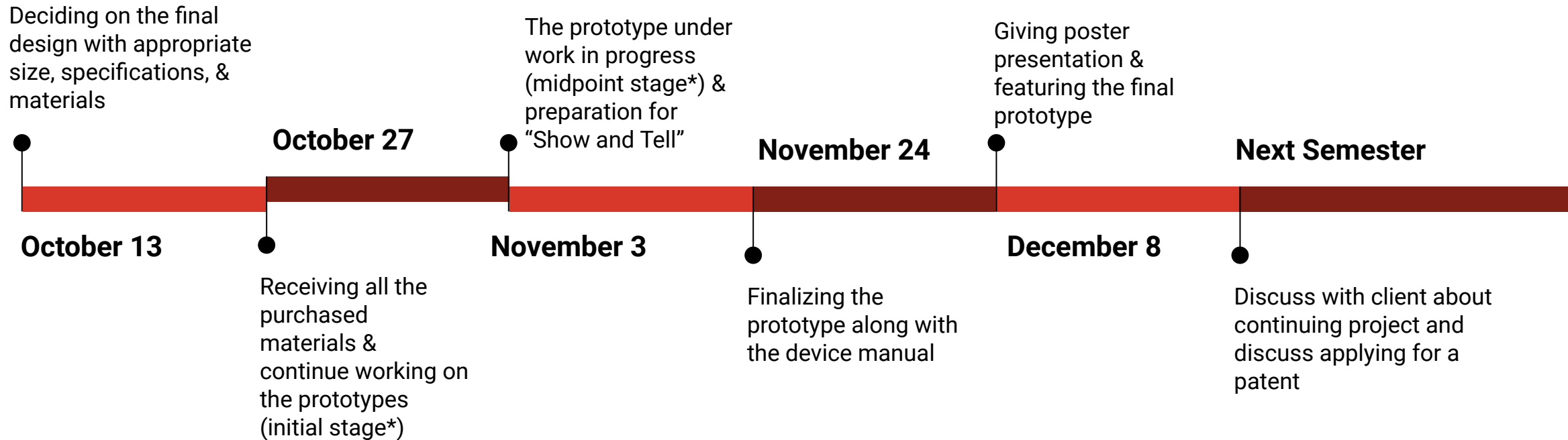


Figure 21: Intended Ribbed Gym Grip [16]

Design Matrix: Handle

Criteria (Weight)	Remote Control Case		Moldable Hand Grip		Ribbed Gym Handle	
						
Grip & Control (35%)	2/5	14%	4/5	28%	4/5	28%
Ease of Fabrication (25%)	3/5	15%	3/5	15%	5/5	25%
Modifiable (20%)	5/5	20%	4/5	16%	2/5	8%
Durability (10%)	3/5	6%	3/5	6%	5/5	10%
Cost (10%)	2/5	4%	4/5	8%	4/5	8%
Total	59%		73%		79%	

Future Plans



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Questions?