DEPARTMENT OF

Biomedical Engineering

UNIVERSITY OF WISCONSIN–MADISON

Grip Strength Assistive Device

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Team Members

Team Members

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Outline

- Problem Statement
- Background
- Product Design Specifications
- Potential Designs
- Design Matrix
- Final Design
- Testing
- Future Work

Speaker: Joey

Problem Statement

- **Task:**
  - Design a grip-strength mechanism that improves the grip function of an adaptive fitness member’s weaker hand.
- **Requirements:**
  - Design aims to strengthen grip for both everyday tasks and workout equipment.
  - Must be easily attached and detached on the user's hand without the need of additional support.
  - Must be easily sanitized for daily usage.
  - Specific to particular client; could be generalized in the future.
  - Display biofeedback.

Figure 1: Active Hands sell a gripping aid that affixes the hand to the gripped object [1].

Speaker: Joey

Background

- Client is a retired mechanical engineer, who has already tried using commercial grip strengthening equipment as well as his own designs
- Hemiplegic: due to a stroke causing weakness or paralysis of one side of the body
- Left Side

Figure 2: Example of previously used commercial trainer [2]

Figure 3: Our client, a member of UW-adaptive fitness [3]

Figure 4: Similar model of what our client has done to solve on their problem on their own [4]

Speaker: Nicholas

Product Design Specifications

- **Performance Requirements:**
  - Improve user's grip strength for hand flexion/extension, aiding stroke recovery.
  - Must be able to be attached and detached without outside assistance
  - Real-time biofeedback for analysis.
  - Target grip strength: >26 kg (standard for weak grip strength) [5].
- **Safety** :
  - Rapid hand release in emergencies.
  - Skin-friendly biomaterial; electronic components follow ISO 10218 [6].
- **Accuracy & Reliability:**
  - Consistent grip on varying-sized objects; accurate biofeedback.
- **Size & Weight:**
  - Adjustable to fit average adult hand size; lightweight to not hinder mobility.

Design 1: Skeleton Glove

Speaker: Nicholas

- **Skeletal Structure:**
  - Rigid plastic sections that mimic the bones of the fingers, allowing natural bending at each knuckle.
- **Silicone Fingers and Fingertips:**
  - User inserts hand into silicone fingers, providing a comfortable fit and flexibility.
- **Thread and Motor System:**
  - Synthetic threads run beneath the silicone fingers, connected to a motor in the wrist, allowing the glove to mimic the user's grip.
- **Locking Switch:**
  - A switch located on the back of the hand enables the user to lock the grip in place.
- **Rechargeable Battery:**
  - The motor is powered by a rechargeable battery, allowing for continuous use.

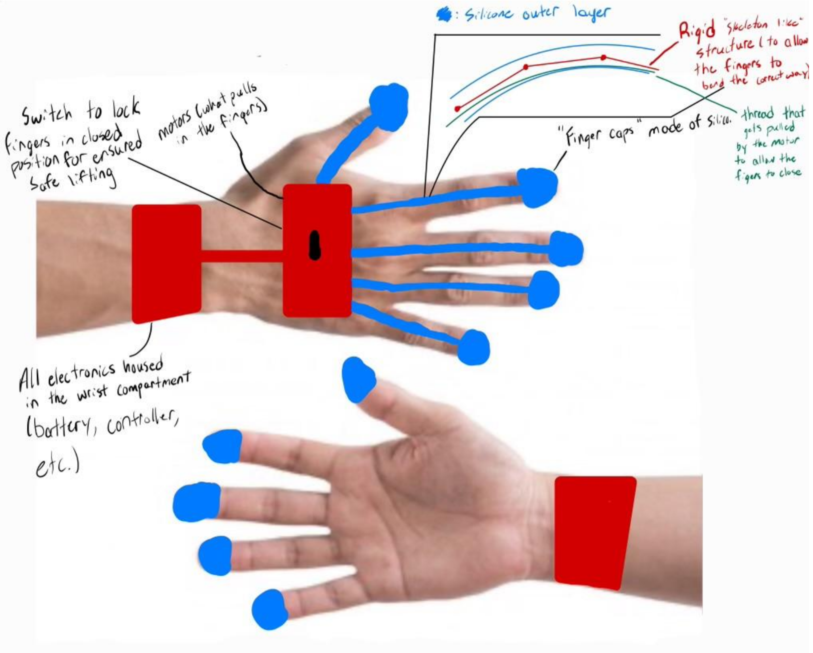

Figure 5: Design Sketch of Skeleton Glove

Speaker: Simon

Design 2: Palm Glove

- **Motor-Assisted Grip**
  - Motor system with wire cables on the palm side
  - Cables contract for gripping and loosen for finger extension.
- **Material & Design**
  - Palm covered in moisture-wicking nylon with grippy circles (similar to anti-slip socks).
  - Velcro strips near knuckles and wrist for easy fastening with the opposite hand.
- **Sensors**
  - Fingertip sensors detect grip or release intent.
- **Discreet & Secure**
  - Emphasis on a secure grip while maintaining maximal discreteness.

Figure 6: Design Sketch of Hand Palm Design

Design 3: Electromagnetic Assistor

Speaker: Simon

- **Electromagnetic Assistance**
  - Embedded electromagnets in finger joints and palm
  - Magnets attract for grip or repel to assist motions
- **EMG Sensors**
  - EMG sensors monitor muscle activity to control the strength and timing of the EM forces
  - Provides adaptive assistance
- **User Control & Electronics**
  - Electronics housed on the wrist with a switch to control gripping/releasing.
  - Powered by rechargeable battery.
- **Ease of Use**
  - Slips on/off using a wrist zipper for easy wear.
- **Feedback & Functionality**
  - Focus on both gripping and extending fingers with real-time user feedback.

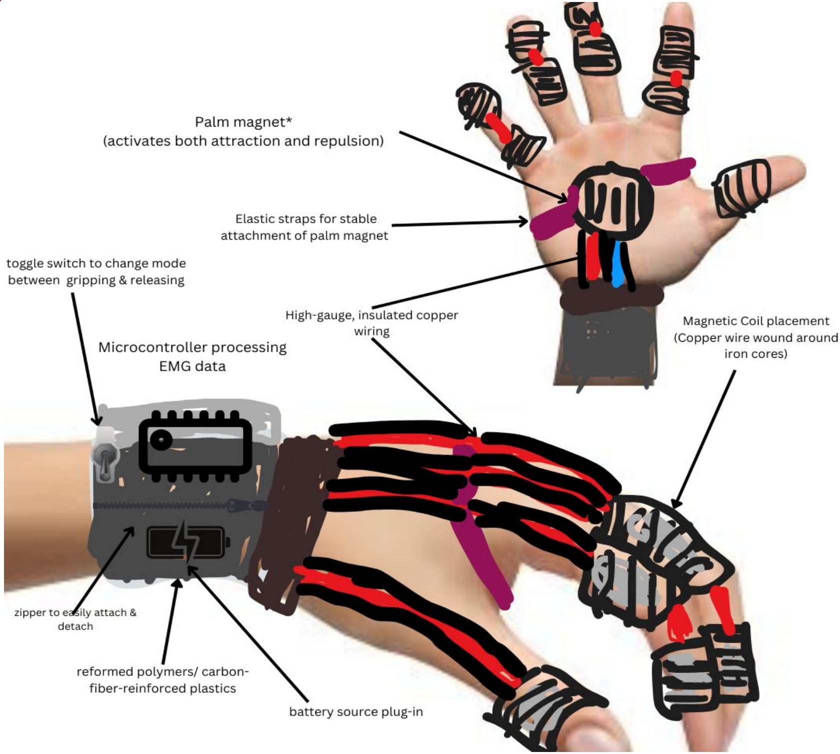

Figure 7: Design Sketch of Electromagnetic Grip Assistor

Speaker: Sarah

Design Matrix

Criteria (Weight)	Design 1: Skeleton Glove		Design 2: Palm Glove		Design 3: Electromagnetic Grip Assistor	
Effectiveness (25)	4/5	20	3/5	15	4/5	20
Safety (20)	5/5	20	5/5	20	3/5	12
Variety of Use (20)	4/5	16	2/5	8	4/5	16
Unassisted Use (15)	4/5	12	5/5	15	3/5	9
Sterilizability (10)	5/5	10	3/5	6	3/5	6
Cost (5)	4/5	4	4/5	4	2/5	2
Discreteness (5)	3/5	3	5/5	5	2/5	2
Total (100)	85		73		67	

Table 1: Design Matrix

Speaker: Sarah

Final Design

Dimensions for Average Male Hand [7]:
Across Palm: 8.5-9.5 in
Wrist Size: 7.1-8.7 in
Distance from Wrist to Tip of Middle Finger: 7.7-11.0 in

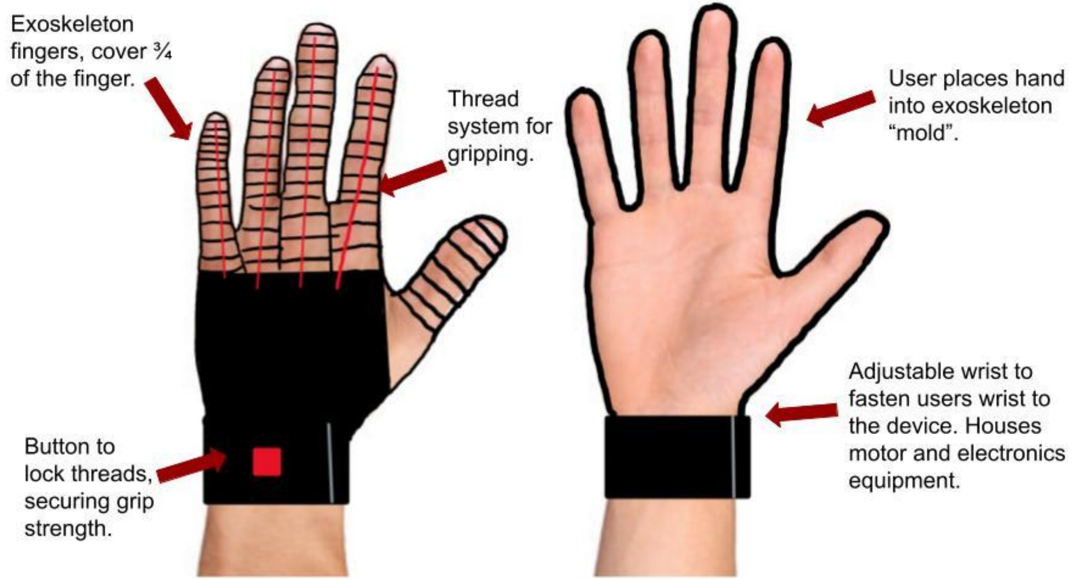

Figure 8: Final Design Drawing.

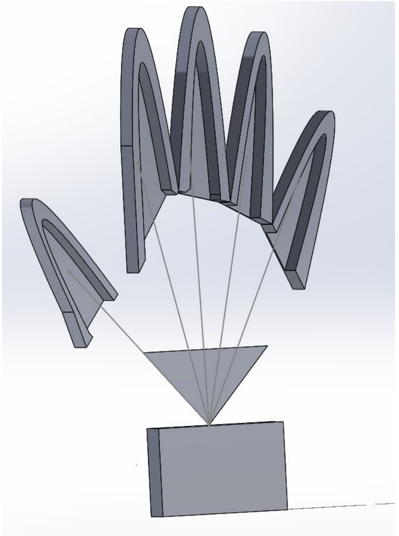

Figure 9: SolidWorks Design (Initial sketch)

Speaker: Owen

Testing

- Measure grip strength progression using hand dynamometer.
- Sample of students will attempt to put on the device using only their dominant hand.
- Observe client performing everyday tasks and exercise activities with and without device.
- Survey feedback for the client to evaluate the device

Figure 10: Hand dynamometer used to measure grip strength [8].

Future Work

Speaker: Owen

- Narrow down material options and decide what specific biomaterials are needed.
- Finalize budget and funding with client.
- Create a detailed fabrication plan.
- Acquire necessary materials and tools
- Begin fabrication on the device.
- Incorporate real-time biofeedback for future semester

Acknowledgements

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References

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