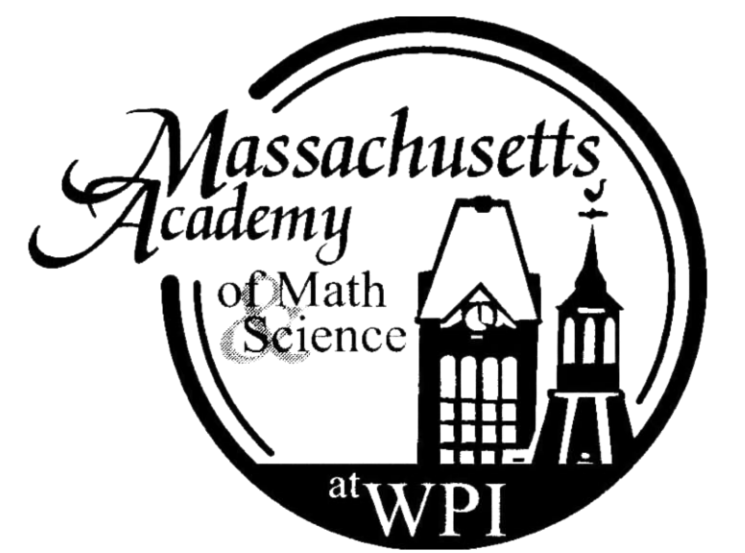


KinetiStep

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 Advisor: Kevin Crowthers, Ph.D.



Problem Statement

Osteoarthritis (OA) is a condition where **cartilage** in **joints** breaks down, and causes bones to rub together, causing pain. People with knee OA struggle with increased pain while traversing **stairs** compared to walking on flat ground.

Engineering Goal

Improve mobility for individuals with Knee Osteoarthritis, particularly during stair navigation.

Methodology

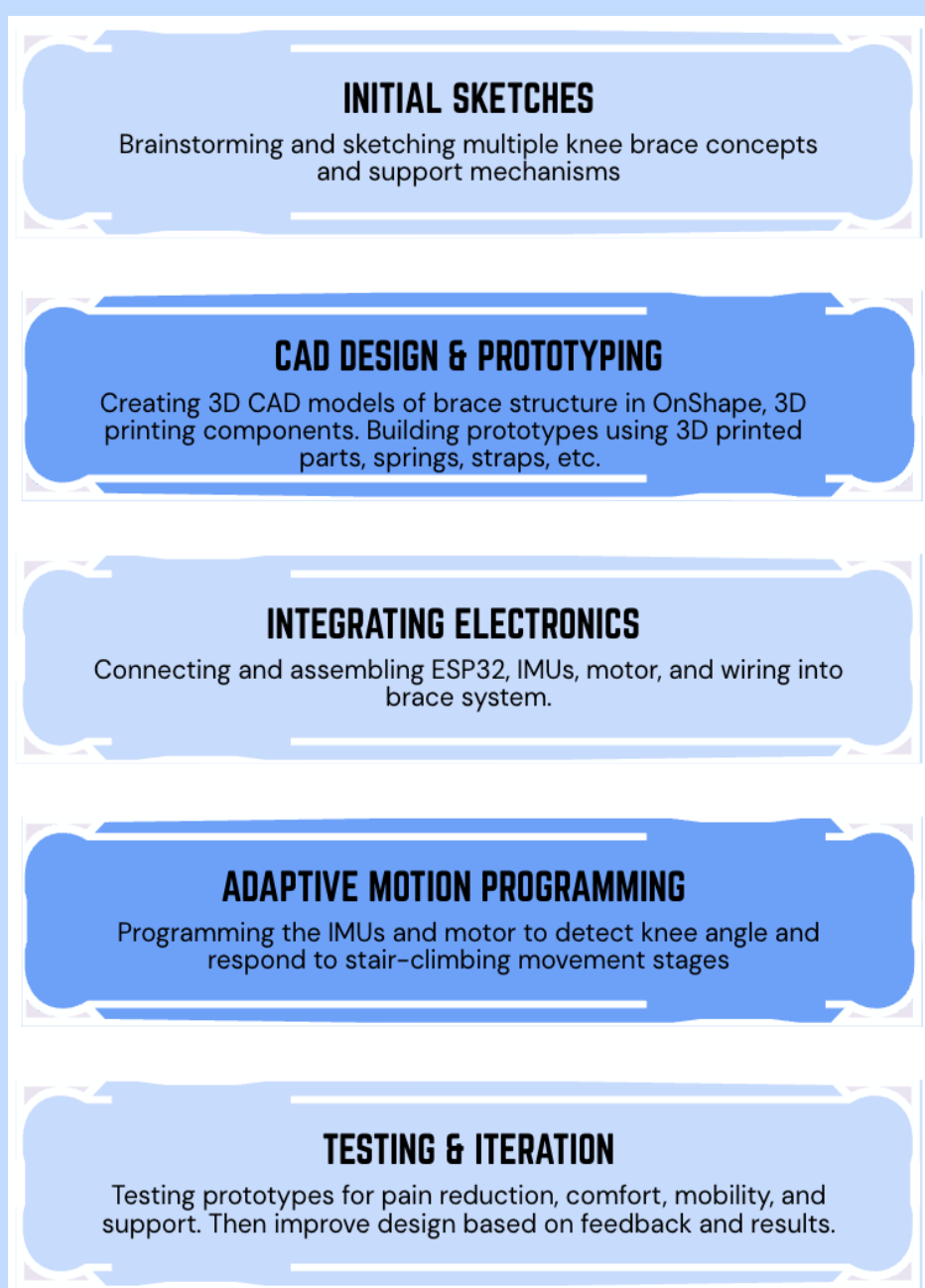


Figure 1: Methodology Flowchart

Requirements

| Physical | Level | Requirement | Torsion Spring Brace | Linear Exoskeleton | Adaptive angle brace |
|------------|-------|--|----------------------|--------------------|----------------------|
| Functional | 1 | The device shall reduce pain by at least 10% | Yes | Yes | Yes |
| | 1 | The device shall reduce knee collapse (valgus motion) under load by at least 10% | Yes | Yes | Yes |
| | 1 | The device shall allow the user to have at least 120 degrees of mobility | Yes | Yes | Yes |
| | 2 | The device shall reduce the force required for knee extension by at least 10% | Yes | No | Yes |
| Physical | 1 | The device shall be rated as comfortable during 10 minutes of use | Yes | Yes | Maybe |
| | 2 | The device shall be able to be put on in under 1 minute independently | Yes | Yes | Yes |
| | 2 | The device shall weigh less than 5 lbs. | Yes | Yes | Yes |
| | 2 | The device shall be durable | Yes | Yes | Yes |
| | 3 | The device shall have an adjustable fit | Yes | Yes | Yes |

Table 1: Requirements Table (Functional and Physical)

Current Design

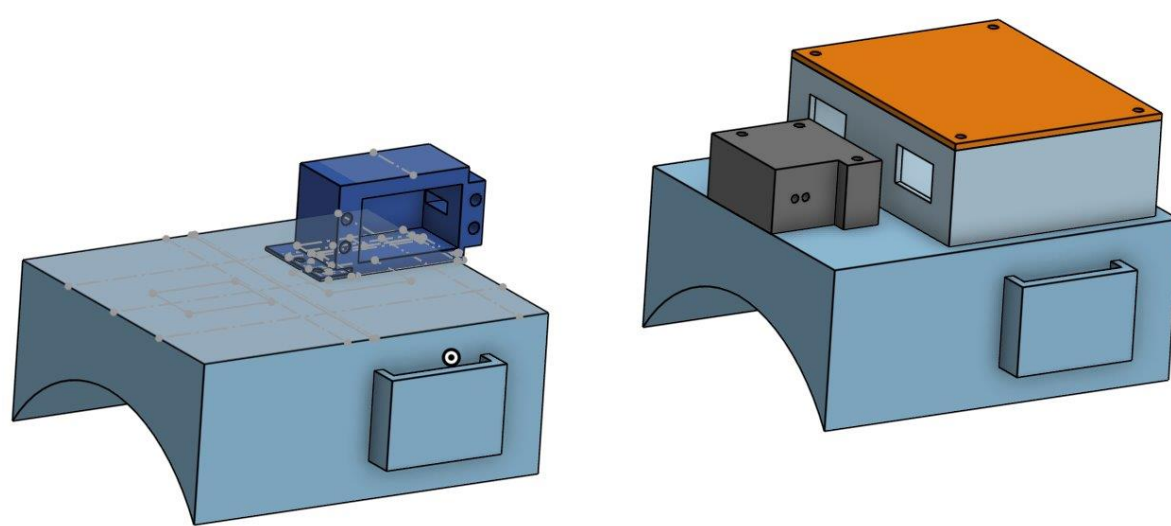


Figure 2: Image of Final CAD Model for Prototype

Current Design:
 An adaptive angle knee brace that uses an IMU to calculate the current angle of the knee, and identify what stage of stair navigation the knee is currently in.

3 Designs

Design #1: Pneumatic Knee Brace

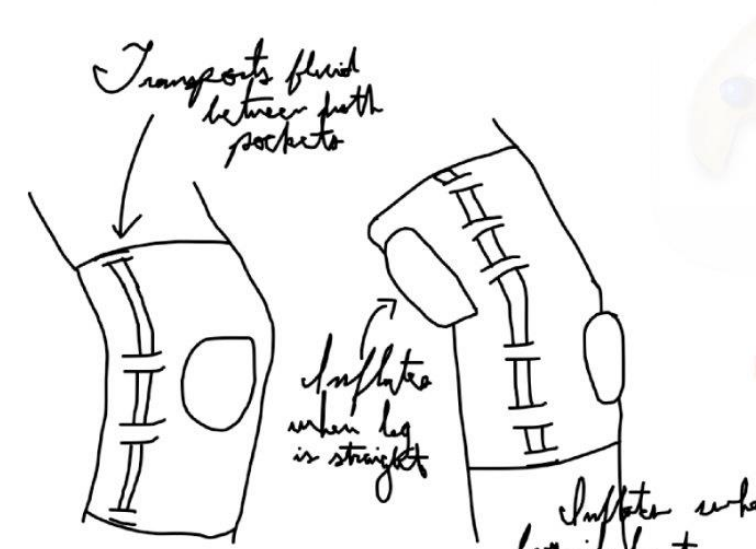


Figure 3: Image of Sketch of Design 1

Design #2: Linear Exoskeleton



Figure 4: Image of Sketch of Design 2

Design #3: Torsion Spring Brace

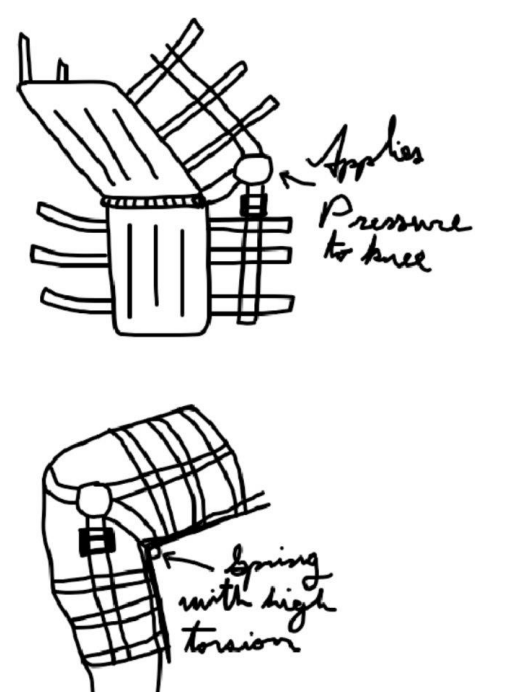


Figure 5: Image of Sketch of Design 3

Design Studies & Testing Results

Study 1:

Evaluate pain reduction with device use

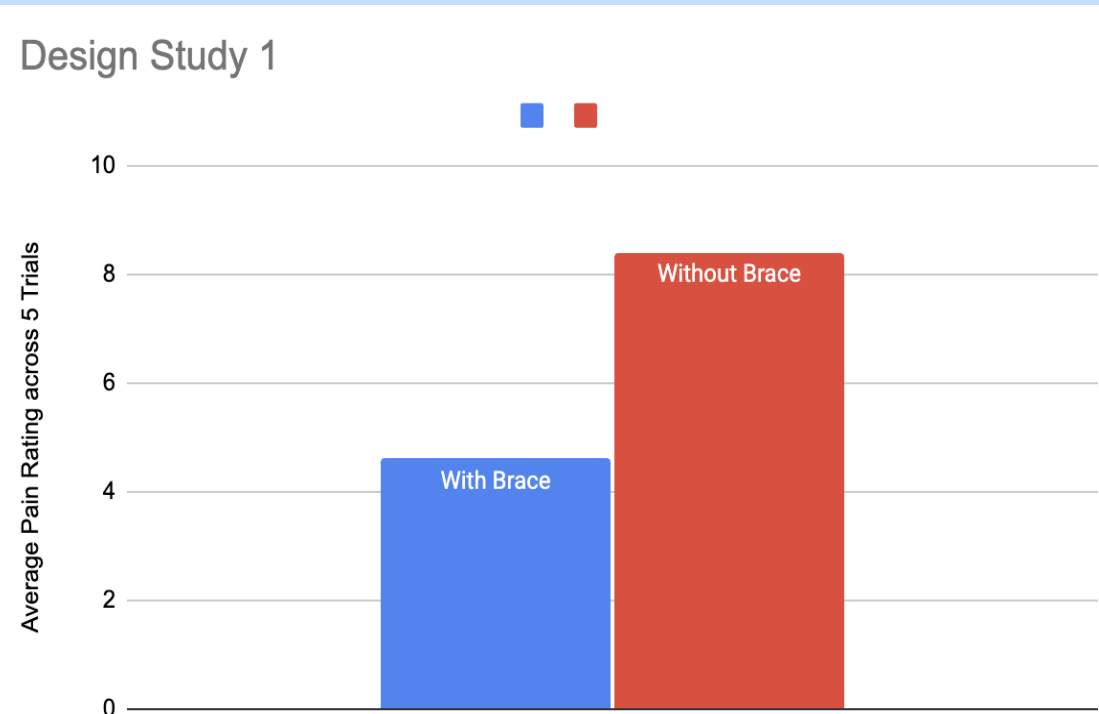


Figure 6: Bar chart comparing average pain rating with brace and without brace for 5 trials. The average pain rating with brace is 4.6 which is a 46% reduction from the average of 8.4 without the brace, showing that our Level 1 criteria was satisfied.

Study 2:

Evaluate knee collapse reduction under load

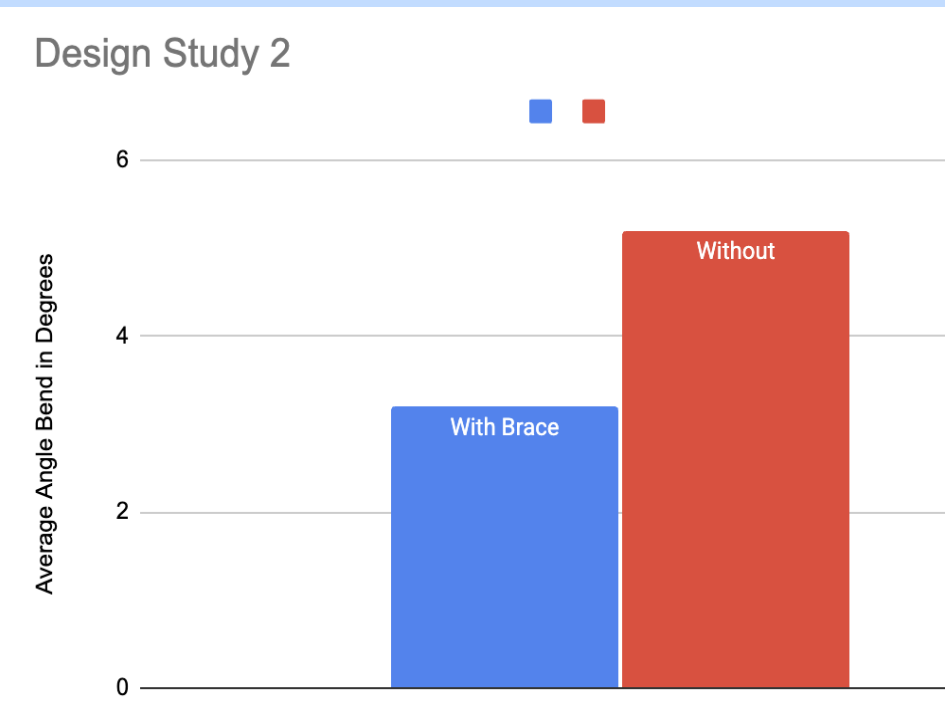


Figure 7: This graph shows the difference in the average angle bend in Degrees with brace or without brace. The angle is 180 – the actual bend allowing us to focus on the change caused by the brace. The average angle bend with brace is 3.2 which is a 39% reduction from the average angle bend of 5.2 without the brace, showing success for the Level 1 criteria.

Study 3:

Evaluate knee mobility range with device

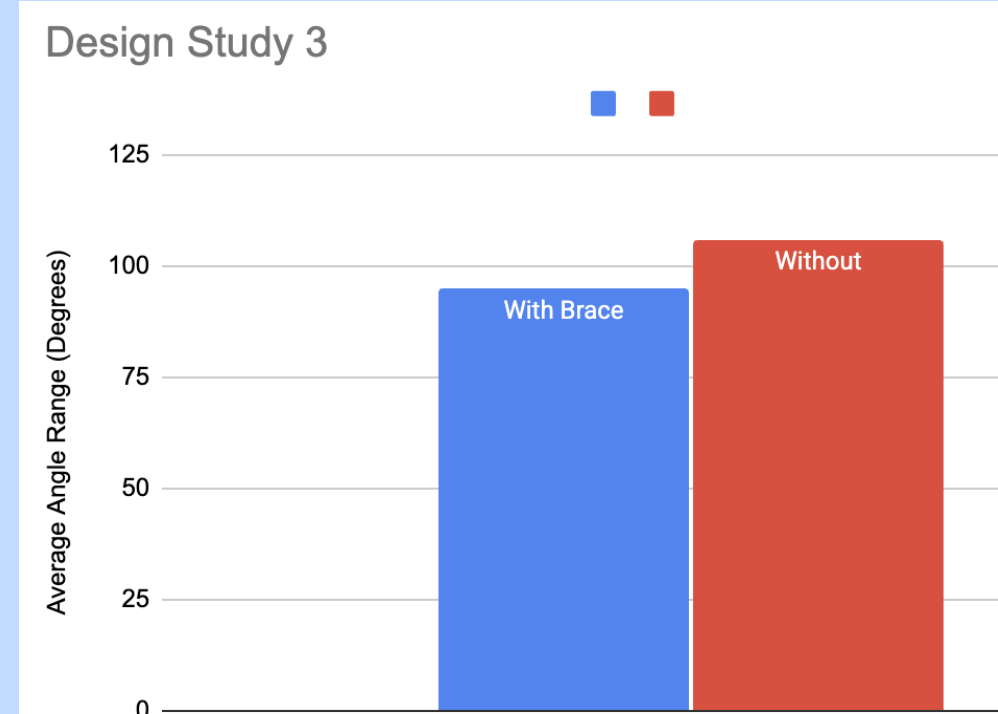


Figure 8: This graph shows the average angle extension the client can do with brace and without brace. The average bend with brace is 95 degrees, which is less than our goal for Level 1, showing that more work can be done to improve the mobility.

Study 4:

Evaluate comfortability of device

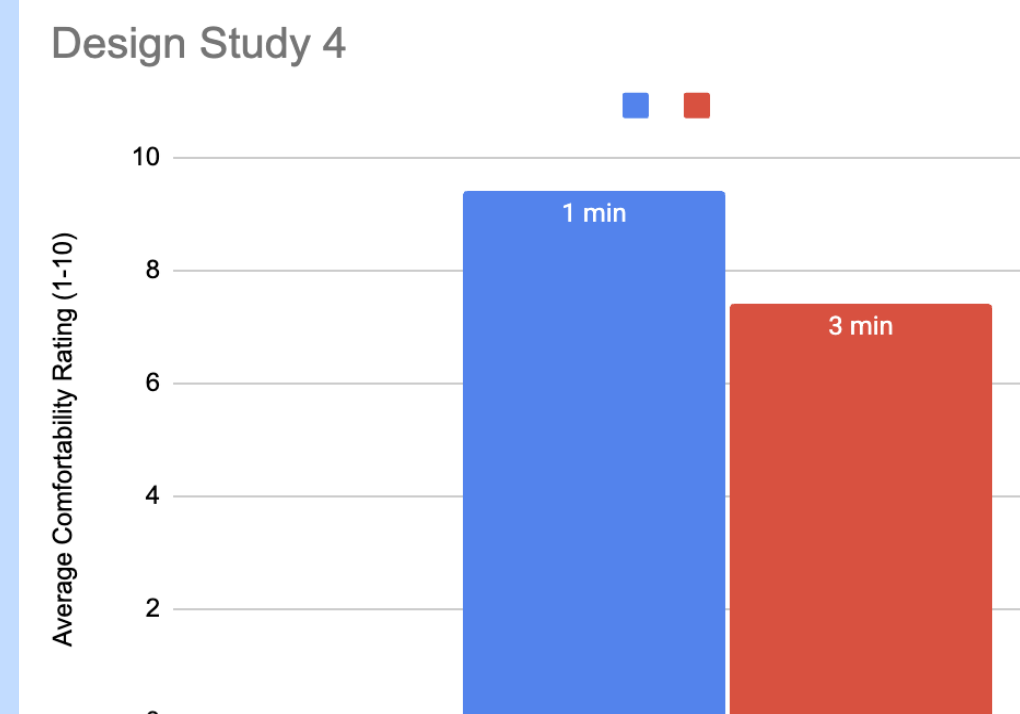


Figure 9: This graph shows the average comfortability rating from 5 participants after wearing brace for 1 minute and 3 minutes. Although 3 minutes is 21% less than 1 minute, both have above 50% comfortability rating, showing success for our Level 1 criteria.

Conclusions & Future Work

- Created a knee brace that allows users with knee osteoarthritis to traverse stairs and reduce pain.
- This allows for more accessibility and mobility for those with osteoarthritis to navigate everyday environments.
- Improve design adding additional spring or elastic to add further resistance
- Add shock absorption to reduce pain further
- Change material of brace to test additional comfort